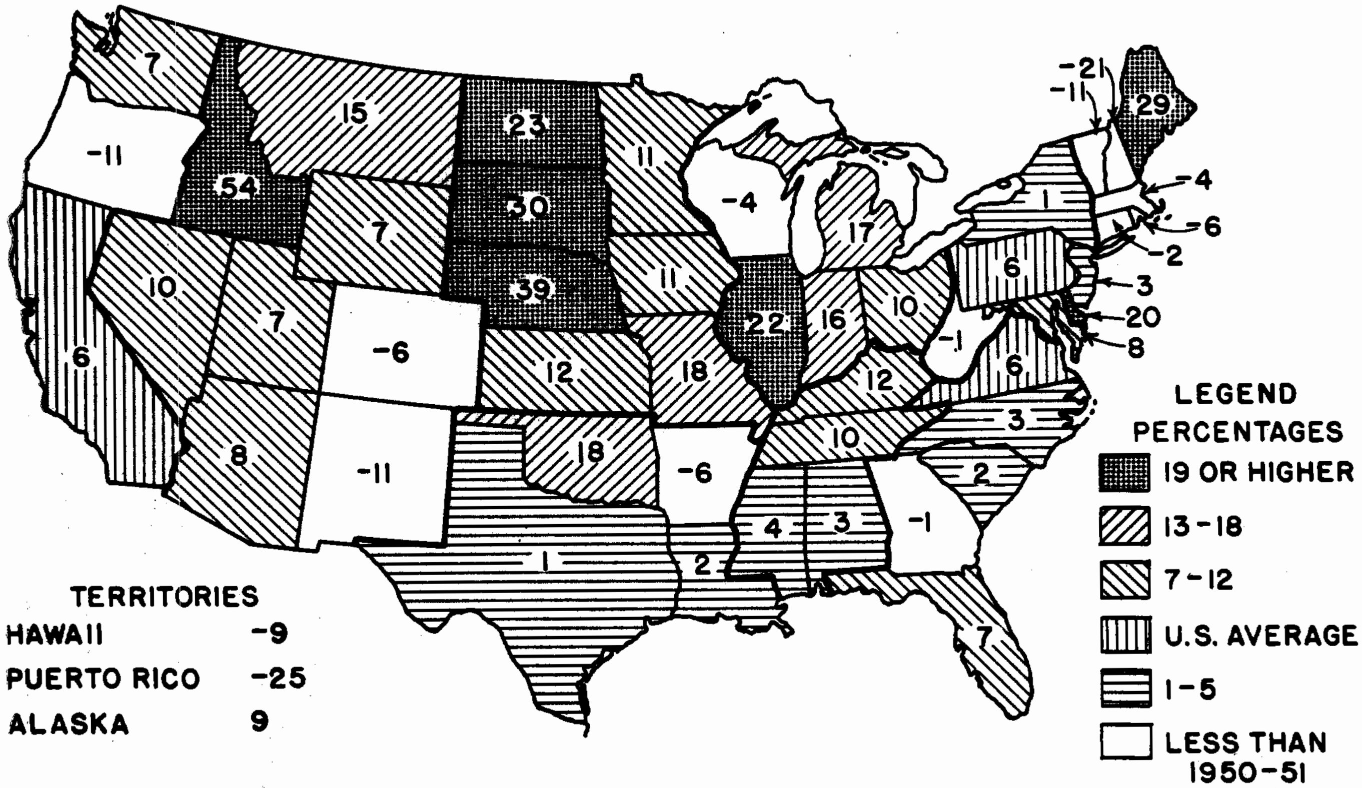
1951–52 U. S. Fertilizer Consumption Average Is Up 6% Over 1950–1951



What's the Status of Fertilizers?

Current Status, Future Prospects, and Potential Use

The current state of business and the outlook for the future are always of interest and vital, not only to the sales force and stockholders, but to every department—research, production, development, and board of directors. The fertilizer industry's state is important beyond that industry. It indicates the trend on the farm and that affects the pesticide, seed, food processing, packaging, and a host of other industries—as well as the welfare of the country. The Editors of Ag and Food, since June 1, have interviewed a cross-section of the men who should know: executives of the companies that sell fertilizers. Their points of view are presented in their own words. Supplementing this is a brief survey of facts of the recent past. The use potential of fertilizers is summarized by geographical area by four authorities in the field.

Leaders in the Industry Find the Farmer Becoming Better Aware of the Value of Plant Foods

Record Consumption of Plant Foods Seen During Next Fertilizer Year

Clyde T. Marshall
General Manager, Agricultural Chemicals Division
Commercial Solvents Corp.
New York, N. Y.

PLANT FOOD consumption may well break all records during the next fertilizer year. This prediction is expected to hold true especially for nitrogen, even in view of the recent decline in prices on principal farm products.

Today's successful farm is mechanized to a great degree. This means the investment per crop acre is such that it demands the use of plant food in order to obtain the lowest possible production costs per crop unit. It is no longer possible for the farmer to postpone application of plant food since only he stands to lose by failing to maintain his profit in the market place.

In this period of declining prices it can be said that the real problem is rather one of providing sufficient nitrogen soon enough to permit the farmer to produce profitably at lower market prices.

Progressive farmers have seen and received increased yields in direct proportion to the amount of nitrogen used. They now know there is a definite relationship between the amount of nitrogen applied and the profits which can be made. For this reason, thousands of tons of nitrogen will, during the next year, continue to be imported and used at prices higher than domestic products, since sufficient quantities of nitrogen cannot be obtained from our own sources.

The same premise will hold true for the increased cost of nitrogen forthcoming from facilities now being built. A look at today's capital expenditures and raw material costs for new nitrogen producing facilities in this country shows that they are nearly three times higher than they were for existing plants. While this means a slightly higher cost per unit of nitrogen than we have been accustomed to, nevertheless nitrogen will continue to be used in increasing quantities because of the guaranteed lower unit cost per crop. Certainly, nitrogen is today the best investment a farmer can make regardless of whether farm prices are high or low.

Striving for Lower Unit Farm Costs Favors Fertilizers' Future

R. L. Hockley
President, Davison Chemical Corp.
Baltimore, Md.

THE OUTLOOK for manufactured fertilizer continues good, despite lower farm income brought about by lower prices for some agricultural products.

Agriculture is, of course, the basic occupation on which the life and economy of the nation depend to a large degree. No technology or price trend can alter this relationship nor will the needs of the expanding population of this country fail to bring increasing demands for food and fiber. It has been estimated that by 1975 our available acres will have to produce 28% more.

Today's farmers are in the main good men of business. No other group has made such obvious advances in management techniques in the last generation. The figures show it—ever greater production with ever less expenditure of labor.

This agricultural revolution was stimulated by the tremendous demand for food and fiber coincident with the growing scarcity of farm labor. Advances followed in machinery, methods, and materials such as seed, fertilizer, and insecticides. These were made known to farmers, large and small, through the educational techniques of the agricultural extension services, the fertilizer industry, and the farm journals.

The net effect is that the farmer is now convinced that the answer to lower prices, in face of scarce and high labor, is further reduction of crop unit cost. Manufactured fertilizer meets this need by increasing production from available acreage with little or no labor increase. Extra yield from a ton of fertilizer often equals the yield from two acres of untreated land.

This concentration on costs tends to stimulate use of higher analysis fertilizer, a trend which will become more evident as triple superphosphate plants now building come into production. There will also, for reasons of efficiency as well as economic considerations, be a consistently growing trend toward the use of granulated forms of mixed fertilizers and superphosphates.

Better Use of Fertilizer Is Part of the Modern Approach

S. L. Nevins
President, Agricultural Chemicals Division
Mathieson Chemical Corp.
Baltimore, Md.

THE CURRENT YEAR is proving to be much better than was indicated only two or three months ago. A significant point to note is the continued growth in fertilizer consumption in the face of declining income; the farmer is realizing more and more that fertilizer is not something which he is being "sold" by high pressure salesmen, but rather that it is a tool with which he can lower his unit cost of production.

That the farmer is exercising more initiative with fertilizer utilization is attested not only by the fact that he is using a larger quantity than ever before, but by his surprisingly ready acceptance of the new analysis materials. The type farmer who not long ago maintained "no fertilizer is worth more than $1 a sack" is now happy to pay over 5 cents per pound for the high analysis goods. New materials such as ammonium nitrate, urea, ammonium phosphates, etc., have been readily accepted.

About 7 years ago when our company first introduced high analysis pelletized concentrated fertilizers, it was thought by many that only a few farmers on the experimental fringe would accept them. The amazing swing of the industry toward building new plants of this type is the most eloquent testimony of the general acceptance of this new concentrated pelletized plant food.

An entirely new concept of the fertilizer business is growing, not only in the manufacture, but in the marketing as well. There is still a great need for research in this field. New materials point up new problems. Use of high analysis fertilizers calls for more attention to minor plant foods such as calcium, magnesium, and sulfur which can be applied to the soil at much lower cost in the form of bulk lime, or gypsum, than as part of the N-P-K mixtures.

Anhydrous ammonia for direct application has found ever increasing acceptance. Soil conditioners as well as fertilizer conditioners are opening up new concepts.

