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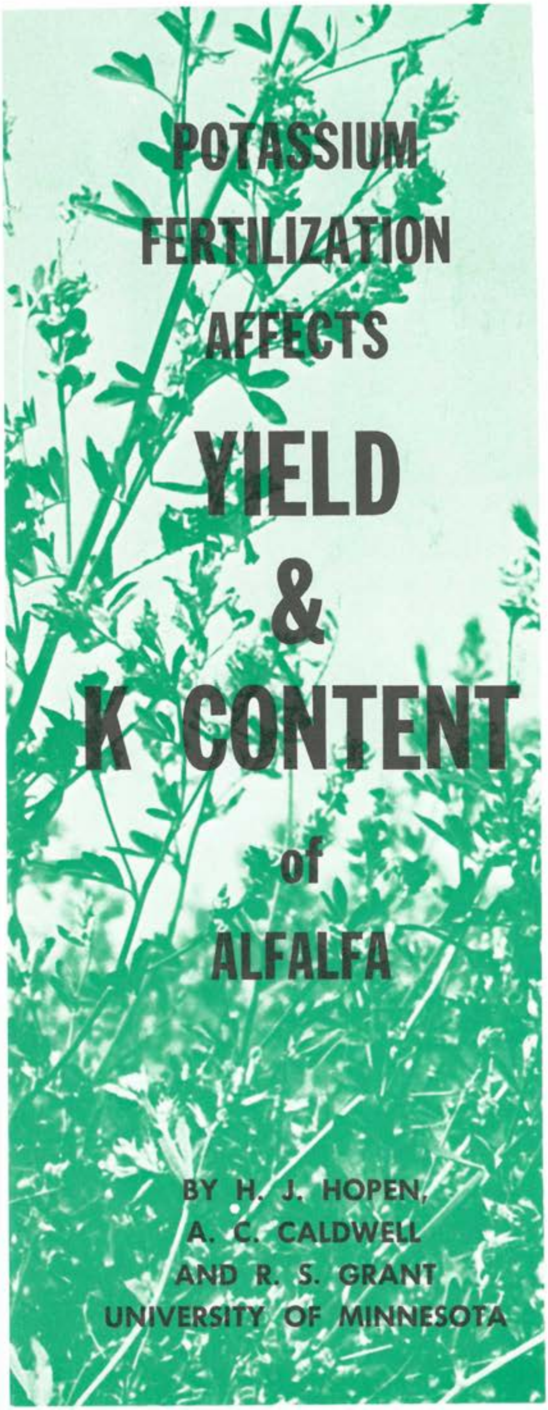


POTASSIUM FERTILIZATION AFFECTS YIELD & K CONTENT of ALFALFA

BY H. J. HOPEN, A. C. CALDWELL AND R. S. GRANT
UNIVERSITY OF MINNESOTA

Why have farmers in northeastern Minnesota had a hard time establishing and maintaining alfalfa stands?

Soils in eastern and northeastern Minnesota are acidic and low in native soil potassium. Alfalfa seeded on UNlimed and UNfertilized soil shows these typical potash hunger symptoms: stunting with typical white spots and browning, leading to winterkill and uneconomic yields.

A trial was established at Duluth in 1960 to determine the effect of 0, 100, 200, 400, and 800 lbs. potash (K_2O) per acre on alfalfa growth. All plots received 125 lbs. phosphorus (P) per acre. The fertilizer treatments were broadcast and plowed down in the fall and alfalfa was planted with a small grain nurse crop in 1961.

Soil tests in 1963 and 1964 showed soil phosphorus medium to high in all plots. Boron was applied to the entire experimental area in 1962. And in 1963, 200 lbs. K_2O per acre was applied as a split-plot topdressing to one half of the 100 lbs., 200 lbs., and 400 lbs. per acre treatments.

To determine how K fertilization affected alfalfa growth, this study used (1) **hay yields** in 1962, '63, and '64, (2) **tissue K content** in 1962, '63, and '64, and (3) the **exchangeable soil K** in 1963 and '64. And here is what happened.

1 YIELD OF FORAGE

As the amount of fertilizer K was increased, the yield increased. Yield was more than doubled in 1964 in spite of a June and July drought. The yields were low of course, *but the benefits of fertilization are more apparent in an adverse season!*

The authors express appreciation to Dr. D. E. Baker, Pennsylvania State University Agronomy Department, for his help in planning this study while at Minnesota.

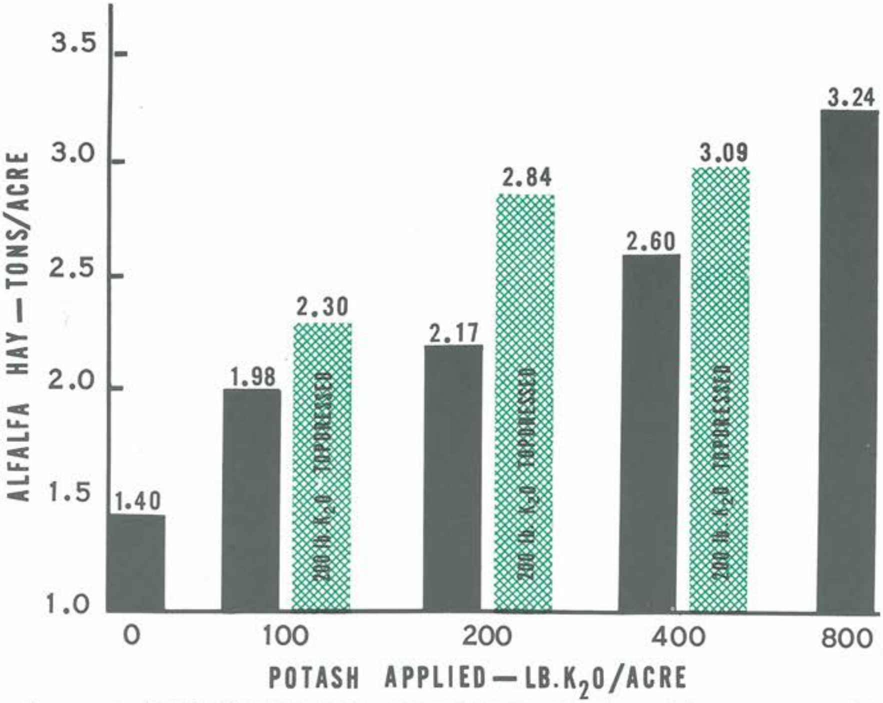


Figure 1—HOW INITIAL AND TOPDRESSED K affected three cuttings following topdressing.

An initial application of 200 lbs. K_2O/A increased yields significantly over the no-K treatment in all three years. As more than 200 lbs. K_2O/A was applied, the yield increase per unit of added K decreased. The 400 lbs. K_2O treatment did not consistently result in higher yields than the 200 lbs. treatment over the three year period—but was helpful in the adverse 1964 growing season.

Farmers aiming at four or more tons forage per acre might wisely apply 400 lbs. K_2O/A at seeding and topdress with additional K later in the rotation. The 800 pounds K_2O/A appears to be more than is needed as one application.

With muriate of potash (0-0-60) costing $55 per ton, an 800 lb. K_2O/A application would be $36/A. The 400 lb., 200 lb., and 100 lb. applications of K_2O would require $18, $9, and $4.50 per acre respectively.

With alfalfa hay selling at $25 per ton, a mere ⅓ ton per acre increase pays for 200 lbs. K_2O per acre with 0-0-60 retailing at $55 per ton. In this study, the smallest yield increase from 200 pounds K_2O/A was ⅓ ton per year.

A potash topdressing increased 1963 yields above those of the initial application. Topdressing 200 lbs. K_2O/A after the first harvest in 1963 increased yields in the second harvest of 1963. The 400 lbs. K_2O applied in 1960 plus 200 lbs. K_2O in 1963 gave about the same yield as the 800 lb. application in both 1963 and 1964. From these results, a split application, part at seeding and part as a topdressing, seems to be the most economical use of K fertilization.

2 POTASSIUM CONTENT OF ALFALFA

As the level of applied K increased, the K of the alfalfa increased. The topdressing following the first cutting in 1963 increased the K content of the second cutting of alfalfa. Tissue K levels were greater from topdressed than from non-topdressed areas in both harvests of 1964. The low K content

TABLE 1.—HOW SINGLE K APPLICATION BOOSTED FORAGE YIELDS (2 Crops Per Year)

Lbs. of K_2O Applied per Acre Fall 1960	Tons/Acre 1962	Tons/Acre 1963	Tons/Acre 1964	Average Annual Yield	Relative* Yield
0	2.71	2.37	1.05	2.04	1.00
100	3.14	3.03	1.67	2.62	1.28
200	3.54	3.69	1.85	3.02	1.48
400	3.42	3.89	2.15	3.16	1.54
800	3.55	4.27	2.45	3.42	1.67

* Yield at treatment level ÷ yield at 0# K_2O/A = Relative Yield.

TABLE 2.—HOW APPLICATION RATE, ANNUAL YIELD, AND K CONTENT OF ALFALFA INFLUENCED POTASH REMOVAL

K_2O Applied Fall 1960	Average Yield (Table 1)	Average K Content (Figure 2)	Average K_2O Removed Yearly
Lbs./A	Tons/A/Yr.	%	Lbs./A/Yr.
0	2.04	1.00	49
100	2.62	1.40	88
200	3.02	1.44	104
400	3.16	1.78	136
800	3.42	2.33	191

TABLE 3.—POUNDS EXCHANGEABLE K AT SEVERAL SOIL DEPTHS, 1963 and 1964.

Lbs. of K_2O Plowed Down in 1960	K_2O* Topdressed in 1963	Exchangeable K–Lb./A. Fall of 1963 0–6 in.	Exchangeable K–Lb./A. Fall of 1964 0–3 in.	Exchangeable K–Lb./A. Fall of 1964 3–6 in.
Lb./A.	Lb./A.			
0		70	67	73
100		80	—	—
100	200	140	—	—
200		83	83	77
200	200	146	133	120
400		106	90	83
400	200	246	207	203
800		203	—	—

* After first harvest in 1963.

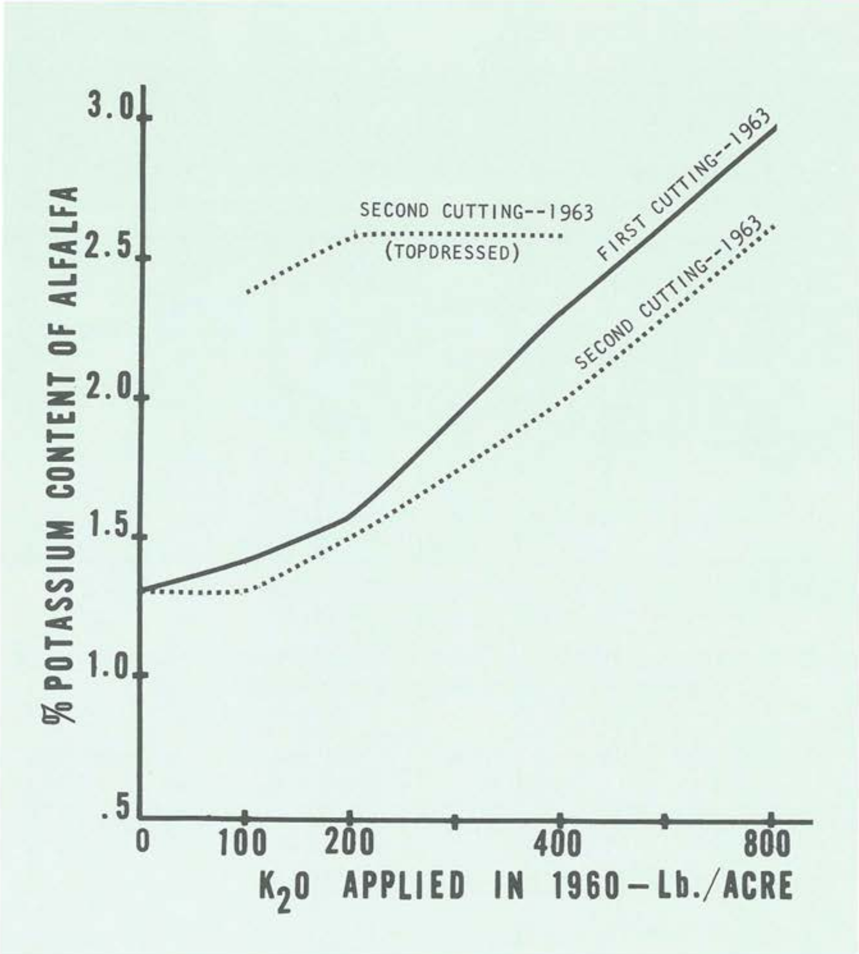


Figure 2-SHOWS PER CENT K IN FIRST AND SECOND CUTTING alfalfa tissue at 0, 100(+200), 200(+200), 400(+200) and 800 lbs. K_2O/A. (FOR 1963)

of 1964 was probably due to dry periods during the fall of 1963 and mid-season 1964.

Tissue K content levels were used in this study to evaluate the uptake and utilization of the applied K. To keep K content at the desired level of 2.0 to 2.25% in this study, a minimum of 400 lbs. K_2O/A should be applied at seeding plus an annual topdressing. As higher yields are produced, more K is removed from the soil (Table 2).

