Ag and Food Interprets . . .

- **Soil surveys help to size up market for fertilizer, pesticides**
- **Cotton pests develop resistance to chlorinated hydrocarbons**
- **Drastic changes needed to better the 4% return on pesticides**
- **Credit administration—big problem in pesticides industry**
- **It may be 10 years before fertilizer makes headway in forests**

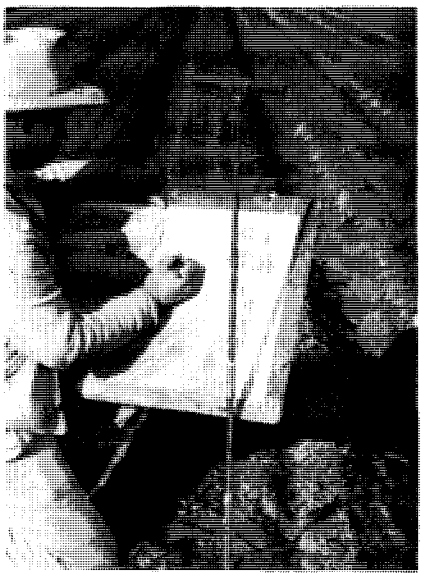
Soil Surveys

Maps and interpretations of soil surveys furnish reliable market research information for fertilizer and pesticide industries

SOIL SURVEYS are the actuarial tables of modern farm management. They capsule experience so that it can be used to reduce inherent risks in selecting crops, types and amounts of fertilizers, planting patterns, and irrigation practices. The detailed maps included in a soil survey allow industry to appraise an area's potential for fertilizer, pesticide, and weed killer sales.

Information for unmapped areas, also, can often be obtained from soil analyses and from planting and fertilizing experience in a similar area already surveyed. For example, 15 to 20 dominant soils from an area must usually be analyzed and characterized before a soil scientist can give technical advice on the use of land. Results of this work can then be extended to other areas where soils are known to be similar, furnishing the basis for predicting crop and chemicals performance in the unmapped district.

Soil mapping currently in progress will contribute to a complete soil map of the United States being compiled by USDA's Soil Conservation Service. To date, says Charles E. Kellogg, assistant administrator for Soil Survey, satisfactory soil maps and modern farm-planning data are ready or published for about 87 million acres of U. S. farmland.



Soil Conservation Service surveyor mapping on aerial photograph

A modern soil survey report, besides giving soil descriptions and classification, includes a great deal of other scientific and economic information:

Soil morphology
Drainage, water, and climate
Transportation and markets
Agricultural history
Types and sizes of farms
Crop yields under alternative systems of farming
Practices required for soil conservation

SCS does not recommend specific crops or fertilizers. Instead, it predicts: If you grow these crops, in this pattern, with suggested fertilizers, then you can expect this result. Basic surveys state the needs for various kinds of fertilizers but not the amounts—e.g., some soils may be spotted as low in phosphorus or potash. It will, says the survey, respond to use of these chemicals in growing certain crops.

In the past, surveys have itemized exact kinds and amounts of fertilizers used or needed in an area. However, specific data of this type become quickly outdated. As farm productivity levels or crop prices change, growers may find it advantageous to use more fertilizers and other cultivating aids. Also, fertilizers are constantly changing—types, grades, uses, and prices. Therefore, believes SCS, it is better for specific information on cultivating to come from the state agricultural experiment stations which cooperate in the soil survey program. Most state colleges now provide soil tests which, with known soils and planned management, can give reliable—about 85% correct—predictions of fertilizer performance.

In planning its rural surveys, SCS gives priority generally to farmland where opportunities exist for improved soil use and crop yields. Two other factors also may determine where SCS will work next—interest of people and groups locally, and seriousness of specific problems. On this basis, special effort has been expended in the drought area for the past two years.

Maps Completed

SCS says it has completed more maps of areas in which fertilizers are important than of areas in which the need is not so great. In Mississippi, Alabama, North Carolina, and Florida, active grower interest is backed up by industrial fertilizer research. Many of these areas, therefore, are mapped in detail. Where they are not, SCS can still furnish useful soil facts to agricultural industries. Some old maps, prepared by the Government in earlier efforts to aid individual farmers, even though not up to date are valuable for fertilizer application data.

The Soil Survey staff of SCS,

like many other research groups, has difficulty finding competent scientists for its fundamental work. This work currently includes perfecting a soil classification system. Both soil formation and soil environment must be studied if the system is to have permanent value.

In this project, some 70,000 U. S. soils are being sorted into units for predicting soil use and management, and finally into "land capability classes" (see chart).

USDA believes a bar to adequate agricultural production may develop in the future if there is no check on diversion of farm lands to urban and other nonagricultural uses. Soil maps and, of course, the soil classification system will play a major role in any program devised to stop this trend. Maps are also needed in the National Water Policy Program. Here the experts foresee a water shortage when the time comes for an increase in farm production.