Higher Test Mixed Fertilizers Is the Trend

H. H. McIver

Alex M. McIver & Son, Charleston, S. C.

So FAR AS THE ANALYSES of fertilizers now on the market in the United States is concerned, the outstanding feature of the last two years has been the steady rise in the test of mixed fertilizers of various grades.

There has also been a steadily increasing demand from farmers throughout the United States for higher testing material containing nitrogen alone. Formerly, the farmers were satisfied with nitrogen materials containing 16% nitrogen. Now the insistent demand is for foreign and domestic materials containing 20.5% nitrogen or better, as well as the 33% nitrogen materials manufactured in the United States and Canada.

It is practically foreseeable that in the next two or three years the demand for 16% nitrogen materials will have dwindled to the vanishing point as demand for 12% and 20% K_2O potash has dwindled in the potash field.

On potash and complete goods containing potash, there has been a continuing demand for higher potash content.

On the supply situation, apparently there will be ample supply of potash for the coming season beginning July 1, taking into consideration the domestic supply and also what limited tonnage of foreign potash will be imported from France and Germany.

Sulfate of potash is the only potash, apparently, that may be in fairly tight supply.

In regards to the supply of phosphoric acid, it appears there will be an ample supply of superphosphate containing 20% available phosphoric acid but we do not believe that enough plant capacity will be operating to take care of the ever-increasing demand for triple superphosphate for the coming season.

As regards supply, mineral nitrogen, particularly sulfate of ammonia and the nitrogen solutions, should be ample to cover requirements.

Changes Now and Future Are the Keynote

W. B. Copeland

Vice President, Smith-Douglas Co., Inc. Norfolk, Va.

CHANGE—radical changes in recent years—with every evidence of more in the future—is the keynote in a quick glance at today's fertilizer situation. A further look centers on fertilizer consumption, concentration, and manufacturing methods.

Farm income and fertilizer consumption have closely paralleled one another in years past. This trend can easily change by further education of the American farmer in good fertilizer practices. Increased mechanization has made the farmer much more production cost-conscious. Both large and small farms are keeping much better cost records. These cost records have revealed to farmers the need for keeping unit costs at a minimum, which means that properly used fertilizer can be a most effective tool. It has been proved that fertilizer alone can do more toward reducing the cost per bushel per acre than any other single improved farming method.

Twenty-one people must be fed by each farm worker by 1975 instead of the 14.5 now being fed. This means more food must be grown on the same acres now in cultivation, which should mean rapidly expanded use of fertilizer.

Economics have forced higher concentration of plant food content in each ton of fertilizer with an increase from about 19 units per ton in 1940 to about 24 units per ton in 1950. Increases in freight rates and labor and material costs have forced higher concentration in order to keep delivery cost to the farmer at a minimum. Improved refining and processing of materials has made possible the continual increase of higher concentrated plant foods. The continued need for better plant foods in less bulk at less cost points toward increased concentration.

Chemically combining highly refined fertilizer materials under controlled temperature and moisture conditions is replacing the mixing of mechanical combinations of physical materials in fertilizer manufacture. Exacting farmers are demanding fertilizers in grained, granulated, and pelletized forms combining nitrogen, phosphorus, and potash in a homogeneous combination of all elements in each individual pellet. This can be assured through aggregation into solid pellets, and at the same time give the farmer more even distribution on his field. Present indications are that competition and convenience will demand improved mechanical condition in fertilizers of the future.

Fertilizer's Future Will Depend on Adaptability

Maurice H. Lockwood

Vice President in Charge, Plant Foods, International Minerals & Chemical Corp., Chicago, Ill.

BOTH INDIVIDUALLY and collectively, our future in the fertilizer industry will depend on the answer to the question: "How adaptable are we"?

Let's assume: (1) the widely publicized goals of production for nitrogen, phosphates, and potash will be attained about on schedule by 1955; (2) farm income decreases 10% more during the next year, levels off for a year, then begins to climb again at about 5% per year for 4 or more years.

At the rate of sales effort and promotion of recent past—not all good—farm income will pretty well determine fertilizer expenditures a year later. Our two assumptions indicate that still further supplies and a smaller farm income will challenge us.

What'll we have to sell? More high analysis fertilizers for which there's been unsatisfied demand. Several hundred thousand tons of new production of concentrated superphosphate. And ideas. Those ideas and the effectiveness with which they're sold will pretty well determine our adaptability against the seeming paradox: more fertilizer—less farm income. Greater economic place of higher analysis fertilizer and effective sales effort will be an important roller bearing in our industry's progress.

Some scanning of sales policies, personnel, and programs will come. The "get-out-and-doers" will survive; the "toll-gate tenders" will beef about unfairness of someone who displaced them.

None of us will decline the fine aid of public agencies, trade associations, radio, press, and others. But those—small, medium, or large—who develop an effective program and make it go places, are the ones who survive best, serve users best, and retain shareholder respect.

The only economic limit of an obvious

nature will be the requirement for certain production units, such as nitrophosphate plants. Capital requirements will limit their numbers.

There May Be Cutbacks in The Southwest

James D. Dawson, Jr.

Vice President,
Fidelity Chemical Corp., Houston, Tex.

In general, there will be a reduction in the amount of fertilizer used in Texas in 1953. This is explained by several conditions. In West and Southwest Texas and the Rio Grande Valley, severe drought conditions exist and unless good rains come soon, fertilizers will not help withering crops. In East Texas and the upper Gulf Coast areas, a reduction in fertilizer will result from more than abundant rains and flood conditions.

Many of our citrus orchards were destroyed by the heavy freeze of 1950. Though they are being rehabilitated, new orchards require about 5 years before they become producers. Large demands for fertilizers will not be required for a couple more years.

Price increases in ammonia and sulfuric acid will have an effect. The farmer is already caught in a tight cost-squeeze. His selling prices have been going down while fertilizer costs have been on the increase. Further increase in fertilizer costs would add materially to an already bad situation. Money from banks for fertilizer purchases is less than for some time.

There is one important exception to the general cutback in fertilizer consumption, though it does not materially affect the over-all picture. Rice farmers produce the one deficit crop in the state, which, last year, amounted to a 12% deficit. Increased use of ammoniated phosphates, nitrogen, and anhydrous ammonia is expected by rice farmers.

With respect to subsidies, I do not think much fertilizer furnished by the Government will be used in this area. People are generally shying away from furnishing fertilizer under these programs. In some newer areas, larger amounts might be used.

Anhydrous Ammonia Use Has Been Spectacular

C. A. Gilna

Sales Manager,
Curry Chemical Co.
Scottsbluff, Neb.

The current fertilizer tonnage use in Nebraska is estimated at about 140,000 tons with an approximate ratio of two units of nitrogen to one unit of phosphoric acid. Relatively little potash is used at present.

Mixed fertilizer consumption is on the increase and this trend will continue. The development of the use of anhydrous ammonia has been spectacular. This material, introduced in the fall of 1950, now rivals ammonium nitrate as a source of total nitrogen. We believe that ammonia will become the principal source of nitrogen in Nebraska in 1954 and will probably not be rivaled by any other source of this element in the forseeable future.

We anticipate a steady increase in fertilizer consumption in this state which should reach a total tonnage figure of not less than 400,000 tons within 10 years. Phosphoric acid consumption will probably overtake nitrogen and the use of potash as a component of mixed fertilizer will become a standard practice on the principal crops in most of the state.

Farmers Have Only Begun To Realize the Possibilities

Howard A. Cowden

President, Consumers Cooperative Association
Kansas City, Mo.

Our organization is a wholesale farm supply cooperative serving a 9-state area. For several years now we have operated three fertilizer mixing plants, and about the middle of next year we expect to have in production at Lawrence, Kan., a nitrogen plant that will produce about 83,000 tons of ammonium nitrate annually, about 13,000 tons of anhydrous ammonia, and a like amount of 40% solutions.

Our experience as handler of mixed fertilizers and our studies preparatory to launching the nitrogen project convince us that farmers of this region are barely beginning to use the fertilizers they eventually will need for the production of cash crops and pasture.

Our territory includes the rich cornlands of Iowa, eastern Nebraska and eastern South Dakota, the great wheat belt in western Oklahoma, Kansas, and Nebraska, and the irrigated farms and ranches of the high plains and Rocky Mountain areas; while the fertilizing needs and practices will vary widely, there is no place in the region that will not be using commercial fertilizer of one kind or another in the next years.

Some farmers have only begun to realize just how much their land is in need of basic plant food.

Our fertilizer consumption in the Midwest is rising faster than the rate in other parts of the country, but that is because we started after the other regions had accepted the regular use of fertilizer as a necessity.

A quarter of a century ago farmers in the Midwest began to use tractors and trucks instead of horses and mules. Petroleum consumption increased rapidly. I expect that fertilizer consumption will follow a similar upward trend as more and more farmers become aware of its need and value.

Demand for Nitrogen Compounds Continues Strong

Joe E. Culpepper

General Sales Manager,
Spencer Chemical Co.
Kansas City, Mo.

It is generally agreed the country's over-all nitrogen supply is well in balance with current annual demands. Pressure continues heavy, however, for such high analysis solid nitrogen materials as ammonium nitrate. This results, in part at least, from ease of handling and favorable delivered cost per unit of nitrogen. No wide-spread shortage is reported on such solid nitrogen materials as sodium nitrate, ammonium sulfate, and imported ammonium-nitrate-limestone compounds.