3 EXCHANGEABLE POTASSIUM CONTENT OF SOIL

Exchangeable K increased as fertilizer K levels were increased. In the falls of 1963 and 1964, the check plot, the 100, and the 200 lbs. K_2O/A applications contained essentially the same amount of exchangeable K. So, without additional K, the 200 lbs. K_2O/A applications were not adequate for forage production on this soil within two years of seeding.

Exchangeable K with 400 and 800 lbs. K_2O treatments was not depleted so much that it declined below applications levels.

Topdressing 200 lbs. K_2O/A in summer 1963 nearly doubled the exchangeable K levels compared to non-topdressed plots the same fall. The 400 lbs. treatment with top-

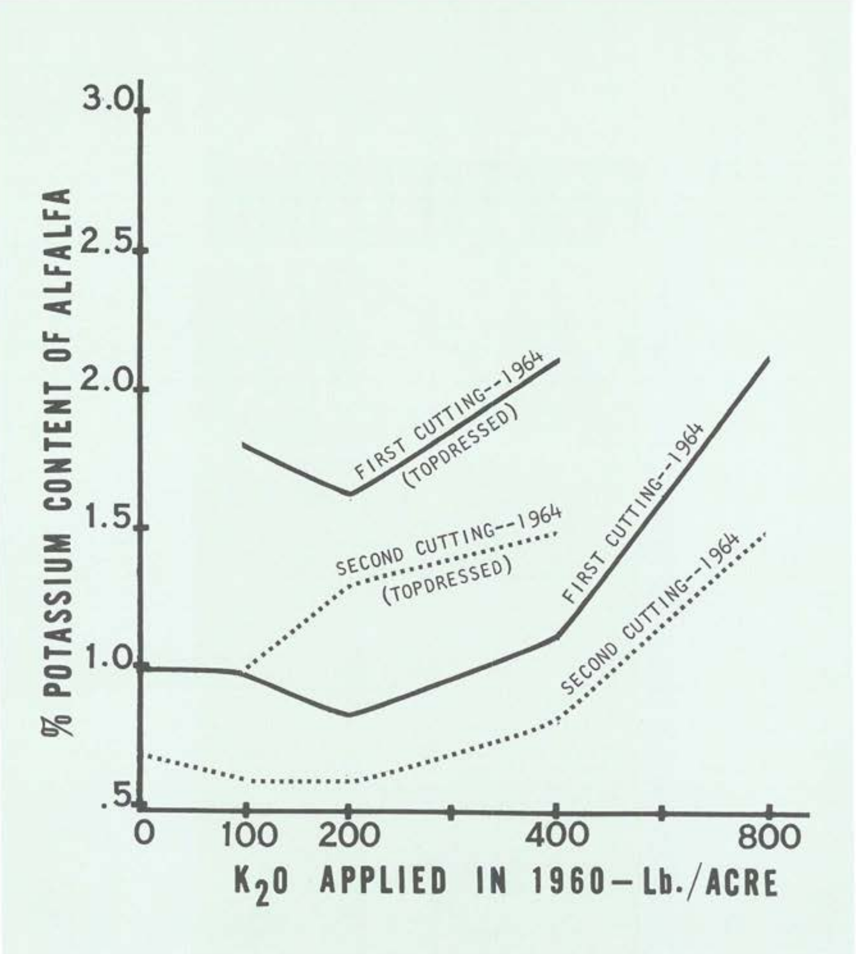


Figure 3—SHOWS PER CENT K IN FIRST AND SECOND CUTTING alfalfa tissue at 0, 100(+200), 200(+200), 400(+200), and 800 lbs. K_2O/A. (FOR 1964)

dressing contained twice as much exchangeable K as the single 400 lbs./A K_2O treatment.

Topdressing 200 lbs. K_2O/A in 1963 had nearly equal amounts of exchangeable K in the 0-3 and 3-6 inch depth when sampled in the fall of 1964. This indicates that although it may be more desirable to incorporate fertilizer elements at seeding time, there is appreciable movement of topdressed K on such loam soil. Two factors verify the usage of the topdressed K: (1) increased K content of the tissue and (2) yield increases from topdressing.

IN SUMMARY

The 100 lbs. K_2O/A at seeding time gave greater yield than the check plot. But typical K hunger symptoms were often evident on this 100 lbs. K_2O treatment.

The 200 lbs. K_2O/A at seeding consistently gave significantly greater yields than the check plot. And no K hunger symptoms were evident to the eye, at least, when 200 lbs. K_2O/A or more was used.

Winterkilling of alfalfa declined when 200 lbs. K_2O or more was topdressed at least once in the 4-year rotation. THE END

FERTILIZING

MAIZE

BY DR. K. W. von BURKERSRODA
International Potash Institute, Berne, Switzerland
Agricultural Mission To Central Africa

In **WORLD CROPS** Magazine
London

Although it appears that maize was firmly entrenched in Central Africa long before the turn of the century, it was mainly due to the rapidly increasing African population that maize became an important crop in Rhodesia.

It is the staple diet of the Africans, upon whom not only European farmers but industry and commerce in general rely for their labour supply.

Maize is also the main livestock feed, being fed as grain, silage and, with urea and molasses, as cob meal. About 75 per cent of the maize marketed comes from European farms and 25 per cent from sales of African producers. The average yield per acre of the African peasant

A STUDY IN EFFICIENCY

. . . Where national yield per acre of maize has more than doubled during the last decade and now compares very favourably with that of any maize growing country in the world. Much of this can be attributed to the very efficient use of fertiliser, consumption of which nearly trebled during the same period. By examining the Rhodesian achievement, one may appreciate the possibilities of effective fertiliser use in other parts of Africa.

in RHODESIA

farmer is considerably smaller than that of the European, although the extensive services provided by the Government are available to both, irrespective of race.

The African farmers, however, are at the present time not in the position to make full use of these facilities as most of them have first to acquire the knowledge of the basic principles underlying modern field husbandry. This article, therefore, deals with the European maize production, in which striking results have been achieved in the recent past.

INCREASE IN POST-WAR YIELDS

The period since the last war, and more particularly the last decade, has witnessed a number of important changes in the production of maize which are reflected in the yields obtained. On European-owned farms in Rhodesia the average yield failed to reach 1,500 lb an acre (= 1,680 kg./ha.) in any pre-war season. Since 1955, the average yield has excessed 2,200 lb/acre (= 2,460 kg./ha.) on six occasions, reaching the record yield of nearly 3,000 lb/acre (= 3,260 kg./ha.) in 1961.

This result, in which also yields of areas with less favourable climatic conditions are included, compares very favourably with any maize growing country in the world. It may well be surpassed in the near future as more farmers adopt the most up-to-date practices.

During the first decade after the war the local crop failed to meet the slowly increasing internal demand, and it became necessary to import maize annually at a price far above that fixed for the locally produced crop. In consequence the producer price was arranged so that it provided an incentive to farmers to increase production up to the level of self-sufficiency.

This policy, together with the adoption of approved methods of production as a result of research, has changed the picture completely and Rhodesia is now exporting considerable quantities of white dent maize annually, and will probably also export yellow maize in the not too distant future.

The most important development in maize production responsible for the significant increases in yield—particularly during the last decade—has been the use of double and single hybrids instead of open-pollinated varieties, the adoption of higher plant populations, earlier planting, an improvement in pest control and in fertiliser practices, together with radical changes in methods of maintaining soil fertility.

VARIETIES

Most striking has been the availability of locally bred hybrid seed since 1950, and the continuous increase in the percentage of land planted to hybrids, which accounts for over 90 per cent of the total present maize acreage. Apart from the aim of producing varieties of a high yield potential, which always receives primary consideration in breeding, attention has also been given in Rhodesia to other characteristics such as resistance to lodging and to diseases, such as leaf blight (*Helminthosporium turcicum*), *Diplodia* and *Fusarium* ear rots.

To date 13 double hybrids have been successfully developed, but many of these have become redundant as improved varieties became available. The general increase in yield brought about by the change from open-pollinated to double hybrid seed is approximately 25 per cent, as proved by comparative data from experiments.

The recent marketing of single hybrids for commercial planting will revolutionise maize production in the near future because their yields are superior to those obtained from double hybrids. Put to large acreage production under practical farm conditions, these single hybrids have in some cases yielded 10,000 lb grain per acre (= 11,200 kg./ha.).

FERTILISER RESEARCH AND RECOMMENDATIONS

The other most important single factor responsible for the high yields has been the striking increase in the use of fertilisers, particularly of nitrogen, as a result of soil fertility investigations and fertiliser research. The facilities offered to the farmers for having their soils chemically analysed have improved substantially, and the extensive use farmers are making of these facilities has placed fertiliser use on a new and far more satisfactory basis.

This is reflected in the number of soil samples analysed annually for advisory purposes, which more than doubled during the last ten years. Recommendations are based on soil analysis procedures specially developed during the last decade for Rhodesian conditions and correlated with the results of accurate fertiliser experiments at the various research stations. It is, therefore, possible today to assess the fertility of individual lands with a fair measure of accuracy within the limits imposed by climatic variations, and to recommend fertiliser applications adapted to plant populations, varieties, rotations, etc., which greatly increase maize yields as economically as possible.

Under Rhodesian conditions, the plant nutrients removed from a double hybrid crop of 5,000 lb/acre (= 5,600 kg./ha.) grain and approximately the same weight of stover—a yield which is frequently obtained under favourable conditions—amount to 90 lb N, 40 lb P_2O_5 and 70 lb K_2O, a ratio of about 100:45:80.

PHOSPHATE

The necessity for corrective applications of phosphate to soils known to be deficient in this nutrient, or for the purpose of maintaining the phosphate status in the soil at an adequate level, has long been appreciated. For a considerable time in the past farmers have been accustomed to applying regular applications of phosphate to maize, corresponding to 20-40 lb P_2O_5 per acre.

NITROGEN

Up to about 1951, nitrogen was applied to maize at planting time and only in the form of fertiliser mixtures such as 3-13-8 or 2-12-3, generally up to about 200 lb per acre. Therefore, the plants had to rely mainly on the mineral nitrogen from the soil for their supply, and on the amount released from green manures such as sunhemp (*Crotalaria juncea*) and velvet beans which, when well grown, provide as much as 100 lb of available nitrogen per acre for the following maize crop.

The ploughing-under of such leguminous green manures was a regular practice for many years, and the amount of nitrogen released by them was normally sufficient to cater for the relatively low yield of open-pollinated maize varieties. However, during the last decade fertiliser nitrogen consumption has nearly trebled, largely as the result of experiments which have revealed spectacular responses to nitrogen coupled with the release of locally bred double hybrids.

Today the average nitrogen application to maize in the higher rainfall areas is estimated to be approximately 80 lb N per acre. Normally a yield increase of 200-400 lb maize can be expected from every 10 lb N applied, depending upon weather, and other conditions.

DECLINE OF GREEN MANURING

The rapid increase in the use of nitrogen fertilisers has brought a notable reduction in the acreage planted to green manures, which dropped during the last decade by nearly two-thirds, primarily because there is no cash return from land in the year the green crop is grown.

Consequently the old system has been replaced to a large extent by a monocultural one. Maize stover, previously removed and fed to livestock or even burned on the lands, is now normally ploughed under with the addition of some nitrogen, frequently after some browsing by cattle. This not only adds organic matter to the soil but also returns a certain amount of nutrients.

According to experimental data, the return of the stover, whether browsed or not, will increase maize yields by approximately 300 lb per acre in comparison with lands where the stover has been removed. It may be expected that over the years this increase in yields will be even greater, due to a cumulative effect.

Nevertheless critical trials indicate that not all the beneficial effects of a leguminous green manure can be obtained by the mere substitution of fertiliser, and the benefits of rotating maize with other cash crops—*eg* soya beans and ground nuts—will certainly be more appreciated with any future decline in the price of maize.

TIMING OF NITROGEN APPLICATION

Over most of the last decade farmers applied a large proportion of nitrogen in the form of a top-dressing—when the maize was approximately knee-high—because it was thought that the response was greater in comparison with applications at planting. However, later results disproved this theory; in general, on heavy soils, it is unimportant whether the nitrogen is applied all at planting or partly at planting and partly as a top-dressing, fluctuations in response being due to the variations in seasonal weather conditions.

On heavier-textured soils as predominate in the main maize belts it is becoming increasingly popular now to plough all the nitrogen fertiliser under together with the stover and certain fertiliser mixtures. On sandy soils, however, where serious leaching is more likely, part of the nitrogen is still applied as a top-dressing, six weeks after planting.

POTASH

The continuous increase in intensification of land use, the rising yields per acre and the extensive use of nitrogen and phosphate have had a widespread effect on the soils of the Rhodesian maize belts. Apart from increasing acidity many of the older maize lands have suffered losses of available potassium and some have already become critically depleted, notably soils of inherently low potash reserves which have been heavily cropped without receiving replenishment in the form of manure, stover or potassic fertiliser.

Rhodesian agricultural chemists and farmers now consider the use of potash fertiliser—either for corrective or for maintenance purposes—as an important part of the maize fertiliser programme, unless the soil is known to be rich in available potassium. The importance which is attributed to potassium appears to be substantiated by the rising consumption of muriate of potash for maize which increased more than twice during the last five years, whilst the acreage under maize increased by only 9 per cent during the same period.