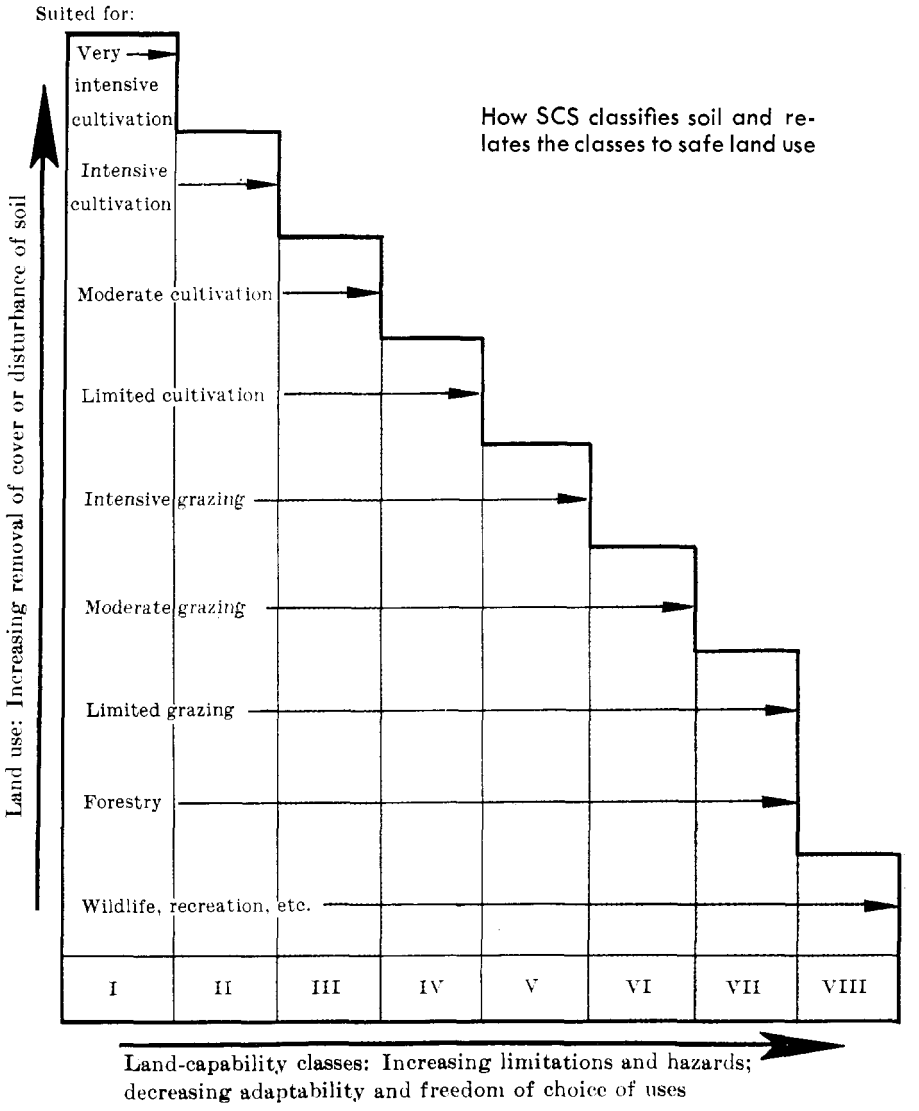
These long term requirements for soil information have helped put SCS's work on a realistic plane. One result: 1960 is now set as a desirable date for completing SCS's conversion of all older surveys to newer standards. Included in this project are some 2000 U. S. counties.

Estimates of SCS's total workload in July 1956 showed approximately 788 million acres of farmland remaining to be fully mapped and described. In addition, 605 million acres of grazing and ranch lands are to be charted in less detail. Progress on this vast project, says Kellogg, can be expected at the rate of 35 to 40 million acres a year.

Soil surveys are published mainly by USDA. Copies may be obtained through local Soil Conservation Districts and state experiment stations. Otherwise surveys may be purchased from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Costs range from $1.25 to $6.75.

An aerial photographic mosaic is pieced together from separate aerial photos to form one picture of a county. Soil data are transferred to plastic-coated mosaic by scribing process (See Cover)

How SCS classifies soil and relates the classes to safe land use



Cotton Pest Resistance

Now widely recognized, although still restricted to local areas, resistance to chlorinated hydrocarbon insecticides adds to planters' worries

RESISTANCE OF COTTON INSECTS to insecticides poses a serious threat to an important segment of the agricultural chemicals industry. While the problem is limited in area and effects now, far-reaching implications lie in the possible development of "hard-to-kill" pests that damage some or all of the useful plants grown by man.