Inasmuch as requirements for nitrogen materials used in fertilizer manufacturing, such as ammoniating solutions, anhydrous ammonia, and ammonium sulfate in bulk, are somewhat seasonal in nature, some relatively small week-to-week shortages are reported in some areas. Generally speaking, supplies for the past 6 to 9 months have been adequate to meet needs.

The forecast program of Army Ordnance for taking approximately 200,000 tons anhydrous ammonia from commercial producers during the next 12 months indicates a tighter short-term supply picture for this product, which, in turn, could be reflected in less degree in other products. New ammonia production scheduled to come in prior to July 1, 1954, should erase any deficiencies which may result from the Army program. Supplies of ammoniating solutions are expected to be reasonably ample.

The last shortage expected to be eliminated entirely is that of high-analysis solid materials such as ammonium nitrate and urea. Production of the former is scheduled to be increased approximately 25% during the next three years. Urea tonnage, from plants now in operation and under construction, will increase at least tenfold during the same period. Therefore, by July 1956, all needs for such materials should be provided for amply.

For the period between July 1956 and January 1960, many people in the nitrogen industry expect supplies to be slightly above demands. It is believed increased population by 1960 will bring about a ready market for all the nitrogen capacity anticipated at the present time.

Experiment Station Recommended Levels Could Bolster Purchasing Power

Leroy Donald

Chemical Sales Manager,
Lion Oil Co.
El Dorado, Ark.

PLANT FOOD CONSUMPTION in the year ending appears slightly in excess of 1951–52 totals. Tonnage in some areas may be smaller but higher analyses are likely to compensate this effect or even exceed it.

The farmer can still get about all of the nitrogen he wants, although he may not be able to get it exactly in the form he wants it. This has been particularly true since the turn of the calendar year because of heavy importation. We are receiving substantial imports of ammonium sulfate and ammonium nitrate-limestone. There has been no prevailing nitrogen deficit. Anhydrous ammonia is tight due to increased industrial demands, the accelerated ordnance program, and rapid expansion in use for direct application to soil.

Ammonium nitrate has continued in strong demand because of high analysis and low unit cost.

Next year nitrogen solutions may have a stronger demand, also ammonium nitrate. Ammonium sulfate supplies may be adequate with anhydrous ammonia continuing tight for reasons given. During the next year new ammonia plants seem likely to bring supply and demand into better balance.

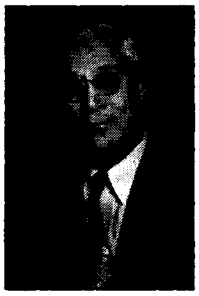
The great growth during recent years has not yet reached the potential represented by experiment station recommendations.

Fertilizer men are much interested in what will be brought by decreasing farm income. There is optimism that more fertilizer will be used to improve the farm purchasing power through higher production and lower unit costs.

All Products Moving in the West, but Cotton Cut Could Hurt

B. H. Jones

President, Sunland Industries
Fresno, Calif.



AS FAR AS California and the West are concerned there has been no difficulty so far in absorbing increased fertilizer production. Dealers here have no difficulty moving every pound they can get their hands on. Inventories of all types are very low and many types are nonexistent.

For the balance of this quarter, demand still is going to be above supply. All fertilizer, nitrogen in particular, is going to be in short supply.

I couldn't make a prediction for 1953–54; only a guess. You know USDA is talking of cutting out cotton acreages in California by some 500,000 acres, nearly a 40% cut. Believe me, if that cut becomes a reality, we are going to have ample fertilizer supplies in California next year.

As to current movement of fertilizers: taking the nitrogen fertilizers first, most any form of nitrogen does the work, and the farmer buys the one most economical for him to use. Anhydrous ammonia seems to be doing particularly well. It is extremely easy to apply, and frequently the dealer selling to the farmer also makes the application, making the farmer's lot easier. Ammonium sulfate is one of the most popular nitrogen fertilizers in the dry form and is one of the cheapest forms of nitrogen, being manufactured right here in California. The Canadians furnish two very popular types of fertilizer to the West Coast. One is 16–20; that is, 16% nitrogen, 20% phosphate, with no potash. Another is ammonium nitrate. Both of these products are pelletized, making for a very practical application. The future looks bright for all three of these products.

In reply to your question on the tendency, indicated by recent House of Representatives boost of the budget for agricultural conservation program for fertilizer subsidy, I don't feel that this is desirable and I don't think that the industry does. As you know, the Government bought about 24% of the phosphate and 16% of the potash produced last year and distributed it free to farmers who conformed to certain conservation recommendations. I do not believe this is economically sound in the long run, that is, buying fertilizer for free application. The fertilizer industry would much prefer that the Department of Agriculture make the use of fertilizer mandatory in the conservation practice, but that the farmer be required to buy the material rather than have the Government furnish it to him free of charge.

More Balanced Fertilizers Will Be Used in the Future

Lisle W. Garner

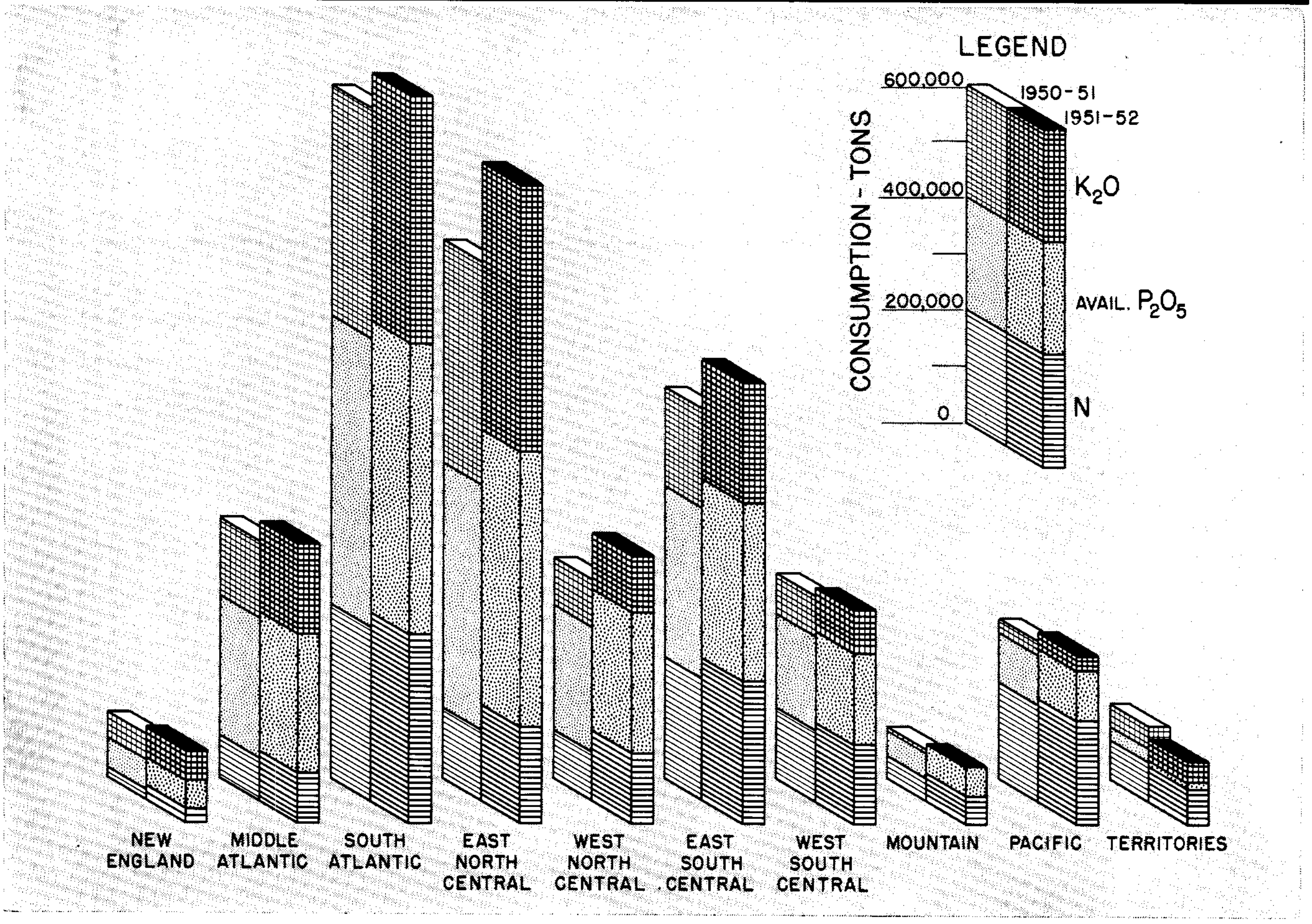
Assistant Manager,
Pacific Guano Co.
Berkeley, Calif.

DROP IN FARM INCOME has been predicted by some to mean a corresponding drop in fertilizer buying. That's a little difficult to pin down. If you judge by the difficulty we have getting supplies to meet demand, and we're having more difficulty than ever before, then there is certainly no drop in fertilizer buying, whatever may be happening to farm income. I have noted more spot buying as contrasted to future buying this year, which may show the farmer is reluctant to commit himself too far in the future. Whether that can be attributed to farm income drop, however, it is impossible to say.