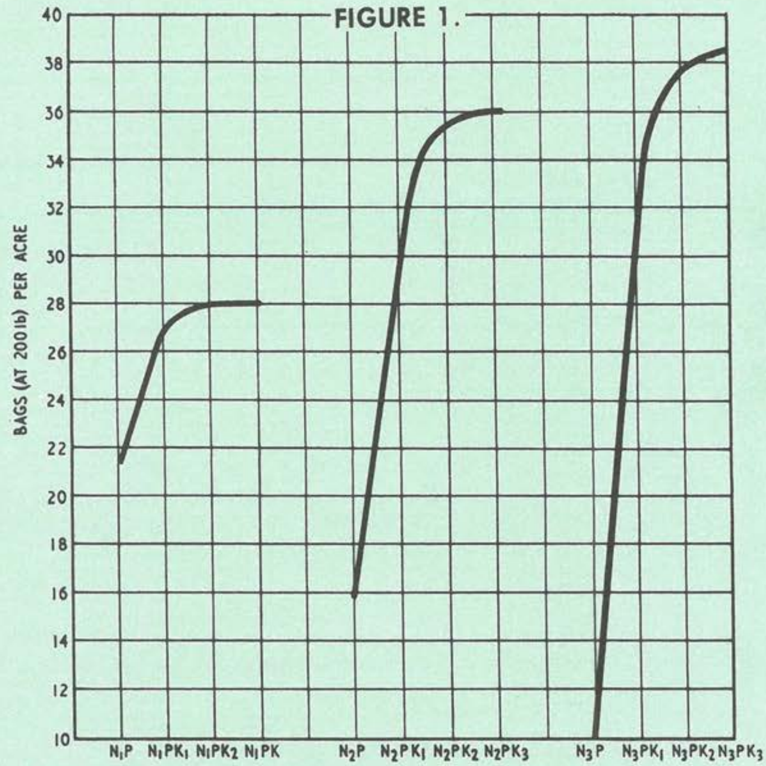
The large effect potassium may have on yield can be seen from experiments carried out on potassium-deficient soils as shown, for instance, in Fig. 1. Though considerable response due to nitrogen applications was observed, without potash application nitrogen fertiliser decreased the yields, whereas with higher potash dressings nitrogen raised the yields.

Although this experiment admittedly represents a more extreme case it is, nevertheless, a demonstration of what the end-result of failing to maintain the potash-status in the soil may be.

Maximum response to nitrogen fertilisers can only be obtained if phosphate and potash are available in sufficient quantities. This also emphasises the necessity of well-balanced NPK fertilisers. Therefore nowadays fertiliser compounds of the formula 8-16-8 or 9-12-9 at the rate of 300-400 lb per acre are commonly used, apart from additional straight nitrogen fertilisers and where more potash is required additional muriate of potash at the rate of 50-100 lb per acre.

Recently, on soils with an 'adequate' potash status (that is, soils on which no response to applied potash is expected), the Ministry of Agriculture recommended 'maintenance' potash applications of approximately 20-30 lb K_2O per ace.

In addition to the main effect of



Yield increases with rising nitrogen and potash applications (N : K interactions). Nitrogen potash fertiliser experiment with Rhodesian double hybrid 11, third season. Umsweswe Intensive Conservation Area.
Fertiliser levels applied:

N_1 = 40lb N per acre	K_1 = 30lb K_2O per acre
N_2 = 80lb N per acre	K_2 = 60lb K_2O per acre
N_3 = 120lb N per acre	K_3 = 120lb K_2O per acre

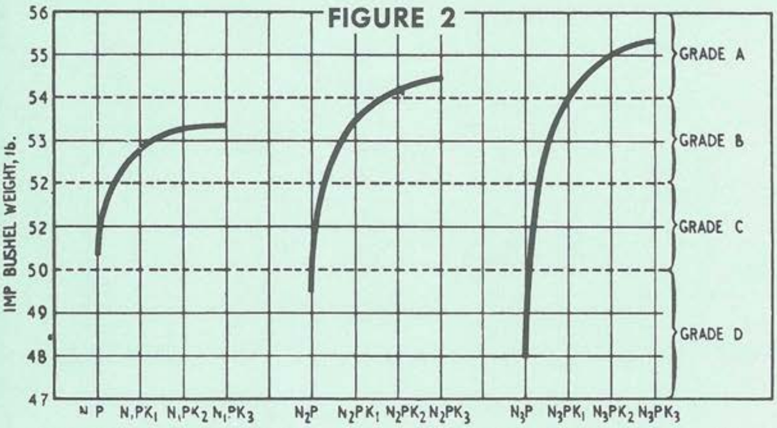
P = 60lb P_2O_5 per acre

potash applications on yield at least two easily detectable side effects are discernible. The quality of the grain plays an important part in the sales of maize. These are governed by strict acceptance regulations stipulating various criteria which finally may greatly influence the cash return for the producer.

One of those more important is the bushel weight, on which certain minimum limits are imposed for each grade. The beneficial effect of potash and nitrogen applications on a potash-deficient soil in raising the bushel weight and the interaction between potash and nitrogen are shown in Fig. 2.

It is further important that maize plants should remain standing, as 'lodging' results in small cobs which become easy prey to termites, apart from the fact that lodged plants are particularly difficult to reap. The extent to which the 'standability' may be influenced by potash and nitrogen applications on a potash-deficient soil is revealed in Fig. 3.

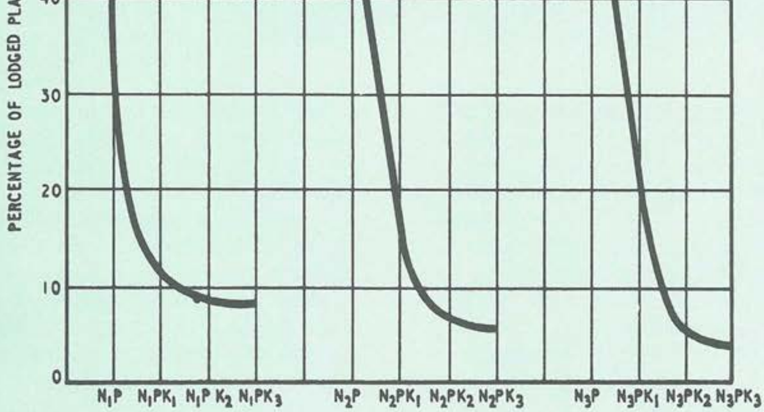
FIGURE 2



Increase in bushel weight due to rising potash applications (N : K interactions). Nitrogen-potash fertiliser experiment with Rhodesian double hybrid 11, third season. The fertiliser levels are the same as in Fig. 1. Umful Intensive Conservation Area

Lodging of maize plants decreases with rising potash applications (N : K interactions). Nitrogen-potash experiment with Rhodesian double hybrid 13, fourth season. The fertiliser levels are the same as in Fig. 1. Marodzi-Toitagura Intensive Conservation Area

FIGURE 3



LIME

The use of lime was, in the past, almost completely neglected in Rhodesia with results that tended to become serious, particularly in the higher rainfall areas. Earlier results from liming trials were in general disappointing, and it was, therefore, concluded that lime was rarely required.

However, with the rapid intensification of maize cultivation, a progressive increase in acidity became apparent. This resulted from losses of basic soil minerals, mainly through leaching and partly through greater crop removal. This process was greatly speeded up where heavier dressings of sulphate of ammonia were continuously used—and this form of nitrogen was the most popular until about five years ago.

Decreased microbiological activity and an occasional build-up in the soil of toxic quantities of manganese or aluminium are associated with such an increase in acidity.

Now, based on new research findings, much publicity is given to the use of agricultural lime and farmers are becoming increasingly conscious of lime, as they are already of fertilisers.

MINOR AND TRACE ELEMENTS

Magnesium deficiency is not a common problem, certainly not in the main maize belts. It is sometimes encountered in cultivated sandy soils but corrective applications of dolomitic limestone normally take care of this.

Zinc deficiency, although occurring in isolated instances, has not been of any consequence. Where treatment is indicated zinc sulphate, row-applied or broadcast before planting, is recommended.

Toxicities of nickel and chromium occur occasionally in isolated pockets on soils derived from serpentine. Sulphur is not yet likely to be in short supply; however, with increasing use of fertilisers containing no sulphate it may eventually become a problem.

FUTURE DEVELOPMENT

In the whole history of Rhodesian maize cultivation, no such great achievement has been accomplished as in the last decade, during which the national yield of non-irrigated maize has been more than doubled. Fertiliser consumption has increased proportionately during the same period.

As 90 per cent of the total maize acreage has already been put under locally-bred hybrid seed, and further, as it has been proved that the latest Rhodesian single hybrid yields up to 10,000 lb white dent grain per acre (= 11,200 kg./ha.) under favourable farming conditions, it appears likely that the Rhodesian national yield might soon become the highest in the world.

Due to the fact that higher-yielding varieties must be fertilised more heavily, investigations concerning how fertiliser can be used more efficiently will have to continue. Comparatively few data on the effect of weed competition and on the control of soil pests are available. The control of both could well lead to further increases in yield. Breeding work is in progress in order to develop yellow hybrids as there is a demand for yellow maize (of a higher carotene content) for stock-feed.

The enormous progress made by Rhodesia in the production of maize is surely symbolic of the tremendous potential which lies ahead for many other parts of Africa.

THE END

Winter Meeting
AIDS
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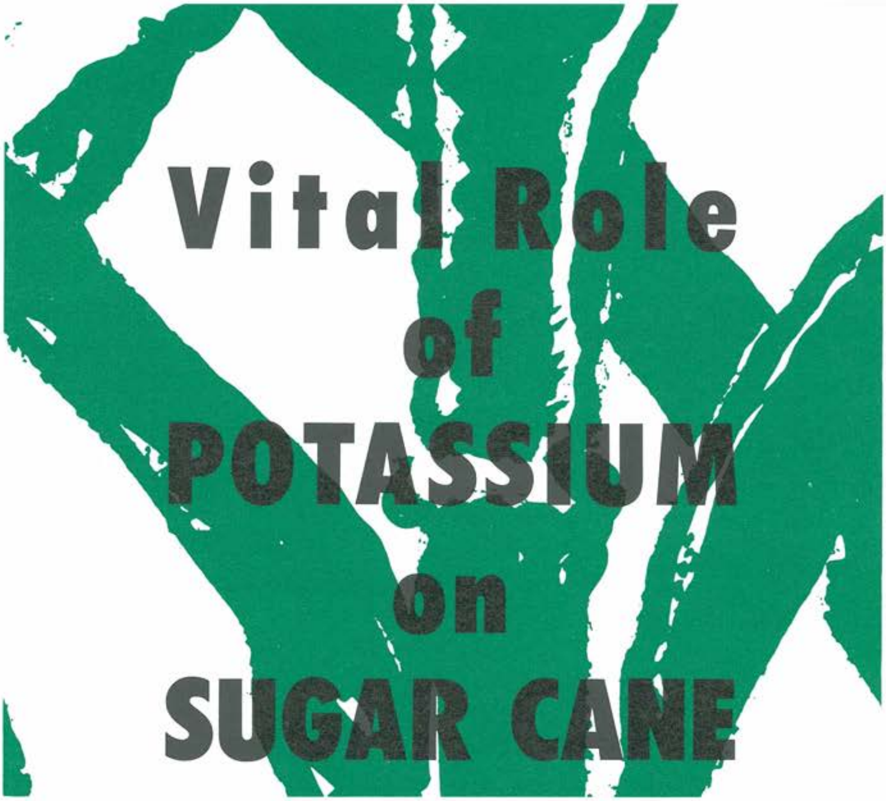
Vital Role of POTASSIUM on SUGAR CANE



BY
RAY RICAUD AND M. B. STURGIS
LOUISIANA STATE UNIVERSITY

IN THE SUGAR JOURNAL

A study of the availability of soil nutrients and responses of sugar cane to the application of fertilizers has been in progress in Louisiana for 25 years.

In a true sense, the crop is the only agent that can determine the amounts of nutrients available in a soil. However, it is practically impossible to test the soil of all farmers by crop response.

To extend the usefulness of field tests, scientists have developed chemical tests for soils to determine fertilizer needs. When the chemical tests are properly calibrated against crop responses from field results, they may serve as a basis for fertilizer recommendations.

Therefore, an important objective in soil fertility work is the calibration of soil testing data with crop responses to applied fertilizers. Of the three major nutrient elements, *the calibration of soil tests for potassium has received the least attention.*

Forty-nine fertilizer experiments conducted at 28 locations in the cane area since 1964 were selected for the calibration of soil potassium. The soils involved are the Alluvial soils of the lower Mississippi and Red River flood plains and Older Alluvial or Terrace soils along Bayou Teche.

The fertilizer treatments in each experiment consisted of combinations of three levels of nitrogen, two levels of phosphorus and two levels of potassium. A randomized block design was used with three replications.

TABLE 1.—POTASSIUM CONTENT OF THE ALLUVIAL SOILS (NOS. 1-12) AND OLDER ALLUVIAL OR TERRACE SOILS (NOS. 13-28).

Loc. No.	Soil Type	Avail. K	Exch. K	Total K	K Sat.	Base Sat.	Exchange Capacity
		ppm.	ppm.	%	%	%	m.e.
1	Yahola sil	93	94	1.76	1.3	100.0	19.5
2	Commerce l	96	113	2.03	2.5	86.6	11.5
3	Commerce sil	86	110	2.06	1.8	94.3	16.1
4	Commerce sil	92	126	1.91	2.8	80.0	11.6
5	Mhoon l	117	127	1.96	1.8	87.2	17.9
6	Mhoon sil	78	85	2.10	1.3	87.4	16.6
7	Mhoon sil	111	141	1.79	1.7	78.9	21.5
8	Mhoon sil	57	65	1.90	1.7	95.0	9.6
9	Mhoon sil	78	72	2.16	1.1	92.8	16.8
10	Mhoon sicl	110	151	2.19	1.4	92.7	27.9
11	Mhoon sic	227	299	1.96	2.2	87.8	35.2
12	Sharkey c	311	585	2.19	2.9	94.5	50.9
Average (Nos. 1-12)		121	164	2.00	1.9	89.8	21.3
13	Cypremort sil	47	46	1.60	1.1	66.5	11.2
14	Baldwin sil	61	65	1.77	1.0	82.6	17.0
15	Baldwin sil	66	76	1.65	1.0	98.0	20.2
16	Baldwin sic	155	201	1.95	1.8	63.3	28.9
17	Jeanerette sil	104	108	1.90	1.0	96.2	27.7
18	Jeanerette sil	80	88	1.51	1.0	91.0	22.1
19	Jeanerette sil	59	56	1.26	0.5	99.5	32.0
20	Jeanerette sil	80	85	1.20	1.2	90.3	17.9
21	Iberia sil	67	68	1.62	0.8	85.1	21.5
22	Iberia sil	85	73	1.20	0.5	100.0	36.3
23	Patoutville sil	75	84	1.22	2.0	59.5	10.5
24	Patoutville sil	47	50	1.26	1.5	60.4	9.1
25	Richland sil	82	98	1.44	1.8	38.0	14.1
26	Richland sil	94	110	1.45	2.2	43.1	12.6
27	Richland sil	69	84	1.38	1.9	50.1	11.5
28	Olivier sil	58	67	1.43	1.4	44.5	12.3
Average (Nos. 13-28)		77	85	1.49	1.3	73.0	19.1

The potassium content of the soil at each experimental location is shown in Table 1. Available potassium content of the Alluvial soils extracted with 0.1 N hydrochloric acid at a 1:20 soil to extractant ratio varied from 57 ppm. in Mhoon silt loam to 311 ppm. in Sharkey clay with an average of 121 ppm.

Exchangeable potassium was slightly higher in amounts but highly associated with available potassium. Total potassium content of the soils varied from 1.76 per cent in Yahalo silt loam to 2.19 in Sharkey clay with an average of 2.00 per cent.

The per cent potassium saturation of the total exchange capacity varied from 1.1 to 2.9 per cent with an average of 1.9 per cent for the Alluvial soils. The available potassium content of the Old Alluvial or Terrace soils varied from 47 ppm. in Cypremort silt loam to 155 ppm. in Baldwin silty clay with an average of 77 ppm. Total potassium varied from 1.20 per cent in Jeanerette silt loam to 1.95 per cent in Baldwin silty clay with an average of 1.49 per cent.

The per cent potassium saturation varied from 0.5 to 2.2 per cent with an average of 1.3 per cent. The potassium content was lower in the Older Alluvial or Terrace soils than in the Alluvial soils.

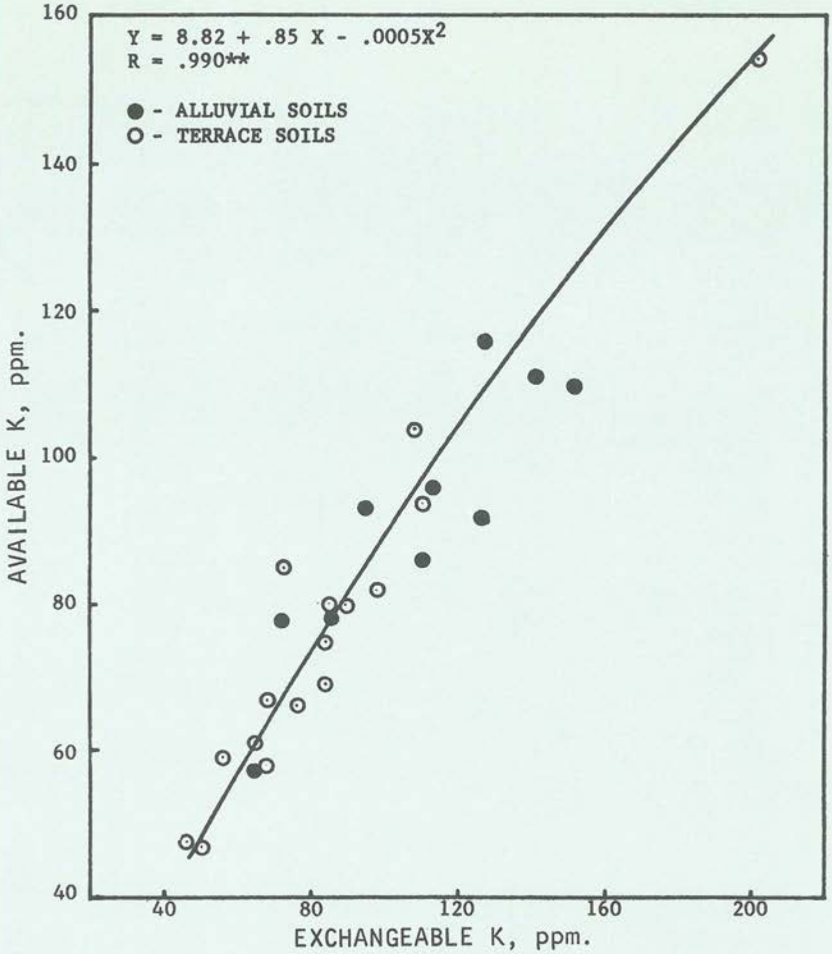


Figure 1. Relationship between exchangeable K and available K extracted with 0.1N HCL at 1:20 soil to solution ratio.

RELIABLE INDEX

Figure 1 shows a close association between available potassium and exchangeable potassium in all the soils studied. This association indicates that the available potassium extracted with 0.1 N hydrochloric acid is a highly reliable index of the amount of soil potassium available to sugar cane. The ease with which available potassium can be determined in the laboratory makes it a more convenient index in comparison with exchangeable potassium.

Figure 2 shows that the association between exchangeable potassium and total soil potassium was barely significant and not highly reliable. Figure 2 also illustrates that a relatively small amount of the total soil potassium was actually exchangeable potassium.

As an average of all the soils, the exchangeable potassium was 0.69 per cent of the total potassium. A soil which contained 1.5 per cent or 30,000 pounds per acre of total potassium in the surface soil had approximately 207 pounds per acre of exchangeable potassium. The per cent

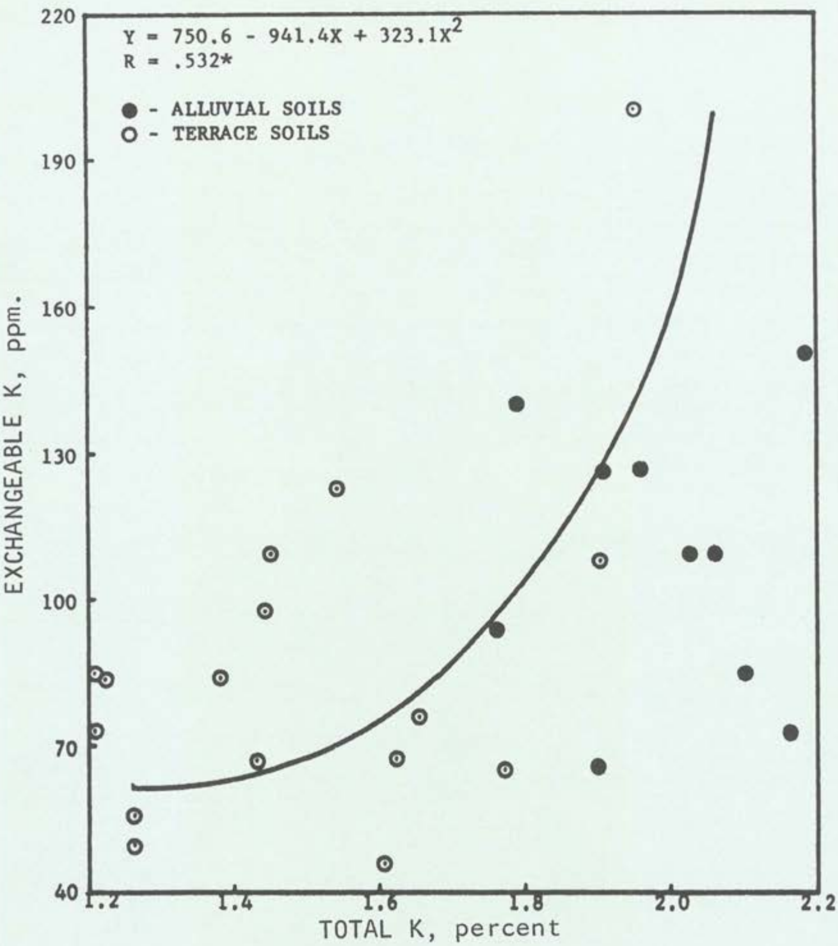


Figure 2. Relationship between exchangeable K and total K contents of the soils.

potassium saturation was significantly associated with exchangeable potassium but not with total soil potassium.

Sugar cane yield responses to fertilizer potassium were determined in each experiment by difference between yield on plots with and without applied potassium at each of the levels of applied nitrogen and phosphorus. The average of these responses and its significance were determined in a factorial analysis of the yield data from each experiment.

Since the N x P x K interactions were significant in some of the experiments, the response to potassium was also determined by a method of comparative analysis. In this method, response to potassium was measured at a nitrogen level and a phosphorus level which were not limiting to plant growth.

IMPORTANT RESPONSE

The average responses by factorial analysis and the responses by the comparative method are shown in Table 2 for plant and stubble cane on Alluvial soils. Response to potassium was significant in several experiments

TABLE 2.—SUGAR CANE YIELD RESPONSE DUE TO FERTILIZER POTASSIUM ON ALLUVIAL SOILS.

Exp. Loc. No.	Soil Type	Avail. Soil K	Age of Cane	Yield without Fert.	Average[1] Yield without K_2O	Average[1] Resp. to K_2O	Comparative Analysis Treat. without K_2O	Comparative Analysis Yield without K_2O	Comparative Analysis Treat. with K_2O	Comparative Analysis Yield with K_2O	Comparative Analysis Resp. to K_2O
		ppm.		T/A.	T/A.	T/A.	$N-P_2O_5-K_2O$ Lbs./A.	T/A.	$N-P_2O_5-K_2O$ Lbs./A.	T/A.	T/A.
1	Yahola sil	93	Pl.	24.2	24.4	1.1	80–40–0	24.3	80–40–60	26.8	2.5
2	Commerce 1	96	Pl.	25.3	31.8	0.8	60–0–0	31.7	60–0–60	33.3	1.6
2	Commerce 1	96	St.	13.6	20.6	1.9*	100–0–0	20.6	100–0–60	22.7	2.1*
3	Commerce sil	86	Pl.	25.1	28.5	0.0	60–40–0	27.1	60–40–60	28.3	1.2
3	Commerce sil	86	St.	20.6	24.6	0.8	80–0–0	22.7	80–0–60	24.7	2.0
4	Commerce sil	92	Pl.	28.0	27.8	1.1	80–40–0	27.0	80–40–80	28.2	1.2
4	Commerce sil	92	St.	24.8	28.2	1.6*	120–0–0	29.6	120–0–80	31.0	1.4
5	Mhoon 1	117	Pl.	20.4	28.5	1.1	60–0–0	28.1	60–0–60	28.5	0.4
5	Mhoon 1	117	St.	21.4	27.3	0.2	100–0–0	28.0	100–0–60	28.7	0.7
5	Mhoon 1	117	St.	12.1	19.1	0.7	100–0–0	20.4	100–0–60	21.3	0.9
6	Mhoon sil	78	St.	16.9	26.7	1.4*	80–40–0	26.6	80–40–60	28.0	1.4
6	Mhoon sil	78	St.	14.4	21.6	0.7	80–40–0	22.7	80–40–60	23.6	0.9
7	Mhoon sil	111	St.	36.8	42.0	0.5	160–40–0	44.7	160–40–80	44.7	0.0
8	Mhoon sil	57	St.	18.7	24.8	0.7	120–40–0	23.8	120–40–60	27.1	3.3
9	Mhoon sil	78	Pl.	28.5	33.5	0.9*	80–0–0	32.9	80–0–80	35.5	2.6*
9	Mhoon sil	78	St.	25.6	32.4	1.6	160–0–0	32.0	160–0–80	34.9	2.9*
9	Mhoon sil	78	St.	14.7	18.7	0.3	120–0–0	17.1	120–0–80	19.0	1.9
10	Mhoon sicl	110	St.	22.8	31.8	0.7	120–40–0	32.0	120–40–80	32.9	0.9
10	Mhoon sicl	110	St.	21.3	27.5	0.4	160–40–0	28.2	120–40–80	29.7	1.5
11	Mhoon sic	227	St.	29.3	37.6	1.1	160–40–0	40.7	160–40–80	41.3	0.6
12	Sharkey c	311	Pl.	21.2	22.3	0.1	120–0–0	22.6	120–0–80	22.8	0.2
12	Sharkey c	311	St.	24.4	29.9	0.7	160–0–0	30.6	160–0–80	30.9	0.3
Average for Alluvial Soils			Pl.	24.7	29.8	0.7		27.7		29.1	1.4
Average for Alluvial Soils			St.	21.2	25.4	0.9		28.0		29.4	1.4

[1] Average yield and response were obtained in a factorial analysis of the yield data.