I don't think that it is generally true that some fertilizers are moving better than others. They all seem to be moving about as in the past with the possible exception of cotton fertilizing. Here ammonium sulfate seems to have the edge on ammonium nitrate. I think that there is going to be a change in fertilizing practice on the West Coast in the future. We are going to have to turn more and more to balanced fertilizers.

In answer to your question as to what's bringing this change about: as our soils become older and have been cropped over long periods of time, phosphate and potash are going to be required as well as nitrogen to give high quality and high quantity. This means more of the balanced fertilizers will be used than in the past.

Primary Plant Nutrients Consumed in Regions Of the U. S. 1950–51 and 1951–52



SOURCE: WALTER SCHOLL AND HILDA M. WALLACE. BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING, USDA

Fertilizer Use Rising but Still Far Below Maximum Potential

In every region of the U. S., fertilizer consumption was up during 1951–52. The rise in use of high analysis fertilizers was significant. The relationship of fertilizer use to farm income appears to be on the rise. But we have by no means approached the ceiling in crop production. In many areas the proper use of fertilizers and improved practices could result in a doubling of production.

FERTILIZER CONSUMPTION in the United States was up last year for most types of fertilizer in all regions of the country, according to the report prepared by Walter Scholl and Hilda M. Wallace, of the Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture. Consumption in the territories was down. On the opposite pages is a compilation of data, from the extensive and detailed tables prepared by these authorities, which show that the over-all increase in the U. S., including Hawaii, Puerto Rico, and Alaska, was about 6% in the year ending June 30, as compared with the previous year. It is significant to note that the total nitrogen, available phosphorus, and potassium, however, increased 10%.

According to the report, the net increase for nitrogen was 15.2 available P_2O_5 4.2%, and K_2O 14.6%. Related to this, and possibly quite significant with respect to fertilizer trends, is the increase in total primary nutrient content in all commercial fertilizers. On the basis of weighted averages, the authors found that the percentage rose to 24.86 from the previous year's average of 24.19.

The data in the Scholl and Wallace report were presented in eight tables and two figures, the latter are used in this article. The author's tabulations were prepared from reports submitted to the Division of Fertilizer and Agricultural Lime by manufacturers. Supplementary information was furnished by state fertilizer control officials and agronomists.

Relationships Between Expenditures for Fertilizers and Farm Income from Crops and Government Payments in the Previous Year

			Expenditures for Fertilizers			
Calendar Year	Cash Income from Crops and Government Payments, Million Dollars	Cash Income Remaining after Paying Production Expenses, %	Actual, million dollars	Estimated by formula, million dollars	Actual as per cent of estimate, %	Per dollar of previous year's income, cents
1946	11,607	42	536	569	94	5.3
1947	13,545	43	606	652	93	5.2
1948	13,393	38	715	708	101	5.3
1949	12,771	34	751	687	109	5.6
1950	12,858	31	828	665	124	6.5
1951	13,468	32	880*	680	129	6.8
1952	14,300*			714		

* Estimates.

Mixtures

Of fertilizer mixtures, 164 grades were consumed in continental U. S. in amounts of 1500 tons or more to account for 95.1% of the total. Nine of these grades accounted for more than 50%. In addition 984 other grades and some 200 to 300 special grades not listed by guaranteed analysis were sold.

Materials

Phosphates continued to lead in quantities of materials consumed, comprising 45.1%, by weight. Chemical compounds of nitrogen followed with 35.1%. Principal net changes in consumption included increases of 42.1% in anhydrous ammonia, 33.8% in ammonium nitrate–limestone mixtures, and 25.2% in ammonium nitrate. Calcium cyanamide consumption decreased 34.2%, while normal and superphosphates fell 20.2 and 6.1%, respectively. Consumption of potassium chloride, and 50 and 60% grades of potassium sulfate rose 10, 8, 56, 6, and 9.2%.

Twelve Grades Represented 74.9% of Mixed Fertilizer Consumption 1951–52

N-P-K-Ratio	Consumption,[a] Tons	Proportion of Total Quantity Mixed Fertilizer, %
0–1–1	784,797	5.30
1–1–1	572,168	3.86
1–2–1	1,025,841	6.93
1–2–2	1,709,354	11.54
1–3–2	1,024,571	6.92
1–3–3	501,610	3.39
1–4–2	756,126	5.10
1–4–4	2,541,223	17.16
1–6–3	512,083	3.46
2–4–3	534,118	3.61
2–5–3	622,084	4.20
4–10–7	508,254	3.43
Total	11,092,229	74.90

[a] Includes all grades having these ratios.

The increase in chemical nitrogen materials was greatest in the east north central region, for natural organics and phosphate in the mountain region and for potassium materials in the west north central region.

Regional Fertilizer Consumption Increases Varied

Area	% Total 1951–52 Consumption	% Total 1951–52 Consumption Increase
North Central	28.1	57
South (South Atlantic and South Central)	49.3	26.6
West	9.6	15.2
Northeast (New England and Middle Atlantic)	11.3	8.1
Territories	1.7	Decrease

Farm Income—Fertilizer Expenditures

The statements by executives of fertilizer organizations show the interest in the effect of changes in farm income on purchase of fertilizers. A study of this matter was presented by A. L. Mehring, Gae A. Bennett, and J. R. Adams, of the Bureau of Plant Industry, Soils, and Agricultural Engineering before the Symposium on Fertilizer Use Potential before the Fertilizer and Soil Chemistry Division of the AMERICAN CHEMICAL SOCIETY in its 122nd meeting (*Plant Food Journal*, VI, No. 4, 2 (1952)).

A formula was developed:

X equals $0.03293A + 0.1766B + 1.159C - 18.844$ where X equals amounts of money spent for fertilizer in given year; A equals cash farm income from crops and government payments in previous year; B equals similar income for current year; C equals proportion of previous year's total cash income remaining after expenses of production are paid.

This formula was applied to data available to give results which were tabulated annually from 1910. The actual amount spent on fertilizer in each of those years has varied from 78 to 111% of the estimate, but more than 70% of the annual figures 1910–48 inclusive, fell between 90 and 105%. In the section of that table shown here, postwar results indicate an upward trend in per dollar expenditure. Rises were visible in the past occasionally but before 1950 the highest level of actual expenditure above the estimate was 115% in 1913. The next highest was 109% in 1930. The trend above this in the period 1949–51 has been striking. However, the authors pointed out that in recent years there has been an increased use of fertilizers by others than farmers. They estimate this amount between \$20 and \$50 million, but even after taking that into consideration, the farm use of fertilizers during the past few years has increased much more rapidly than has farm income. The expenditure for fertilizer of 6.8 cents per dollar of farm income in 1951 set a new high up to that time.

Table V. Fertilizers Consumed in Regions of the United States, During Year Ended June 30, 1952 [a]