* Significant at 5% level of probability.

Pl. = Plant cane; St. = Stubble cane.

TABLE 3.—SUGAR CANE YIELD RESPONSE DUE TO FERTILIZER POTASSIUM ON OLDER ALLUVIAL OR TERRACE SOILS.

Exp. Loc. No.	Soil Type	Avail. Soil K	Age of Cane	Yield without Fert.	Average[1]: Yield without K_2O	Average[1]: Resp. to K_2O	Comparative Analysis: Treat. without K_2O	Comparative Analysis: Yield without K_2O	Comparative Analysis: Treat. with K_2O	Comparative Analysis: Yield with K_2O	Comparative Analysis: Resp. to K_2O
		ppm.		T/A.	T/A.	T/A.	$N-P_2O_5-K_2O$ Lbs./A.	T/A.	$N-P_2O_5-K_2O$ Lbs./A.	T/A.	T/A.
13	Cypremort sil	47	St.	27.9	31.2	2.0*	160–0–0	31.8	160–0–80	35.0	3.2
14	Baldwin sil	61	Pl.	25.3	28.3	1.3	60–0–0	27.5	60–0–60	29.6	2.1
14	Baldwin sil	61	St.	20.3	26.7	3.2*	120–0–0	27.7	120–0–60	30.7	3.0
14	Baldwin sil	61	St.	17.6	21.7	2.5	120–0–0	21.3	120–0–60	23.8	2.5
15	Baldwin sil	66	Pl.	35.8	38.3	−0.4	120–40–0	38.4	120–40–80	39.8	1.4
15	Baldwin sil	66	St.	27.3	37.9	0.0	160–40–0	38.2	160–40–80	40.8	2.6
16	Baldwin sic	155	Pl.	15.8	20.8	1.0	40–0–0	19.8	40–0–60	20.1	0.3
16	Baldwin sic	155	St.	17.6	27.7	2.4*	120–40–0	30.3	120–40–60	30.2	−0.1
16	Baldwin sic	155	St.	11.3	16.7	1.9*	80–40–0	17.8	80–40–60	18.9	1.1
17	Jeanerette sil	104	Pl.	27.4	31.9	0.7	80–0–0	31.7	80–0–60	32.6	0.9
17	Jeanerette sil	104	St.	22.0	27.7	2.1*	100–0–0	28.8	100–0–60	29.4	0.6
18	Jeanerette sil	80	Pl.	37.3	38.4	−0.8	120–0–0	36.9	120–0–80	38.5	1.6
19	Jeanerette sil	59	St.	23.9	25.2	2.2*	160–40–0	24.9	160–40–80	27.7	2.8
20	Jeanerette sil	80	Pl.	22.3	21.7	1.1	40–40–0	21.1	40–40–80	21.9	0.8
20	Jeanerette sil	80	St.	21.9	30.4	2.1*	120–40–0	29.7	120–40–80	32.1	2.4
21	Iberia sil	67	Pl.	18.5	22.9	0.1	40–0–0	21.8	40–0–60	22.5	0.7
21	Iberia sil	67	St.	14.9	19.4	2.1*	100–0–0	19.0	100–0–60	20.3	1.3
22	Iberia sil	85	Pl.	22.7	25.9	0.9	80–0–0	25.6	80–0–60	27.7	2.1
23	Patoutville sil	75	Pl.	18.0	22.6	1.2	80–0–0	24.0	80–0–60	26.3	2.3
24	Patoutville sil	47	Pl.	18.1	23.1	0.8*	60–0–0	23.0	60–0–60	25.4	2.4*
25	Richland sil	82	Pl.	18.9	22.9	2.2	60–0–0	24.0	60–0–60	25.9	1.9*
25	Richland sil	82	St.	12.3	19.6	3.3	80–0–0	16.4	80–0–60	17.9	1.5
26	Richland sil	94	Pl.	15.2	18.0	0.6	40–0–0	16.3	40–0–60	17.0	0.7*
27	Richland sil	69	St.	17.6	21.6	1.4	100–0–0	20.3	100–0–60	22.9	2.6*
28	Olivier sil	58	Pl.	25.0	26.6	0.8	40–40–0	25.7	40–40–60	27.6	1.9
28	Olivier sil	58	St.	19.0	21.4	1.5*	100–40–0	20.2	100–40–60	23.8	3.6*
28	Olivier sil	58	St.	22.0	24.3	2.9	80–40–0	25.0	80–40–80	28.8	3.8
Average for Terrace Soils			Pl.	23.1	26.3	0.7		25.8		27.3	1.5
Average for Terrace Soils			St.	19.7.	23.6	2.2		25.1		27.3	2.2

[1] Average yield and response were obtained in a factorial analysis of the yield data.
* Significant at 5% level of probability.
Pl. = Plant cane; St. = Stubble cane.

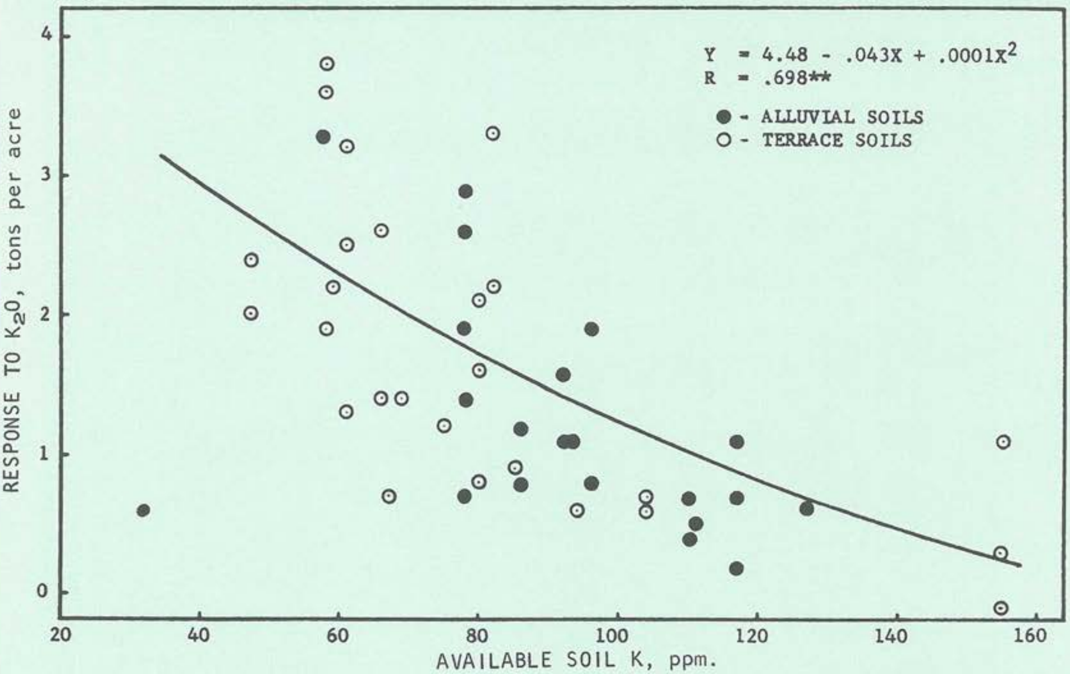


Figure 3. Relationship between response of sugar cane to K_2O and available soil K extracted with 0.1N HCl at a 1:20 soil to solution ratio.

but was positive in all experiments on Alluvial soil. The maximum response to fertilizer potassium was 3.3 tons with an average response of 1.4 tons for acre.

The average responses by factorial analysis and the responses by the comparative method are shown in Table 3 for the Older Alluvial or Terrace soils. There was a response to fertilizer potassium in most of the experiments. Generally, greater response was obtained with stubble cane than with plant cane. The maximum response to potassium was 3.8 tons with an average response of 1.9 tons per acre for the Old Alluvial or Terrace soils.

SOME PROFITABLE RESPONSE

The relationship between available soil potassium and yield response to fertilizer potassium was evaluated. The relationship was not significant when only the average responses by factorial analysis were considered, but it was more significant when the responses as determined by the comparative analysis were considered. The relationship was also examined by using the average responses by the factorial method in experiments without interaction and by using the responses shown by the comparative analysis in experiments with interactions.

The regression curve shown in Figure 3 for this latter analysis was highly significant. The curve shows that a profitable response of more than one ton of sugar cane per acre was obtained on soils which contained less than 110 ppm. of available potassium.

A one ton response to 80 pounds of K_2O gave a return of two dollars per dollar invested in fertilizer.

The average production of sugar cane in the state in 1963 was close to 29 tons per acre. Since work reported elsewhere shows that a ton of millable cane contains 3.5 pounds of K_2O, over 100 pounds of K_2O per acre left the field.

Most of the soils were responsive at a level below 110 ppm. of available potassium. As the yield of sugar cane increases in the future, more soils will be at a responsive level. Therefore, more potassium fertilizer must be utilized in sugar cane production to maintain the present yield or to increase yield in the future.

Farmers in the sugar cane area should have their soils tested periodically and should follow the specific fertilizer recommendation for their soils.

THE END

Will We FERTILIZE the Air?

Who knows, the time may come sooner than expected when farmers will be "fertilizing" the air in their fields of growing crops with carbon dioxide gas to increase yields. Plant scientists are working on the idea and the results look promising, says Joseph P. Vavra, Southern Illinois University soil specialist.

As yet a practical way of adding carbon dioxide to fields mechanically has not been developed, he says, but as the world population grows and the need for more food and fiber increases greatly, the way undoubtedly will be found.

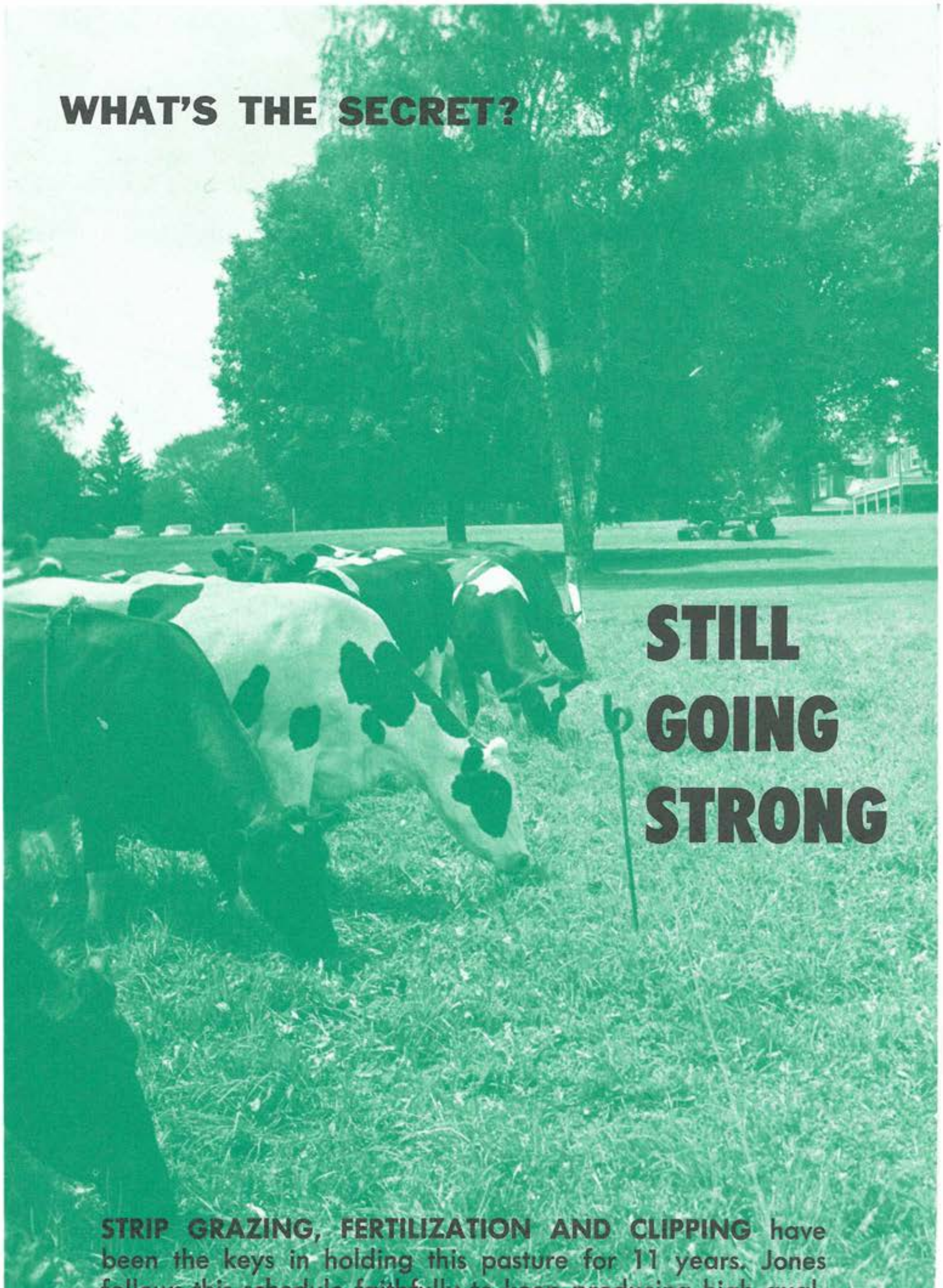
Carbon dioxide is something animal life wants to get out of the body as a waste in exchange for oxygen. Plants need this carbon dioxide as the primary raw product for manufacturing sugar with the sun's energy in the presence of chlorophyll, the substance giving green color to plants. The process is called photosynthesis which really makes all life possible since animal life depends on plants.