Kinds	New England	Middle Atlantic	South Atlantic	East North Central	West North Central	East South Central	West South Central	Mountain	Pacific	Territories	Total
Mixed Grades											
N-P-K	336,132	1,579,938	4,638,255	3,078,696	761,514	1,910,120	636,873	25,997	229,316	267,828	13,464,669
N-P	288	155	1,033	835	184,787	647	16,395	39,115	30,765	1,565	275,585
P-K	65,976	131,624	281,787	316,640	74,101	254,974	73,355	83	1,289	1,170	1,200,999
N-K	0	2	134,919	1,069	10	1,746	27	38	3	7,282	145,096
Chemical Nitrogen Materials											
Ammonia—anhydrous	0	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]	168,273
Ammonia—aqua	0	0	183	53	110	0	1,234	19	18,427	0	20,026
Ammonium nitrate	3,510	17,180	70,218	99,134	119,246	255,832	98,541	29,783	105,614	131	799,189
Ammonium nitrate-limestone mixtures	295	1,478	184,307	28,013	15,618	21,890	5,697	0	219	0	257,517
Ammonium sulfate	781	3,918	9,564	43,804	30,635	36,221	43,524	49,447	192,789	76,134	486,817
Calcium cyanamide	310	4,146	15,496	2,789	296	9,084	3,795	841	5,398	99	42,254
Calcium nitrate	0	0	7,064	872	87	4,909	1,305	4,027	31,109	83	49,456
Sodium nitrate	2,750	19,534	398,523	5,744	571	183,586	67,907	1,721	1,245	180	681,761
Other chemical nitrogen materials [c]	320	2,028	10,669	14,864	18,221	36,751	48,890	23,575	83,352	7,234	77,631 [d]
Natural Organics											
Blood, dried	0	286	48	89	0	0	0	7	1,214	0	1,644
Castor pomace	2,761	51	2,171	0	0	0	7	0	996	0	5,986
Compost and muck	0	0	416	0	0	0	0	0	0	0	416
Cottonseed meal	10,823	31	1,137	0	0	2	0	0	22	0	12,015
Fish emulsion	0	0	0	0	0	0	0	0	842	0	842
Fish scrap and meal	712	16	17	0	0	0	0	0	433	0	1,178
Hoof and horn meal	200	0	0	0	0	0	0	0	0	0	200
Manures, dried	4,477	14,228	3,185	6,162	2,622	994	3,245	2,566	161,243	4	198,726
Sewage sludge, activated	4,343	9,235	3,623	27,295	6,850	1,189	1,731	1,499	14,674	80	70,519
Sewage sludge, other	0	0	0	0	0	0	0	24	37,567	0	37,591
Tankage, animal	0	760	0	0	0	0	0	0	409	0	1,169
Tankage, garbage	0	1	0	73	0	0	0	0	1,100	0	1,174
Tankage, process	1,103	3,227	1,555	92	0	0	0	0	0	0	5,977
Other [e]	517	330	76	0	0	0	0	0	5,455	0	6,378
Phosphorus materials											
Ammonium phosphate, 11-48	0	0	0	205	2,886	3	198	1,203	6,819	3,391	14,705
Ammonium phosphate, 16-20	0	0	4	2,713	33,157	70	64,436	24,106	72,551	1,081	198,118
Ammonium phosphate, 13-39	0	0	0	40	14,180	0	4,083	2,731	0	0	21,034
Ammoniated superphosphate	0	0	491	0	0	0	2,557	0	4,210	0	7,258
Basic lime phosphate	0	145	195	0	0	1,374	0	0	0	0	1,714
Basic slag	0	70	52,736	19	0	320,314	18,635	0	0	0	391,774
Bonemeal, raw	566	2,176	1,085	336	72	104	230	0	2,317	0	6,886
Bonemeal, steamed	1,394	2,041	261	789	6	203	0	0	62	0	4,756
Calcium metaphosphate	0	0	3,086	6,644	6,107	8,451	297	0	189	0	24,774
Fused tricalcium phosphate	0	0	1,799	590	1,650	10,930	0	0	0	0	14,969
Phosphoric acid: 20-53% P_2O_5	0	0	0	0	0	0	41	4,654	13,813	0	18,508
Phosphate rock	474	6,224	21,212	711,359	271,649	24,049	77,481	714	4,021	1,674	1,118,857
Colloidal phosphate	80	2,565	1,386	10,692	12,688	12,521	1,011	220	0	0	41,163
Precipitated bone	291	0	0	0	0	0	0	0	0	0	291
Superphosphate, 18%	1,942	31,736	76,466	27,921	12,270	52,010	880	4,332	75,387	0	282,944
Superphosphate, 19%	169	1	3,770	82	4,051	1,311	16,051	32,895	23,928	0	82,258
Superphosphate, 20%	41,090	203,625	79,360	75,624	88,980	147,059	218,704	3,067	2	1,577	859,088
Superphosphate, 30%	0	0	0	0	797	0	3,655	184	0	787	5,423
Superphosphate, 38%	0	0	0	36	17	0	5	0	0	0	58
Superphosphate, 42%	0	0	0	0	21,720	0	0	40,173	5,294	0	67,187
Superphosphate, 43%	0	0	0	0	0	0	0	0	46	0	46
Superphosphate, 45%	1	608	1	5,899	14,666	2,836	23,466	8,298	16,558	211	72,544
Superphosphate, 46%	0	101	0	3,888	21,167	3,088	1,508	3,201	629	0	33,582
Superphosphate, 47%	7	30	145	1,948	4,736	7,297	752	1,004	321	0	16,240
Superphosphate, 48%	0	0	2,399	848	7,293	12,969	1,328	40	0	0	24,877
Superphosphate, 49%	0	0	1,607	57	62	729	1,673	400	0	0	4,528
Superphosphate, 50%	0	0	0	0	337	60	177	0	0	0	574
Potassium materials											
Cement flue dust	0	587	23,639	0	0	500	0	0	0	0	24,726
Cotton hull ash	695	1	0	3	0	0	0	0	0	0	699
Manure salts: 22-30% K_2O	0	115	3,583	1,306	2	165	460	0	0	0	5,631
Potassium carbonate	0	0	148	0	0	0	0	0	0	0	148
Potassium chloride: 50% K_2O	90	665	36,466	29,458	762	35,851	17,415	13	1,825	0	122,545
Potassium chloride: 60% K_2O	2,184	3,144	12,368	43,055	13,663	27,962	10,925	440	2,441	7,849	124,031
Potassium magnesium sulfate	79	126	2,056	814	342	1,096	611	0	0	749	5,873
Potassium nitrate	0	0	5,919	0	0	0	0	0	0	0	5,919
Potassium phosphate ash	0	0	1,363	0	0	725	0	0	0	0	2,088
Potassium sodium nitrate	16	29	213	0	227	1,546	0	540	0	0	2,571
Potassium sulfate	204	122	5,338	460	0	9,348	61	14	3,878	1,008	20,433
Tobacco stems	0	121	1,808	2	0	0	0	0	0	0	1,931
Wood ashes	0	10	3,518	0	0	0	1	0	0	0	3,529
Total primary nutrient fertilizers	484,580	2,042,410	6,106,668	4,551,012	1,748,155	3,400,516	1,419,167	306,971	1,157,772	380,117	21,647,368
Secondary and minor element materials [f]											
Aluminum sulfate	4	58	1	6	0	0	0	0	0	0	69
Borax	54	174	227	331	0	250	7	18	302	0	1,363
Calcium sulfate	1,016	1,577	53,113	40	1,502	440	0	15,046	663,966	0	736,700
Copper sulfate	11	85	5,115	107	0	0	0	0	20	0	5,338
Ferrous sulfate	0	0	0	0	0	0	0	14	0	0	14
Magnesium carbonate	0	0	0	0	0	0	0	0	1,070	0	1,070
Magnesium sulfate	85	21	0	29	0	0	0	0	4	5	144
Manganese sulfate	2	58	8,167	268	24	0	0	0	326	0	8,845
Sulfur: 25-99+%	2	65	4,255	11	0	0	1,465	636	5,505	0	11,939
Sulfuric acid: 40-93%	0	0	0	0	0	0	0	0	6,909	0	6,909
Zinc sulfate	0	11	1,911	5	0	10	0	2	30	99	2,068
Minerals not classified	0	27	926	5	16	0	6,457	7	3,153	0	10,591
Total Sec. and Minor Elem. Mat.	1,174	2,076	73,715	802	1,542	700	7,929	15,723	681,285	104	785,050
TOTAL ALL FERTILIZERS	485,754	2,044,486	6,180,383	4,551,814	1,749,697	3,401,216	1,477,096	322,694	1,839,057	380,221	22,432,418
Relative Consumption, 1951-52											
Fertilizers [g]	106	105	103	114	116	106	101	111	104	79	106
Total N, Available P_2O_5 and K_2O	109	107	105	119	122	112	105	111	104	85	110

[a] Includes distribution by government agencies. Does not include materials for manufacture of commercial fertilizers.
[b] Included with "Other Chemical Nitrogen Materials." Regional data cannot be published without disclosing operations of individual suppliers.
[c] Anhydrous ammonia, ammonium sulfate-nitrate, nitrogen solutions, urea, and unsegregated chemical nitrogen materials.
[d] Does not include above total for anhydrous ammonia.
[e] Miscellaneous seed meals: Linseed (162), Peanut (51), Soybean (362), Tung (15), and unsegregated organics (5788).
[f] Excludes materials distributed by other than manufacturers of fertilizers.
[g] Excludes material not guaranteed to contain the primary elements N, P_2O_5, or K_2O.

SOURCE: WALTER SCHOLL AND HILDA M. WALLACE, BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING, USDA

Summaries from the Symposium on Fertilizer Use Potential at the 122nd ACS Meeting Show that Fertilizers Could Effect Further Great Production Increases

West — Plant Nutrients Use Will Increase

JOHN P. CONRAD, California Agricultural Experiment Station

Within each of the several western states, there is a great contrast in the geographical relief pattern with marked changes in climate and native vegetation. Soils also vary both with regard to parent materials and to the extent of weathering. It is not surprising then, that fertilizer use and practices differ among these states.

Figure 1 shows the fluctuation in consumption of the three principal plant foods in California to be greater than that for the U. S. as a whole.

Figure 2 emphasizes the marked contrast in consumption of phosphate and potash relative to nitrogen.

Why should California use less phosphoric acid and much less potash relative to nitrogen than any other state selected? Hilgard long ago stressed the depth of arid soils and the high reserves of potash, calcium, and magnesium encountered therein. In much of the West, moisture rather than nutrients has been the dominant factor limiting growth. Much of the land has been farmed a much shorter time than has that of the East. Large areas not previously cropped only recently have come into use through irrigation. The removal of the limiting factor of water shortage may, in time, bring a need for increased use of fertilizer.