Although considerable carbon dioxide is released from decaying plant residues in the soil, plants need about four times as much as is released from the soil. Most of the needs come from carbon dioxide already in the atmosphere. Much of it enters the plant through the leaves and stems rather than through the roots. The greatest requirements come during the warmer and brighter times of the day when plants are busiest manufacturing food. Scientists have found carbon dioxide concentrations in corn fields rising sharply at night and going down during the day.

Crops & Soils

WHAT'S THE SECRET?

STILL GOING STRONG



STRIP GRAZING, FERTILIZATION AND CLIPPING have been the keys in holding this pasture for 11 years. Jones follows this schedule faithfully to keep producing high quality forage.

AFTER ELEVEN YEARS

NORMAN REBER IN PENNSYLVANIA FARMER

A 19-ACRE orchardgrass-ladino pasture at Polk State School in Venango County is still going strong after supplying all the pasture for an 80-cow herd for eleven years.

Using a constant feeding ratio of 2.6 to 2.7 pounds of grain to one pound of milk, during the entire period, Tom Jones, farm manager at Polk, has upped his herd's milk production on this pasture. The hay and silage feeding has been the same, too, throughout the period.

Here's a comparison of the first year on this pasture with the eleventh: DHIA average of 82.1 cows in 1953 was 13,174 pounds of milk, while in 1964 a herd of 79 cows averaged 15,-088 pounds of milk. This was 110,367 more pounds of milk in 1964 than in 1953 and with fewer cows. The herd average has been increased through exclusive use of herd sires obtained from the USDA Beltsville Research Farm.

Although ladino has faded out in spots, Jones maintains it by cutting the pasture early to eliminate the orchardgrass competition. As he puts it, "I get the orchardgrass off early in the spring to keep as much of the ladino as possible. This gives me young tender grass and also aids the ladino, which still makes up 45 percent of the crop." The red and alsike clover seeded along with the ladino and orchardgrass disappeared after the first season.

Here are the highlights of the 11-year history of this well-known pasture which rated a feature story in Pennsylvania Farmer six years ago:

The field was strip grazed in 1953 for the first time. Tom's general plan was followed faithfully. It was to apply 500 pounds of 0-20-20 every fall and to test for lime every three years.

The previous year, in June, 1952, he had the land tested for lime while it was in wheat and the tests showed a pH of 6.6. One ton of ground limestone to the acre was then applied. In 1956 the tests showed 6.7 pH, and in April, 1960, it was 6.5. A ton of ground limestone per acre was applied that year. Soil tests show, too, that organic matter is on the increase.

The most recent pH test was made in 1963 when 6.7 was indicated and no lime applied.

The herd is confined by electric fences three to four rods apart. They have access to the ration strip from a shady grove of large trees. The fence along the grazing edge is moved ahead once a day and the back fence is moved usually every three days. Pasture behind the cows is clipped every week or whenever necessary. Hay is kept in the racks in the grove at all times.

For the past 30 years, says, Tom, the Polk cows have been milked three time a day. The cows are turned out on pasture in the morning at 7 and stay until 11 o'clock. They are brought in for milking and go out again at one o'clock and remain on pasture until five.

If his cows were on a twice-a-day milking schedule, says Tom, he would keep his herd in the barn all day and put them on pasture at night.

In addition to their grain ration, the cows get all the hay they will clean up at night in the barn, but "they don't eat very much," claims Tom, "when they're on pasture." Corn silage is usually fed except when grass silage is available during the summer.

BEAT A WET SPRING . . . F

DON'T WAIT TO BOG DOWN and damage your soils in a wet spring. Heavy loads traveling over wet fields compact soils. This soil will be slow to recover from such a beating. Poor crops mean disappointed people—farmer, dealer, landlord.

W. L

Severe winters or wet springs can prevent your getting on those heavy broadcast applications of fertilizer needed for top profit yields.

On most soils, top profit yields are impossible with only band applications of fertilizer at planting. The plow-down can well be done in the fall on level soils. Then crops won't "run out of gas" halfway through the growing season. REMEMBER: Band plus plow-down equals fast start plus strong finish!

CORRECTIVE APPLICATIONS FOR SOIL BUILDUP

Both research and grower experience show that soil test levels should be medium to high in P and K. Broadcast application at heavy rates on low fertility soils is the solution. ***Growers are in a hurry to remove low fertility as a limiting factor.***

FERTILIZE THIS FALL!

WHY?

. . . **BECAUSE DRY, FIRM SOILS OF FALL mean no bogged down spreaders, no time-eating delays, no compaction, soil damage, or lost power . . . much less wear and tear.**

.. N.

. . . **BECAUSE FALL FERTILIZATION can mean discounts, tax writeoffs, capital investment, savings on labor, less waiting time at plant or for custom spreading . . . and better odds for top profit yields next year!**

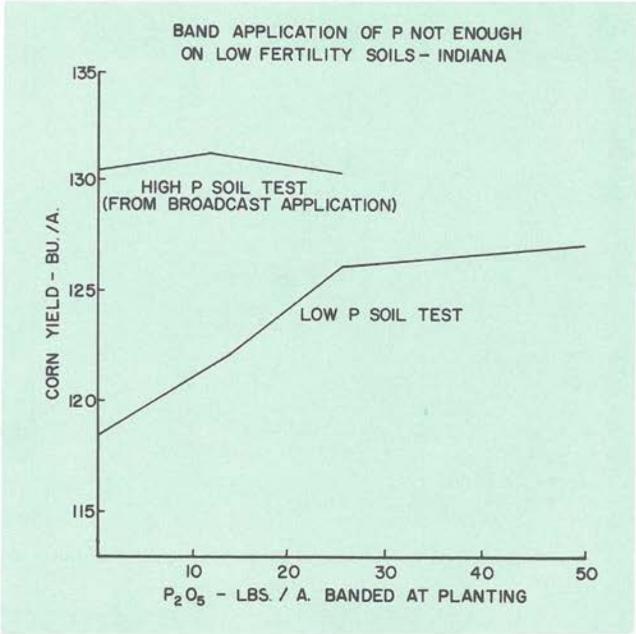
PLOW-DOWN BETTER THAN DISKED IN (Iowa)

	Increase in yield of corn
	bu./A.
Phosphorus applied	
Plow-down	**20**
Disked in	16
Potassium applied	
Plow-down	**43**
Disked in	39

Fall applications are more likely to be plowed down than disked in.

PLOW-DOWN AS DROUTH INSURANCE

Plow-down puts nutrients deeper so they are in moist soil



BAND APPLICATIONS HELP INCREASE yields on low fertility soils but it's hard to reach top profit yields. Broadcast applications of P (phosphorus) are necessary to build soil fertility level. The high soil test here came from P broadcast and plowed down in fall. The same principles apply to K (potassium).

longer during drouth periods. Disked-in applications are near the surface where the soil dries out quickly.

FALL, EARLY SPRING, OR SIDEDRESS N FOR CORN

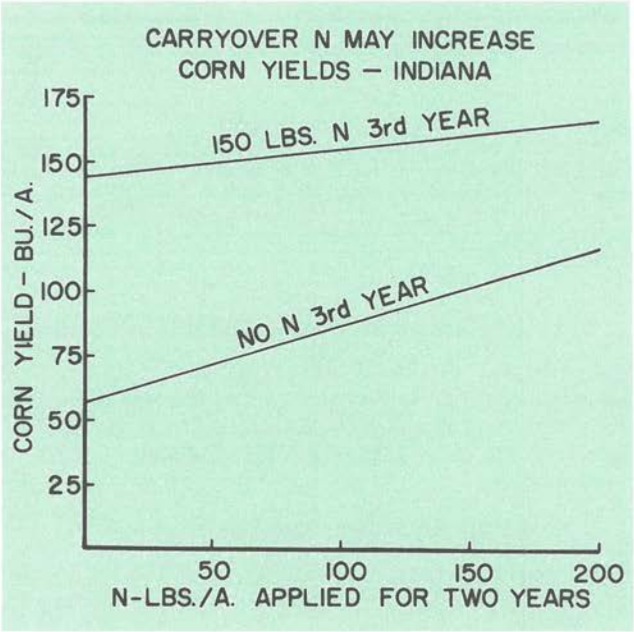
In general, there are small inconsistent differences among the various times of application in the Corn Belt.

Sidedressed N may be more efficient in some instances—but sidedressing time is a busy time for the growers and the industry couldn't possibly supply the N needed in the Corn Belt in this short period.

So, growers will be inclined to sacrifice some efficiency for a less rushed application time. **The grower will choose the time that best fits his operation.** This will include some plow-down N in the fall. On sandy soils, of course, N is applied at planting as well as sidedressed, but not in the fall.

WHAT IS SUFFICIENT POTASSIUM

It depends on your soil test and crop rotation.



CONTINUED HEAVY N APPLICATIONS HELP BUILD soil fertility. This is due to more crop residues that release N (nitrogen) on decay and to actual carryover of N. Nitrogen in the subsoil may help carry crops through drouth periods.

K_2O APPLIED IN ROTATION

	Medium or high K test	Very low K test*
	lbs./A.	lbs./A.
Corn-soybean rotation	120	200
Corn-corn-soy-bean-wheat-hay rotation	396	660

* Increase 2/3 over medium test (Purdue).

Broadcast in the fall is a perfect time to apply this K. Illinois research over a 10-year period on three silt loam soils shows a loss of only 2 lbs. K/A. each year.

CAN BE FALL OR WINTER APPLIED BUT NOT PLOWED

1 On frozen or light snow-covered level land.

2 On slopes up to 5% if there is a physical barrier to prevent surface washing such as shredded corn stalks or a heavy sod.

YES . . . . . BUT

Fertilizer may be lost from that sandy soil or that sloping field. True, but for every such field, there are 1,000 that have been properly fall fertilized . . . and 10,000 more fields which should have been!

FALL FERTILIZER IN GOOD PHYSICAL SHAPE

Manufactured fertilizers have had more time to cure. Blenders can obtain materials of proper granule size. All this means a better spreading job. Also, fertilizer is more plentiful and growers are more sure of getting what they need.

RAPID SOIL TEST SERVICE IN FALL

Broadcast-plow-down applications should be based on soil tests whenever possible. In the fall, your dealer has more time for extra services, such as soil sampling and advisory work. Most laboratories will return your recommendations in a week.

Another interesting factor—recently spring soil testing in one state was down 50% because of the *wet* conditions.

AVOID SPRING RUSH

1 Because growers are pushed.

2 Custom operators are pushed.

3 Fertilizer supplies may be temporarily short.

THE RUSH TO EARLY PLANTING

Early planting is a must on such crops as corn, soybeans, and grain sorghum. Each day of delay in planting corn after the first week in May can drop yields one or two bushels per acre. A farmer's time at planting is worth an estimated $50 per hour.

This means **1** Growers will plant as soon as the ground is fit, starting the last week in April—making fewer days to broadcast fertilizer.

2 Growers will plow down more of their fertilizer and apply less in the row.

All this favors fall fertilization, because the modern farmer must save time to make profits.

FALL FERTILIZATION ECONOMICS

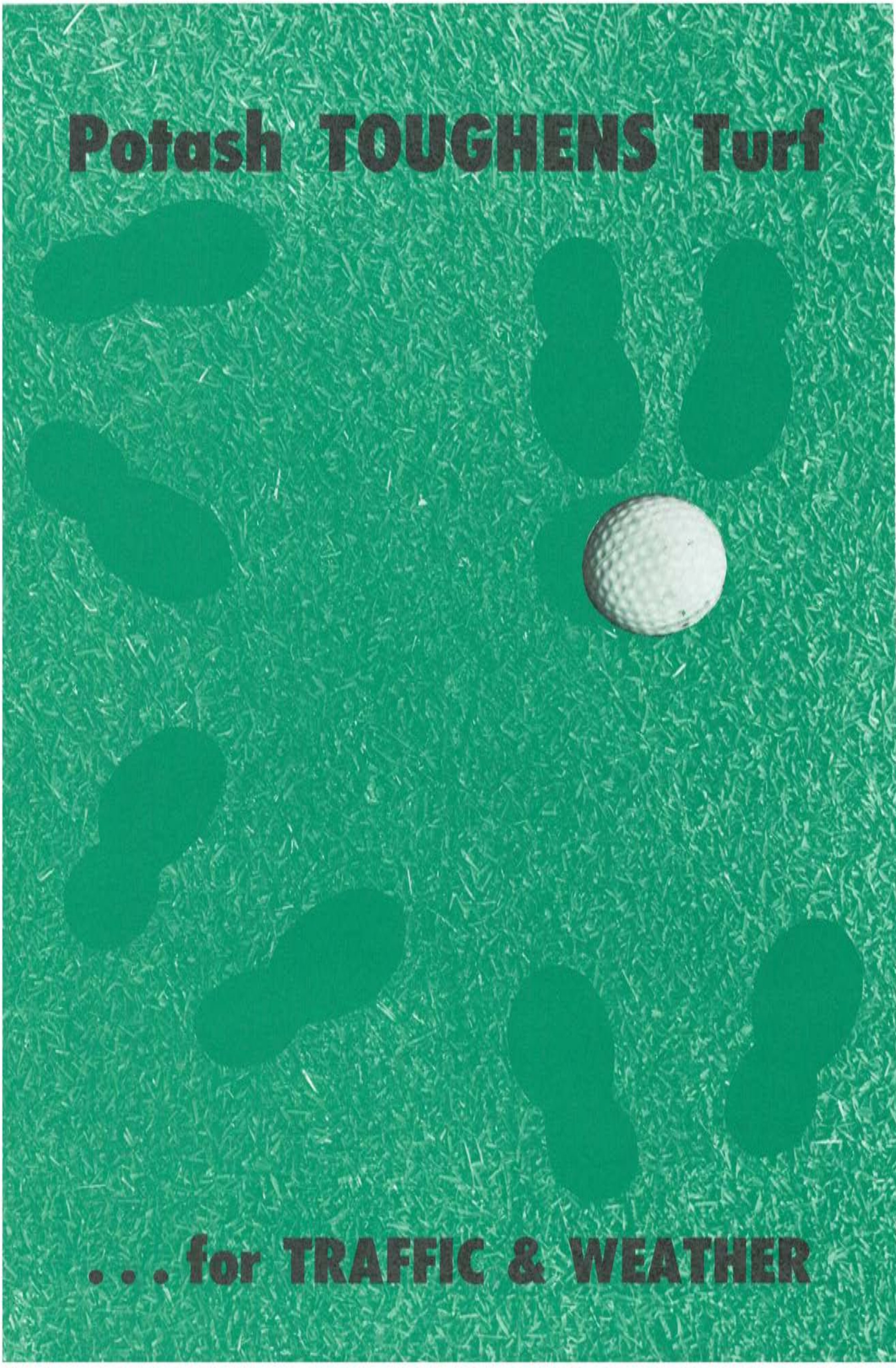
Discounts	Less power and fuel costs
Tax writeoff	Less waiting time for fertilizer
Capital investment	No mired spreaders
Savings on labor	Top profits more probable

IN A NUTSHELL

The heavy level soils, which remain wet longer in the spring and delay broadcasting, are the ones where fall application is feasible. NPK applied in the fall will be held quite well by the clay and organic matter.

THE END

Potash TOUGHENS Turf



. . . for TRAFFIC & WEATHER

Scientific reports now show . . .

1 That **potash-HUNGRY** grass is often soft and lush, the leaves lacking turgor and the blades neither erect nor stiff enough for good putting.

2 That **potash-HUNGRY** grass is more subject to certain diseases—important where regular turf clipping prevents plant from maturing and increases susceptibility to disease.

1 That **potash-FED** turf is more winter hardy than K-neglected turfs—due greatly to K's role in building carbohydrate reserves in the cell sap and roots.

2 That **potash-FED** turf withstands hot weather better than K-neglected grasses—due greatly to K's role in reducing plant respiration and water loss.

A CONDENSATION

FROM H. E. HAMPTON, TEXAS A&M UNIVERSITY, IN THE U. S. GOLF ASSOCIATION'S GREEN SECTION RECORD

Potassium is one of the several chemical elements essential for plant growth. It is needed in rather large amounts by plants, especially the grasses.

Potassium has been aptly called the neglected nutrient. Its effect on the growth and appearance of grass is not as pronounced as that of nitrogen, therefore a deficiency of potassium is not so evident and is often overlooked. From experimental evidence, we are certain that proper attention to potassium fertilization is essential for a healthy, vigorous turf.

All growing portions of plants, both tops and roots, are rich in the element. Potassium seems especially abundant in the cells of new roots and young leaves. It is one of the more mobile nutrient elements and is apparently withdrawn from older tissues of the plant and transferred to regions of new growth, As plants approach maturity, it has been found that potassium can be translocated into the soil.

WORKING AS A CATALYST

Of all the major nutrients, potassium seems to be the only one that does not become a constituent of plant compounds. Its primary role seems to be that of a catalyst: a substance which accelerates a chemical reaction or enables it to go on but does not enter into the products of the reaction.

An Australian researcher working with perennial ryegrass found that potassium occurs entirely as soluble, ionic potassium in cell sap and protoplasm. Other workers have found the potassium contained in plants to be readily soluble in water. It appears that if the potassium in plants is combined at all with the protoplasm, it is easily dissociated from it.

The plant's inability to synthesize carbohydrate in the absence of potassium has been reported in several papers. It seems that potassium is essential for the process of photosynthesis in which sugars are manufactured. Potassium has been found essential for condensing the simple sugars into more complex carbohydrates such as starches and the celluloses and for forming lignin, the principal compound of woody plants.

Several workers have reported evidence that potassium is necessary for translocating the carbohydrates from one part of the plant to another.

LIGNIN CONTENT: A STRENGTH FACTOR

The lignin contained in plants contributes to the strength of stems and also the leaves. It has been reported that potassium significantly affects the lignin content of plant parts. The highest lignin content was found in plants of the grass family when the plants were supplied with medium amounts of potassium. Both deficient and excessive supplies resulted in lower lignin contents.

ESSENTIAL FOR PROTEIN

Potassium is considered to play a role in the synthesis of plant proteins. A number of authors believe it is essential for manufacturing the protein in plant cells. A deficiency of potassium has been found to result in significantly higher amounts of both amino nitrogen and nitrate nitrogen in the cell sap at the expense of protein.

. . . AND FOR TOP & ROOT GROWTH

Several studies have shown rather conclusively that an adequate potassium supply is necessary for normal development of the growing apexes of plants, especially the grasses. Not only will the above-ground parts show abnormal growth but root growth and extension is curtailed as well.

But what has been said about the role of potassium is just so much "book learning" to the golf course superintendent. What he wants to know is how potassium affects the turf on a golf course.

It has been said many times, and often not so humorously, that it would be a much easier job to grow grass on a golf course if it were not for the golfers. This is simply another way of saying that foot traffic and cart traffic and swinging golf clubs are hard on turf.

We pointed out earlier the essential nature of potassium on the formation of complex carbohydrates and lignins and it was stated further that these compounds, especially lignin, contribute strength to stems and leaves. **Turf plants deficient in potassium are soft and lush, the leaves are lacking in turgor, and the blades are neither erect enough nor stiff enough to present a desirable putting surface. The leaves are easily bruised by traffic. The correct ratio of potassium to other nutrients particularly nitrogen, will do much to harden and stiffen the turf.**

THE "HEALTH NUTRIENT"

Potassium has been referred to as

the "health nutrient." It is generally accepted that potassium-deficient plants are more subject to certain diseases. The regular clipping of turf, especially on putting greens, prevents the plant from maturing and thereby increases the susceptibility of the plants to disease. Several studies have indicated that leaf spot disease of turfgrasses (Helminthosporium spp.) especially is more prevalent when the supply of potassium is limited.

Other diseases of turf may be similarly affected by potassium. The influence is due in part to the soft, easily-crushed leaves of potassium-deficient plants which enable the pathogens to gain entrance, and in part to the concentration of sugars and nitrates in the leaves which makes more favorable media for the development of the organisms. This does not mean that applications of potassium constitute a specific cure for diseases.

If it is found, however, that a disease persists in spite of regular use of fungicides, it would be wise to check the potassium status of the soil. Any practice which will promote the vigor of the plants will help combat disease.

INCREASES WINTER-HARDINESS

Both phosphorus and potassium fertilization have been reported to increase the winter-hardiness of turfgrasses. The effect has been attributed to the increased concentration of dissolved substances, largely soluble carbohydrates, in the cell sap. The fact that potassium increases the reserve of stored carbohydrates in the roots is thought also to make perennials more cold-tolerant.

. . . AND SUMMER SURVIVAL

In an experiment conducted at Iowa State, it was found that Kentucky bluegrass which was supplied relatively low nitrogen and phosphorus and high potassium withstood hot weather better than bluegrass supplied with either high nitrogen, phosphorus, and potassium or high nitrogen and phosphorus and low potassium.

The practice of applying nitrogen alone during the summer months is likely to induce a nitrogen-to-potassium imbalance resulting in greater heat damage to the turf. Many superintendents wisely make a practice of reducing the amount of nitrogen applied during the hot months to about half the amount they apply during the same period of time in the cooler spring months. Some withhold nitrogen entirely during the hot months, especially on bent greens.

If adequate potassium has been applied in the fall and spring, a summer application of potassium fertilizer may not be needed. In case a shortage of potassium becomes apparent, however, it might be wise to apply a light application of potassium fertilizer in the hot months.

HELPS TURF DENSITY

A common problem in the management of turfgrasses is the maintenance of a good stand, often referred to as turf density. Although much of the loss in density is due to winterkilling, injuries associated with high temperatures and the weakening of turf by disease also cause many plants to die. Potassium deficiencies aggravate all of the above.

The growth and extension of roots which are promoted by potassium are particularly important in keeping a cover of healthy, vigorous turf. The importance of potassium in helping to maintain the density of turf should be emphasized but the need for potassium fertilization is often overlooked.

Potassium occurs in several forms in the soil. By far the greatest portion of it is present as a constituent of the minerals and the organic matter composing the solid portion of the soil. **Only a relatively small portion of the potassium occurs in soluble, available forms.**

Potassium is taken up through the roots of plants as the potassium ion which occurs in the soil solution and which is also attracted to the clay particles. Either of these can be absorbed by plants.

Plant species vary considerably in their potassium needs. A review of the literature seems to indicate that potassium requirements of turf grasses are intermediate to high, compared to plants as a whole. At least the turf grasses are generally benefited by potassium fertilization.

Since fairways and tees are usually constructed of the soil occurring locally, potassium may be lacking or in adequate supply depending on the nature of the soil.

The soil mixture used to construct putting greens contains more sand, and potassium deficiencies commonly occur. This is especially true if the putting greens have been constructed according to USGA Green Section specifications. The potassium problem under putting greens is aggravated by the practice of removing the grass clippings.

The removal accelerates exhaustion of several plant nutrients, including potassium, unless the nutrients are regularly replaced. It has been shown that the removal of large amounts of herbage can reduce potassium from an apparently high to a low level in one season, bringing about problems associated with potassium deficiency.

Much has been written about "nutrient balance," which is to say that an over-supply of one nutrient will bring about deficiencies of one or more other nutrients. Large applications of lime, for example, have been known to induce shortage of phosphorus and potassium and often magnesium. The trend toward the use of nitrogen fertilizers alone or nitrogen and phosphorus fertilizers has resulted in deficiencies of potassium. On the other hand, too much potassium may induce deficiencies of calcium and magnesium.

SIGNS OF DEFICIENCIES

Deficiencies of potassium may be indicated in several ways. The specific symptom depends on the species or possibly the group of plants and to an extent on the available supply of other nutrient elements. Signs of potassium starvation are often seen as premature dying of the leaves when nitrogen and phosphorus fertilizers are applied in high amounts relative to the potassium.

When nitrogen and potassium are simultaneously in short supply, the plants tend to be stunted, their leaves small and somewhat ashgray in color. Premature death often occurs, starting at the tips and along the margins of the leaves. Large supplies of nitrogen relative to potassium, on the other hand, result in the development of large leaves which are watery and lush.

Actually clear-cut visible symptoms of potassium deficiency in turf grasses are not common. The growth and health of turfgrasses may be impaired due to a potassium shortage although there are no visible signs. The result is an overall loss of vigor in the plants.

The insidious nature of "hidden hunger," especially that induced by a shortage of potassium, has been mentioned by several writers.

Most golf course superintendents use liberal amounts of nitrogen fertilizer. Many make applications of phosphorus and potassium alone or with nitrogen once or perhaps twice a year. On some courses, only nitrogen and phosphorus are applied. There is evidence that enough phosphorus fertilizers are being used on most courses to satisfy the needs of the turf.

There is about as much evidence to indicate that the amount of potassium which is being applied does not adequately supply the grass plants throughout the year. Either an insufficient amount of potassium fertilizer is being put on or the amount being applied could be better distributed through the year.

Such a statement may be made because plants are known to take up more potassium than they need if the soil supply is high in potassium and a fall or winter application of potassium can be exhausted before summer.

The variations in soil characteristics and the differences in plant species mean that there is no such thing as a balanced fertilizer. Amounts of N, P, and K which seem adequate or "balanced" for a certain turfgrass on one soil are likely to prove inadequate on another soil or for the desirable growth of another turfgrass.

The need for better balance between nitrogen and potassium is currently receiving more attention. Relative amounts of nitrogen and potassium which appear to result in the production of desirable turf in the cooler spring months usually do not work out so well in the hot months. This is not to say that nitrogen is not needed during the summer. But it does appear that more potassium in relation to the nitrogen is needed during summer, especially on Bermuda greens.

THE END

TODAY'S ELECTRONIC TEL

USING ELECTRONICS to help farmers determine which enterprises are paying them and which are not.

From **TEL FARM** Bulletin

Editor's Note:

Why have net farm incomes gone down, NOT UP, in this day of improved farm technology?

Such a question might generate many answers—some heated, no doubt—but a big factor can be a farmer's method of managing and controlling his business.

Modern farming is a business. And in the area of business management, many farmers have not kept pace with other improved practices.

Because of this, Michigan State University has launched an educational program to help today's farmer modernize his business management techniques.

The program is called **TEL FARM**—involving electronic computers and consultations with professional people who serve farmers.

The purpose is to help the farmer acquire and interpret facts he *needs* to make better business decisions.

Those facts include income and expense summaries, depreciation records, business analyses, enterprise analyses, credit and financial breakdowns, family living and labor summaries.