If the decisions of the agriculturist to recommend and the farmer to purchase are relatively unfettered, we may look upon fertilizer applied as a first approximation to the appraisal of the plant nutrient deficiencies for the crop in the area concerned. The carriers of the three main plant foods often contain notable amounts of sulfur, calcium, and magnesium, and one or more micronutrients. Where that is not true, the validity of the above appraisal is limited. Otherwise, the ratios of nitrogen, phosphorus, and potash used in an area may be looked upon as a general recognition of the soil deficiencies for crops of the area. Undoubtedly the consumptions of the various states (Table I) have been affected by the crops grown in those states. This is brought out in Table II. There, as previously mentioned, it is seen that less phosphoric acid and potash are used in the West than in the rest of the U. S. Crop influence stands out with

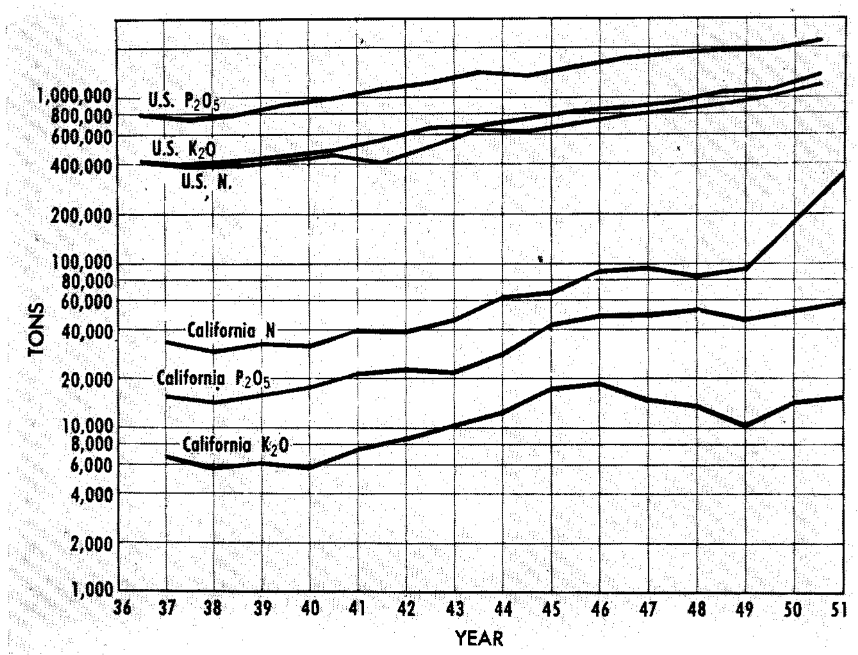


Figure 1. Trends in the consumption of plant foods in the United States and in California

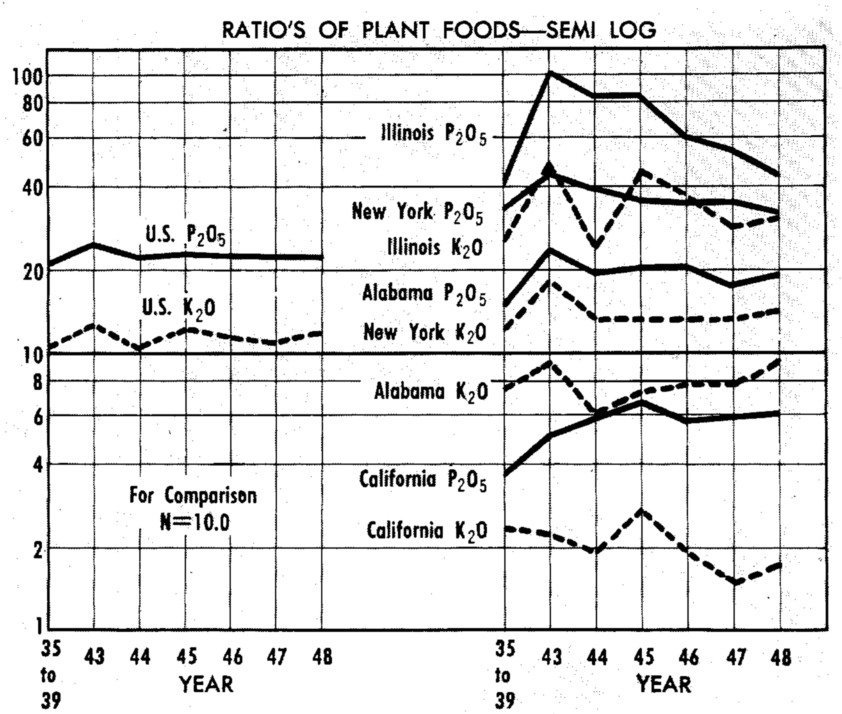


Figure 2. Ratios of plant foods consumed in the United States and in selected states. For comparison nitrogen is assumed as 10.0

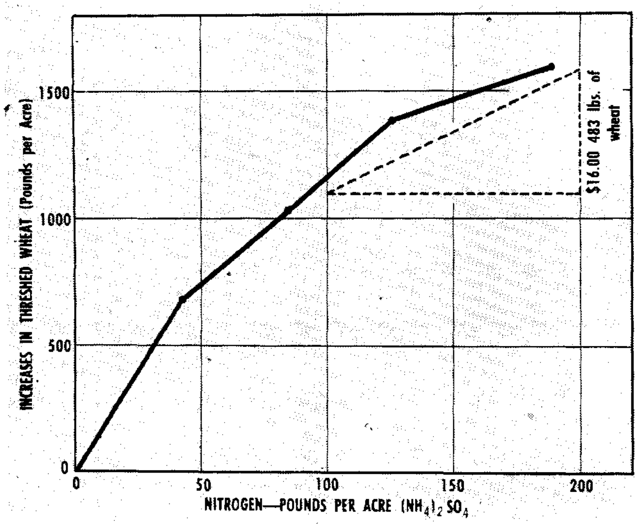


Figure 3. Increases in the yield of wheat following sorghum from nitrogen—El Centro, California

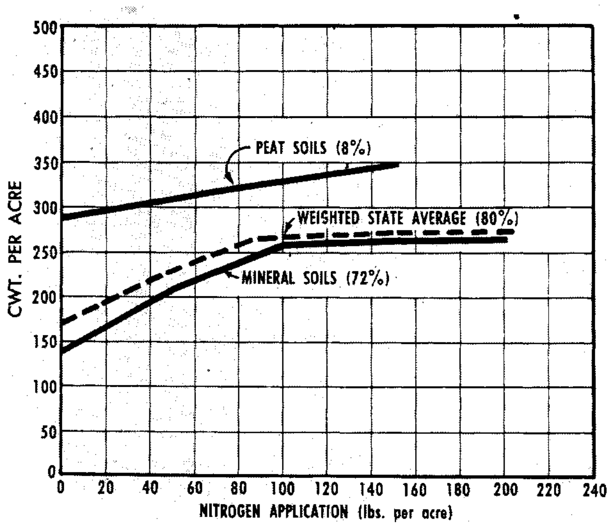


Figure 4. Responses of potatoes to nitrogen from 36 field trials—California

hay which has high phosphorus and potassium requirements, while fruits are low in those requirements.

Figure 3 shows a method of estimating potentials of fertilizer use for more efficient crop production. The curve shown is for one crop area for one year. To get an average for a district, several tests must be grouped. In actual practice, we gather much information from the farmer as to the results of their experiments.

The National Fertilizer Work Group and its colleagues have gathered a great deal of data on fertilizer and its uses. Figure 4 shows an example of a basic type of data with a particular nutrient and a specific group.

A study has been made to estimate agricultural production capacity to 1955. Table III shows the estimated increases in the use of plant foods in the 11 western states, as compared with the U. S. total.

Table IV shows the estimates by crop type. Largest increases in the use of fertilizers on field crops are anticipated with cotton, small grains including rice, and irrigated forages including hay and pasture.

Nitrogen, phosphoric acid, and potash are the plant foods generally contained in fertilizers to correct one or more deficiencies. But other deficiencies occur and we have found the following listed by crop and in decreasing order:

Citrus fruits: N, Zn, Mn, P, Cu, K, Fe (Mg)

If future changes in economic conditions are not too great, we may look forward to a small, but gradually increasing, use of added plant nutrients on horticultural crops as acreage is increased and virgin fertility declines.

There are greater potentials perhaps in view of the increasing number of plant nutrient needs for our field, pasture, and range plants on the different soils of the western states.

Table I. Annual Consumption of Plant Foods and Their Ratios In the Western States, 1950–1951

State	Nitrogen, Tons	Phosphoric Acid, Tons	Potash, Tons	Ratio, $N:P_2O_5:K_2O$
Montana	2,018	5,328	28	10:26.4:0.13
Wyoming	190	2,040	38	10:107.0:2.00
Colorado	6,760	11,060	1,159	10:16.4:1.70
New Mexico	2,367	5,188	104	10:22.0:0.40
Idaho	3,347	9,186	252	10:27.4:0.75
Nevada	20	250	9	10:125.0:4.50
Utah	4,027	3,472	189	10:8.7:0.50
Arizona	22,349	11,174	631	10:5.0:0.30
Washington	11,907	9,417	3,970	10:7.9:3.30
Oregon	17,285	13,540	3,107	10:7.9:1.80
California	142,063	66,270	18,170	10:4.6:1.30
TOTAL				
Western States	212,323	136,915	27,645	10:6.4:1.30
Continental United States	1,171,418	2,086,007	1,337,322	10:17.7:11.40

Table II. Ratios of the Total Tonnages of N, P_2O_5, and K_2O Received by Selected Crops in the Western States and in the United States with Acreages and Tons of Nitrogen Applied in the Former Area

Nitrogen Tons	Acres, 1,000 A	Crop	Ratios: Western region $N:P_2O_5:K_2O$	Ratios: United States $N:P_2O_5:K_2O$
6,772	11,500	Wheat	10:4.0:0.00	10:34.0:16.0
13,474	4,900	Barley	10:2.6:0.00	10:13.0:2.6
26,708	1,100	Cotton	10:2.9:0.06	10:6.4:5.7
14,083	653	Sugar Beets	10:9.8:0.50	10:13.0:3.2
9,868	453	Potatoes	10:8.0:1.60	10:1.60:14.8
28,040	1,001	Vegetables	10:7.8:2.80	10:16.0:10.3
55,133	1,897	Fruits	10:1.4:0.20	10:5.5:5.0
1,005	8,222	Hay	10:300.0:0.00	10:120.0:28.0
7,828	3,822	Pasture	10:19.0:0.40	10:91.0:22.0

Table III. Estimated Increases in the Use of Plant Foods In the Eleven Western States, 1950–1955

Sub-Region	Nitrogen 1,000 tons	Nitrogen %	Phosphoric Acid 1,000 tons	Phosphoric Acid %	Potash 1,000 tons	Potash %	Total Plant Foods 1,000 tons	Total Plant Foods %
Mountain	32.1	88	29.8	61	0.1	2	61.9	70
Pacific	72.0	48	49.6	62	3.8	21	125.4	50
Total U. S.	971.3	93	1,132.4	54	834.2	77	2,927.9	70

Table IV. Estimated Acreage in and Use of Plant Foods on Different Types of Crops in California In 1950 and 1955

	Fruit & Nut		*Truck*		*Field*		*Total*	
	1950	*1955*	*1950*	*1955*	*1950*	*1955*	*1950*	*1955*
Acres, 1,000	1,495.0	1,533.5	613.2	654.0	7,188.8	7,762.5	9,297.0	9,950.0
Increases	38.5 =	2.6%	40.8 =	6.7%	573.7 =	8.0%	653.0 =	7.0%
Nitrogen (N) tons	48,957	52,322	19,338	21,144	57,358	98,519	125,653	171,985
Increases	3,365 =	7.5%	1,806 =	9.3%	41,161 =	72%	46,332 =	36.9%
Phosphoric Acid (P_2O_5) tons	8,005	8,514	15,169	16,361	36,693	76,634	59,867	101,509
Increases	509 =	6.3%	1,192 =	7.8%	39,941 =	109%	41,642 =	69.6%
Potash (K_2O) tons	5,850	6,206	4,075	4,596	2,251	2,577	12,176	13,379
Increases	356 =	6.1%	521 =	12.8%	326 =	14.4%	1,203 =	9.9%

South — Farmers Must Be Convinced

JAMES A. NAFTEL,
Pacific Coast Borax Co.

It is only through the use of some quantity of applied fertilizers that farmers of the South have been able to continue in production. As recently as 1938, the Southeast consumed over 60% of the commercial fertilizer of the entire U. S.

Table I shows that many of the crops produced in the South are at a production level of one third to one half of the potential considered feasible. The consumption of plant food per acre in 1950 gives a good answer to much of the cause for low crop production. Only with tobacco and vegetables does the use of plant foods appear adequate; there, the resultant yields approach a fair potential.

It is time that consideration be given to the production of maximum potential yields consistent with profitable and efficient crop production.

In Alabama, for example, more than 1.13 million tons of chemical fertilizer was used in the year 1951–52; this was less than half the amount recommended by state agricultural leaders. Although twice as much fertilizer was consumed in 1951 as in 1940, it is estimated that only 30 pounds of P_2O_5 is being applied per acre of fertilized pasture lands while 80 pounds is recommended and profitable. The importance of secondary and minor elements has been shown at the Monroeville Experiment Field where, in 1951, the addition of sulfur yielded an increase of 550 pounds of seed cotton. The use of borax increased crimson clover seed yields by 244%.

"Extra yield farming" is possible through research information and application, and this is needed in the South. In 1950, cotton received an average of 14-14-9 pounds of N, P_2O_5 and K_2O per acre for a potential of only 38% of maximum. In Mississippi in 1949, the average quantity was 38-15-10 pounds per acre to realize a 36% potential of production. In 1951, 207 farmers in the "five acre contests" produced an average of 730 pounds of lint cotton per acre on 1035 acres while the state average was only 316 pounds. The winner produced 1507 pounds per acre. It does not seem visionary to state that cotton production in Mississippi could be doubled without new acreage. In 1951 in South Carolina, cotton averaged 389 pounds per acre which was a high average but was dwarfed by an all time record of 1676 pounds of lint per acre, set that year on 5 acres. The stimulant in this extra yield farming was adequate plant food and other good practices and man-

Table I. Principle Crops, Acreage, and Current Fertilizer Usage of Important Crops in Southern Region[a] (Preliminary Data)

Crop	Acreage	Current Fertilizer Usage, lbs./A N	P_2O_5	K_2O	Production Potential, %	Current Yield per A
Cotton	24,976,000	14	14	9	38	640 lbs.
Corn	23,899,000	15	13	9	34	26 bu.
Hay	13,075,000	1	11	3	54	2000 lbs.
Pastures	154,082,000	0.4	5	0.8	—	—
Peanuts	2,296,000	3	15	9	61	807 lbs.
Togacco	1,453,000	37	89	64	78	1201 lbs.
Vegetables	1,749,700	43	72	50	—	—

[a] Fertilizer use and crop yields in the Southern Region, Report No. 1 of the Fertilizer Work Group, National Soil and Fertilizer Research Committee, July 1951.

Table II. Average Efficiency of Different Rates of Nitrate of Soda Nitrogen Applied to Bermuda Grass in Producing Hay and Protein During the 3-year Period 1947–1949

Pounds of N applied per acre per year[a]	Pounds of Hay: Per acre	Due to N	Per pound of N	Pounds of Crude Protein: Per acre	Due to N	Per Pound of N	Percent of N Recovered in Hay
0	2,100	—	—	137	—	—	—
50	4,212	2,112	42.2	269	132	2.64	42.3
100	7,448	5,348	53.5	513	376	3.76	60.2
200	10,834	8,734	43.7	959	822	4.11	65.7
400	16,339	14,239	35.6	1,746	1,609	4.02	64.4

[a] Annual supply of N applied in four equal amounts, one in March and one after each of the first three cuttings of hay.

Table III. Effect of Borax on Alfalfa Strains

(Acre yields—average 3 years 1945–47)

Strain	Treated 20# Borax per Acre Dry Hay Average Tons	Untreated Dry Hay Average Tons	Increase from Borax Tons
Kansas A-147	5.58	4.87	.71
Kansas Common	5.14	4.15	.99
Ranger	4.75	3.50	1.25
Kansas Common	5.54	4.51	1.03
Buffalo	5.68	4.39	1.29
Oklahoma Common NC	5.68	4.27	1.41
Oklahoma Common SW	5.25	4.19	1.06
Oklahoma A-185	5.96	4.58	1.38
		Average increase for 20 pounds borax	1.14

agement. The South Carolina Agricultural Experiment Station has indicated that for the period 1921–51, fertilizer can be credited with an increase in average cotton yield from 604 pounds to approximately 1900 pounds seed cotton per acre.

Many agricultural leaders consider corn production the number one opportunity in the South. An example of what can be done is seen in experiments of the Mississippi Agricultural Experiment Station from 1946–51 throughout the hill section of Mississippi where the response of corn to fertilizers (and proper spacing) was measured as follows:

Nitrogen Lb/ Acre	*Plants No./ Acre*	*Yield Bu./ Acre*	*Increase Over No N*	*Ratio Returns/ Cost of N*[a]
0	4000	22	..	...
60	8000	52	30	$8.75
120	12000	72	50	$7.07

[a] Corn valued at $1.75 per bu. and N at 10 cents per pound.

The data show a mean return of one bushel of corn for each two pounds of nitrogen for the first 60-pound increment of nitrogen and a somewhat lower rate for the second 60-pound increment of nitrogen.

The world's "Corn King" in 1951, Cledith Rowe of Magoffin County, Ky., produced 233.2 bushels of corn on an acre of land which had been built up from a level of 17 bushels per acre in 1936.

Only recently has the importance of grassland farming to the agricultural economy begun to attract attention in the humid South. Year-round grassland farming systems are replacing the one-crop, half-time farm operations that brought despair and near economic ruin to the area. It is estimated that by proper grassland management, the Southeast could increase its cattle and sheep production by 475%. One of the foremost examples of grassland development is the growth of Coastal Bermuda grass by Glenn Burton of the USDA and the Georgia Experiment Station at Tifton.

Table II gives an indication of what has been done during the three-year test period with Coastal Bermuda.

Reports from the Florida Agricultural Experiment Station show that new grasses with adequate fertilization make for more and better quality feeds. As an example, Pangola grass treated with 500 pounds per acre of 6-6-6 in February yielded 3.82 tons per acre in July and where this was followed by 200 pounds per acre of nitrate of soda, yielded an additional 2.31 tons of hay, giving a total of 6.13 tons of hay for the season.

The greatest problem facing us is the conversion of farmers to the desire and determination to use adequate plant foods and other necessary production and management factors to at least double their production per acre.