The following pointers are adapted from the **TEL FARM** bulletin issued by the Agricultural Economics Department, Coopera-

FARM RECORDS FOR MANAGEMENT

FARM

GUIDING FARMERS toward sound business decisions in a day of increasing farm investments and expanding livestock enterprises.

Department of Agricultural Economics
Cooperative Extension Service
Michigan State University

tive Extension Service, Michigan State University.

How does **TEL FARM** work? This is what the farmer-cooperator does:

- Takes an inventory at the start of the program of capital items, livestock and feed. Help is available in starting the records.
- Reports, each month, receipts, expenses and investments on forms provided and mails these forms and reports of crop yields and livestock numbers to the Computer Center at Michigan State University.

The cooperator who is willing to supply the extra information needed may also keep the following special records:

Labor—amounts paid in wages and social security on each hired laborer.

Farm credit—statements of the amount and sources of farm credit currently being used in the business.

Family living—Reports of non-farm business income and expenses.

Enterprise—summaries of certain items of income and expense associated with selected enterprises.

How does **TEL FARM** help?

It includes professional counsel to help you learn to acquire and interpret the information you need to make better business decisions.

A starting place toward better management is a knowledge of the past through records. Today's farm business needs several types of farm records.

TEL FARM places at your service several million dollars worth of computers and business machines to take over the routine jobs of summarizing, analyzing and printing these records.

You don't need to keep a half dozen record books to have a half dozen different reports. The machines do the jobs accurately, neatly and at fantastic speeds.

INCOME-EXPENSE RECORDS

You should know exactly what you take in and pay out. You can use these facts for . . .

estimating the effects of a change in farm organization

estimating taxable income for tax management

understanding how much you have left for family living and new investments

deciding how much credit to use

planning loan repayments

DEPRECIATION RECORD

You can use the depreciation report to save dollars and reduce tax reviews.

With **TEL FARM,** the computer figures and prints an accurate, up-to-date depreciation schedule. And you can attach the second copy of this report to your income tax report.

TEL FARM keeps you on top of changes in income tax laws. The computer has been set up to allow you to take advantage of the latest changes.

The depreciation report and your third quarter income and expense re-

COMPUTERS AT WORK FOR YOU: The columns in Tel Farm Form 2 illustrate what the computers can do for you. Almost all entries are made on this form and in any order you wish to put them.

Seven special columns on Form 2 can signal the computer that you want special summaries. The Labor Code numbers, entered in Column 5, are grouped by the

TEL FARM®

FORM 2
MONTHLY REPORT OF
INCOME AND OUTGO
(Except depreciable capital investment items)

Name

Line	Date: Month	Date: Day	Item description: Describe item and if appropriate tell what it was for. Example: "Feed-supplement — dairy," "weed spray — corn" (Do not use trade names)	To whom & from whom: Code for credit and labor records	To whom & from whom: Name of person or firm in both cash and credit transactions	Number of Head
1	2	3	4	5	6	7
1						
2						
3						
4						
5						
6						
7						

port help you plan purchases and sales so taxable income is evened out and taxes minimized.

BUSINESS ANALYSIS . . .

TEL FARM enables you to take a good look at your TOTAL business. Years of experience with farm records have revealed that certain characteristics of the farm business are crucial to financial success. The yearly Business Analysis Report is a quick picture of your farm organization and an evaluation of this organization. You may also compare your performance with average performance of farms of similar size and organization.

What do you look for?

1 Volume of business is an important factor in business success. It is best measured by total sales. Gross income per man in another important indicator of business volume.

2 Crop and livestock efficiency are necessary too. You need high yields of high profit crops plus high production per unit from your livestock. The Business Analysis Report pinpoints sources of efficiency or inefficiency so you can better judge where to turn to improve your business.

3 Cost analysis and vigilant cost control must accompany volume and physical efficiency. A cost analysis section of **TEL FARM's** Business Analysis Report helps you watch this aspect of your business.

. . . & ENTERPRISE ANALYSIS

TEL FARM can also put a spotlight on KEY parts of your farm business. Your most profitable decisions require that you know costs and returns for individual parts of the business. Enterprise analysis takes you from the "whole farm" to parts of the business. You choose both the parts and the size of the parts you wish to analyze.

You may, for example, divide your dairy enterprise into a replacement raising enterprise and a milking herd enterprise. You may want a single corn enterprise, or enterprise summaries on individual corn fields.

---

computer into a Labor Report; entries in the enterprise column are put together by the computer into Enterprise Summaries; entries carrying code numbers in Column 16 are grouped into Income and Expense Summaries for each person in the business.

Machines do the tedious work. You have more time for important management decisions.

Address				County / State				Form Number / Month			Page
Quantity		Kind		Incoming		Outgoing		Owner			Item Code
Amount in lbs., bu., ton, days, gal., mo. etc.	Leave blank	Farm 1 Family Living 2 Outside 4		1 Receipts 72 Decrease in Acct. Rec. 81 Borrowed or charged 9 Internal transactions		2 Expenses 9 Internal transactions 71 Increase Acct. Rec. 82 Debt Principal Pymt.		10 Partnership or Corp. 11 Operator or 1st partner 12 Second partner 21 First landlord, etc.			Leave Blank
		Market Memo.	Code	Code	Dollar Amount	Code	Dollar Amount	Code	Enterprise Code	Lot No.	
8	9	10	11	12	13	14	15	16	17	18	19

TEL FARM Enterprise Summaries help answer these critical questions:
• Should I expand, reduce or eliminate an enterprise?
• What changes in practices offer the best chances to make an enterprise more profitable?
• If expansion is needed, Enterprise Records suggest how long it will take to pay for the new facilities, using a certain percentage of returns above out-of-pocket costs to pay for the new building or equipment.

CREDIT-FINANCIAL FACTS

TEL FARM helps you keep on top of your credit condition and financial standing.
Know what you owe and what others owe you. The Credit Record is a quarterly summary of loans and loan repayments.

To help in

- managing your finances
- appraising your ability to take on new debts
- checking the accuracy of charge accounts and credit statements
- evaluating the cost of credit

Follow yearly changes in your assets, liabilities and net worth.
Use this report to judge financial progress.
Have a copy to give to your creditor when you are shopping for credit.

FAMILY-LIVING-LABOR SUMMARIES

TEL FARM lets you know exactly what it costs you to live.
To a large extent the basic reason for operating a farm business is to make money to be spent by the family. On the other hand family spending competes directly for money which could be invested in the farm business.

TEL FARM's Family Living Record:

- Guides you in deciding how much farm income to use for family living expenses.
- Provides a record of deductible family living expenses for income tax management.
- Helps appraise your ability to pay debts or assume new capital investments.

TEL FARM's Labor Summaries let you know:

- the quantity and cost of your hired labor
- the amount withheld for Social Security
- if you wish the amount of hired labor for individual enterprises

In order to have

- records for Social Socurity
- an analysis of the amount and value of labor used in your various enterprises

For further facts on this Michigan program, write the Department of Agricultural Economics, Cooperative Extension Service, Michigan State University, East Lansing, Michigan.

THE END

FOLDER ON PAGE 29

In the ladies' lounge of a very fashionable hotel, where there's a turnstile between the lounge and the lavatory, four matrons were searching in their purses for change when one of them said:

"No, Myrtle—you took us to lunch. This is my treat."

Friend: "Why do you have such misspelled and ungrammatical signs in your window?"

Sharp Merchant: "People think I am a dunce, and come in to swindle me. Trade's just fine!"

Little boy (at country fair): "Why does that man go around pinching those animals?"

Mother: "He just wants to buy one and he's just seeing that they are in good condition."

Little boy: "Mommy, I think daddy wants to buy our maid."

Statistics show that every four seconds a woman gives birth to a baby. Our problem is to find this woman and stop her.

USA is the only country where it takes more brains to make out the income tax return than it does to make the income.

"Name?" queried the immigration official.

"Sneeze," replied the Chinese proudly.

The official looked up. "Is that your Chinese name?" he asked.

"No, that my 'merican name," replied the oriental gentleman.

"Then let us have your native name."

Replied the Chinese, "A Choo."

Ulcers are what you get from mountain-climbing over molehills.

Small Boy: "Can I go to the bathroom?"

Grammar-conscious Teacher: "Did you say **can?"**

Small Boy: "No Ma'am. I said **bathroom."**

Mrs. Highbrow and her poodle were shopping one day, when she noticed that the gentleman standing next to her at the counter was looking fearfully at the dog frisking about his legs.

"Don't be afraid of Pierre," she reassured him, "he won't bite you."

"My good woman," said the man, "I wasn't afraid he'd bite, but I noticed him lifting his hind leg and I thought he was going to kick me."

Undoubtedly all men are created equal, but after that they're on their own.

PLAN NOW!

WINTER MEETING AIDS

PAGES 43-48

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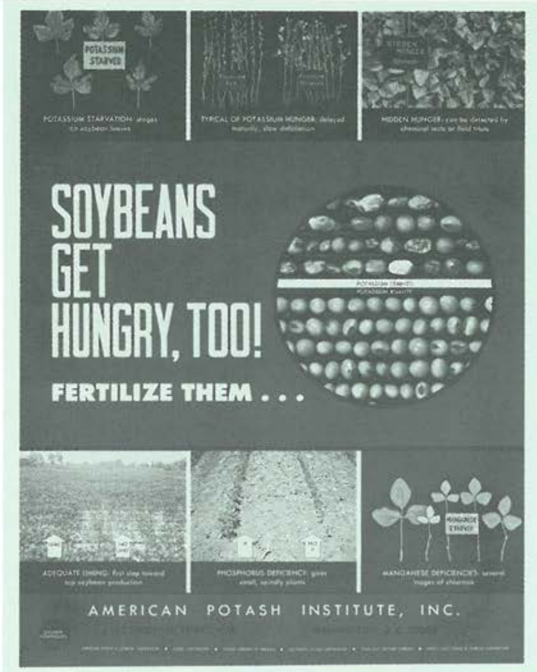

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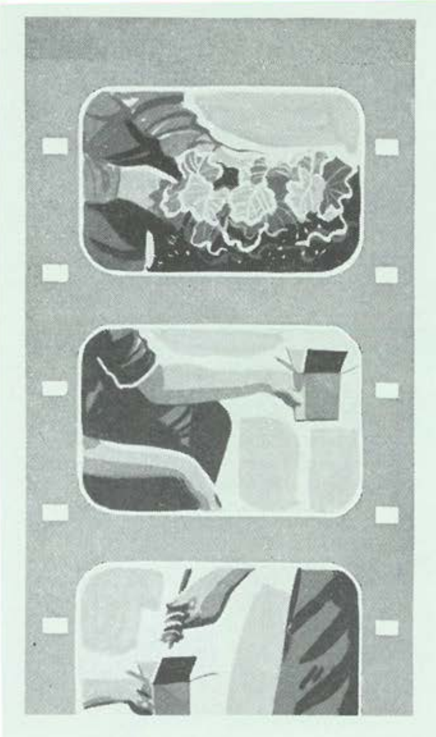

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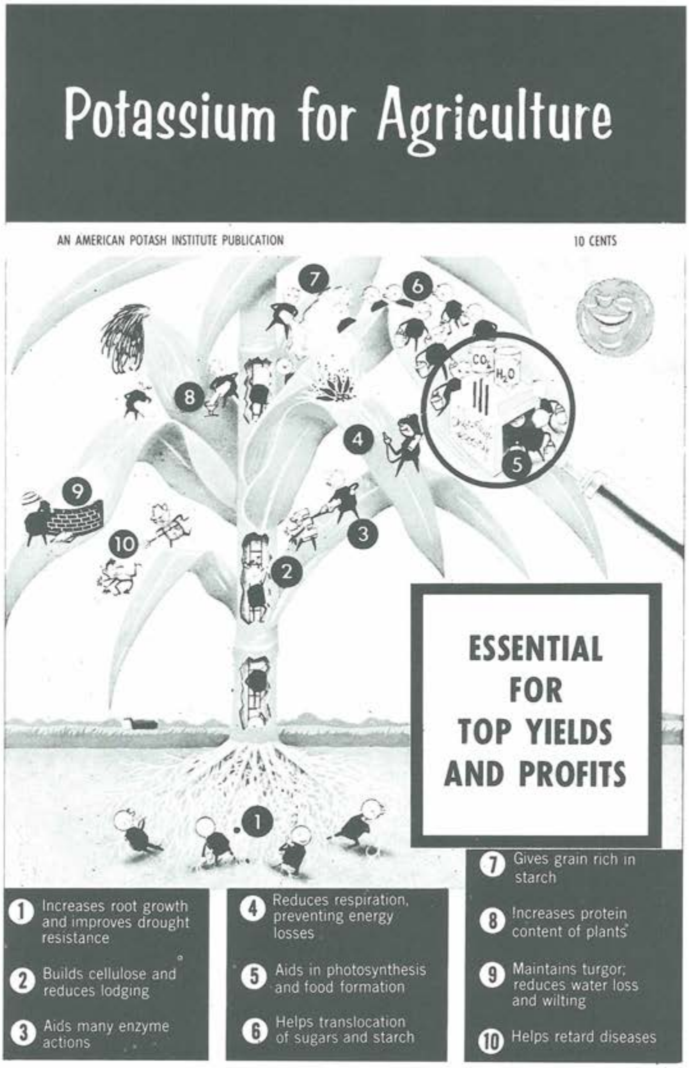

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