North Central — Doubled Yields Are Possible

K. C. BERGER,
University of Wisconsin

Great progress has been made during the past 10 years in increasing crop production in the north central region of the U. S. This must be credited mainly to the expansion in the use of commercial fertilizer, the increased technological information available on methods of fertilization, better control of insects and diseases, and increased farm mechanization.

In the eastern part of this geographical area, soils have been farmed longer and are in the humid region where considerable leaching has taken place. In general soils are more acid and lower in available plant food elements. In the western part of the region, many of the soils are neutral to slightly alkaline. The northern soils are generally higher in organic matter than the southern.

Table I shows that only during the past decade has the north central region become fertilizer conscious. The increase in use is greater in this area than in any other of the U. S. Within the north central, fertilizer use still is relatively small: on the slightly more than 225 million acres, the average annual application is only 1.5 pounds N, 6.8 pounds P_2O_5, and 3.3 pounds K_2O per acre.

Fertilizer usage by crops is shown in Table II. Corn receives the greatest total, while tobacco, minor in area, receives the highest concentration.

Data given in the preliminary report of the Fertilizer Work Group of the National Soil and Fertilizer Research Committee show for the north central region that raising the application of nitrogen would give the results indicated in Table 3.

Table III. Increases Estimated Possible by Increasing Use of Various Fertilizer Elements to 40 lb. per Acre

Crop	Increase of Fertilizer Element	Predicted Yield Increase (%)
Corn	Nitrogen	25
Wheat	Nitrogen	33
Rye	Nitrogen	46
Oats	Nitrogen	41
Potatoes	Nitrogen	38
Pasture	Nitrogen	62
Flaxseed	Phosphate (as P_2O_5)	26
Barley	Phosphate (as P_2O_5)	22
Rye	Phosphate (as P_2O_5)	48
Corn	Phosphate (as P_2O_5)	12
Hay	Potash	26
Pasture	Potash	15
Soybeans	Potash	19
Corn	Potash	7

The effects shown in Table III are translated, in Table IV, into combined effects of full fertilization to show the potential increase in actual bushels.

Estimates of yield potentials in the

Table I. Fertilizer Consumption in the United States, 1941 and 1951

Region	*Total Consumption Short Tons*		*Increase in Consumption*	
	1941	*1951*	*Short Tons*	*%*
North Central	1,219,501	4,633,934	3,414,433	280
Western	382,266	1,257,776	875,510	229
Southern	5,816,656	10,456,233	4,639,577	80
Northeastern	1,762,920	2,315,806	552,886	31

Table II. Acre Usage of N, P_2O_5, and K_2O for the Major Fertilizer Using Crops in the North Central Region, 1950

Crop	*Acres in Region, 1000 Acres*	*Fertilizer Usage, Pounds per Acre*		
		N	*P_2O_5*	*K_2O*
Corn	52,804	3.0	8.4	5.8
Sorghum	1,910	0.7	0.8	0.2
Wheat	40,706	1.8	7.2	3.4
Rye	904	1.4	8.0	5.0
Barley	6,507	0.3	2.6	1.3
Oats	28,813	1.4	7.0	3.6
Soybeans	10,494	0.2	3.0	2.7
Cotton	445	13.0	13.0	17.8
Tobacco	30	43.4	118.0	144.3
Beets	354	7.0	36.6	24.4
Flaxseed	2,012	0.5	3.2	1.5
Potatoes	565	9.3	36.6	38.8
Vegetables	1,367	16.3	35.0	26.0
Fruits	798	17.7	19.0	17.8
Hay	27,704	0.3	7.4	1.3
Pasture	50,178	0.2	4.4	0.7
All Crops	225,591	1.5	6.8	3.3

Table IV. Production Potential of Major Fertilizer Using Crops In North Central Region.

Crop and Unit	Yield in 1950: Average Per Acre	Yield in 1950: Total for Region, 1000 Units	Potential Yield With Full Fertilization: Average Per Acre	Potential Yield With Full Fertilization: Total For Region, 1000 Units	Increase Obtainable With Full Fertilization, 1000 Units
Corn, bu.	44	2,438,694	65	3,586,314	1,147,620
Wheat, bu.	14	598,954	29	1,247,820	648,866
Rye, bu.	14	6,998	30	14,889	7,891
Barley, bu.	19	85,355	37	167,363	82,008
Oats, bu.	35	996,095	58	1,660,158	664,063
Soybeans, bu.	24	188,792	34	265,904	77,112
Potatoes, bu.	144	100,954	335	234,777	133,823
Hay, tons	2	42,842	4.3	93,135	50,293

north central region are very conservative and reflect generally on the increase that could be expected from the increased application of fertilizer. Continued heavy fertilization with resultant increases in active soil organic matter would improve soil tilth and aeration and, thus, contribute to yield still greater increases. This could be increased further through improvements in farm machinery, seed distribution, fertilizer placement, tillage, insect and disease control, and plant variety improvement. The possibility of doubling, rather than increasing by 50%, the corn yield does not seem impossible.

Fertilizer requirements for maximum yields are very large when the practices are first initiated. In Wisconsin, for example, tests indicate that an increase from about 400,000 tons to between 2 and 2.5 million tons of fertilizer annually would be needed. Later applications need not be so great. Experience on the east coast indicates that build-up of plant nutrients occurs following a few years of heavy fertilization. Recent Wisconsin experiments indicate that high crop yields obtained with following initial heavy applications of phosphate and potash can be maintained with subsequent smaller amounts.

Under pressure for all-out food production, present yields in the north central area could be approximately doubled with adequate fertilization and other improved practices.

Northeast — Largest Potential Is in Forage Crops

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THE LARGEST POTENTIAL EXPANSION of fertilizer use in the northeastern states is on forage crops. The report of the Fertilizer Work Group indicates that throughout the Northeast tremendous increases are possible in the production of forage by the adequate fertilization of improved legume-grass mixtures.

The average annual use of nitrogen on permanent grass in the twelve northeastern states is only three pounds per acre on 12 million acres. On two thirds of that land, an increase to 40 pounds per acre of nitrogen applied, providing adequate phosphorus and potash were used, could increase the grass yield 50%. This means that by using an additional 110,000 tons of nitrogen, or doubling the nitrogen consumption of the Northeast, production could be increased to the equivalent of an additional 4 million acres on the current basis. Small grains also could profit greatly by additional nitrogen.

The current use of potash on 10 million acres of improved legumes and grass in the Northeast is only four pounds K_2O per acre. By increasing these applications to 80 pounds—which is still below the minimum which should be added to some soils growing high yielding legumes—this yield increase could also be equivalent to the production of an additional 4 million acres. The 380,000 tons K_2O required as potash would nearly triple present consumption.

Current average phosphorus applications are:

Corn & small grains	30–40 lb. P_2O_5/acre	
Vegetables	105 lb.	"
Potatoes	157 lb.	"
Improved legume-grass mixtures	13 lb.	"
Permanent pasture	5 lb.	"

Experimental results show that increasing the annual phosphorus application from 13 to 40 pounds P_2O_5 on improved legume-grass mixtures would produce a 50% increase in hay and pasture on more than 10 million acres. This change would require an additional 165,000 tons P_2O_5 or an increase of 54% over the 1949 use.

In contrast to the above, the addition of phosphorus and potash to vegetables and potatoes is now at a level so high that as shown in Table I, reductions could be made without serious reductions in yield. Roughly 9000 tons P_2O_5 could be diverted by 10% reduction and 22,000 tons P_2O_5 by a 25% reduction in current use of phosphorus on potatoes and vegetables.

Table I. Effects of Changing Current Applications of Phosphorus to Potatoes and Vegetables

Change in Current Use	Yield Potatoes (Current use —157 lb. P_2O_5/Acre)	Yield Vegetables (Current use —105 lb. P_2O_5/Acre)
−25%	−3.0%	−10%
−10%	−0.9%	− 4%
+10%	+0.7%	+ 3%
+25%	+1.0%	+ 8%

Increased effectiveness of applied phosphorus can be brought about by proper use of manure, sod-forming crops, and crop residues, as the decomposition of these materials by microorganisms produces organic compounds which inactivate iron and aluminum in the soil.

Phosphorus fixation can also be reduced mechanically by application of the fertilizer in bands near the seed and by special pelleting.

The highly inefficient and wasteful use of phosphorus resulting from the side-dressing of crops with complete fertilizer should be outlawed.

Fundamental studies of the mechanism of cation uptake by plant roots should aid understanding of the differences in cation requirement and cation uptake by plant species.

Table II. Average Use of N, P_2O_5, and K_2O for the Major Fertilizer Using Crops in the Northeastern Region

Crops	Acres	Pounds per Acre: N	P_2O_5	K_2O
Corn grain	3,194,000	14	34	26
Corn Silage	114,000	10	28	14
Wheat	1,880,000	5	42	22
Rye	312,000	7	26	10
Barley	344,000	9	40	17
Oats	2,082,000	6	30	14
Soybeans	202,000	—	22	16
Tobacco	119,000	77	79	130
Potatoes	472,000	82	157	196
Vegetables	1,011,000	58	105	83
Fruits	640,000	2	10	9
Legume Grass	10,295,000	1	13	4
Perm. Grass	11,875,000	1	5	2
Average All Crops	32,569,000	8	20	13