In 1954, chlorinated hydrocarbon insecticides failed to control boll weevils satisfactorily in some areas of Louisiana. However, skepticism greeted first reports of hard-to-kill weevils. Subsequent programs seeking reliable data on insect resistance in Louisiana turned up the additional finding that weevil resistance appears to be genetic.

Still, most entomologists hesitate to make general statements. Marvin Merkl of USDA's station at Stoneville, Miss., points out that his work to date hasn't conclusively answered such questions as what resistance means to pest control measures, how resistance varies in degree, or how it can be overcome. There has been no uniform correlation between resistance and kill

of pests or crop yields in experiments conducted in Mississippi. There are only indications of the trends resistance takes. Each field is an individual problem in Mississippi, concludes Merkl, and each should have pesticide recommendations on the basis of local pest-vs.-pesticide experience.

What and How of Resistance

L. D. Newsom of Louisiana State University, who summarized the resistance picture through 1956 at the National Cotton Council's recent production conference, says several mechanisms for insects' development of resistance to chemicals are theoretically possible:

- Changes in composition or in permeability of the cuticle.
- Development of a detoxication mechanism.
- Storage of the insecticide at an insensitive site.
- Development of an insensitive mechanism to perform a function previously performed by a sensitive mechanism.

On the other hand, entomologists, custom applicators, and others agree that factors other than resistance often cause or contribute to failure to control cotton pests. Some are: excessive rainfall, low temperatures during growing season, heavy carryovers of weevils from the previous year and favorable conditions for early build-up of heavy populations, poor formulations, careless applications, inadequate doses of pesticides, and seasonal variations in pests' tolerance of insecticides. By failing to follow application recommendations—time, quantity, and method—planters may aid development of populations that are hard to bring under control.

Population pressure is actually the limiting factor in many control programs, Merkl points out. With given weather conditions, population pressure may be such that no insecticide will give satisfactory control. With other population pressures, good control can be achieved with virtually any insecticide. Still another population pressure may make poisoning economically unsound.

Combating Resistant Cotton Pests

Some hard-to-kill insects can be controlled satisfactorily, on a short term basis at least, by use of insecticides other than the chlorinated hydrocarbons. In Louisiana during 1956, recommendations called for use of calcium arsenate and methyl parathion in areas known to contain many resistant boll weevils. Chlorinated hydrocarbons were recommended with reservations for those areas where resistance was not important in 1955. Louisiana recommendations for 1957 are similar to those of 1956, with guthion, malathion, and EPN also recommended for use in areas where weevils are resistant.

In Texas, where resistance was reported in a few fields in one county in 1956, proof of resistance will not be available until additional toxicity tests are made in 1957, say Texas Agricultural Experiment Station entomologists. George P. Wene, entomologist of the Weslaco substation, reports that no resistance has been found in Texas' Rio Grande Valley, an important cotton growing area. Wene continues to recommend chlorinated hydrocarbon insecticides there; during rainy periods, he suggests increasing dose and application rate and shortening the interval between applications.

In Mississippi it appears that resistance occurs in areas where many applications of chlorinated hydrocarbon insecticides have been consistently used for five or six years, says Ross E. Hutchins, entomologist at Mississippi's experiment station. Studies on the extent of resistance and on killing effectiveness of various insecticide combinations will continue this year. In 1956 many Mississippi planters met the problem by using mixtures of chlorinated hydrocarbon insecticides with malathion, or by using methyl parathion or calcium arsenate.

Two drawbacks arise in substituting one pesticide for another to combat resistance. First, hazards associated with use of some alternative insecticides prevent their being completely satisfactory for boll weevil control. Second, switching from one insecticide to another is likely to provide nothing more than temporary relief in fighting hard-to-kill pests. C. H. Hoffman of USDA's Entomology Research Branch points out that development of tolerance to one insecticide seems to dispose an insect to developing tolerance to other insecticides of the same type. Furthermore, certain mites and insects

Status of Cotton Pests' Resistance to Chemicals at End of 1956 Season

(Resistance found only in small areas in all states except Louisiana)

State	Pest	Status[a]	Insecticide Involved
Alabama	Boll weevil	Suspected	BHC and toxaphene
	Cotton aphid	Suspected	BHC
Arizona	Salt marsh caterpillar	Proved	Chlorinated hydrocarbons
	Cotton leaf perforator	Proved	Chlorinated hydrocarbons
	Lygus hesperus	Proved	Chlorinated hydrocarbons
Arkansas	Boll weevil	Proved	Chlorinated hydrocarbons
	Cotton aphid	Suspected	BHC
California	Cabbage looper	Proved	DDT
	Salt marsh caterpiller	Proved	Toxaphene
	Spider mites (*T. pacificus* and *T. atlanticus*)	Proved	Organic phosphates
	Beet armyworm	Suspected	....
	Cotton leaf perforator	Suspected	....
	Lygus hesperus	Suspected	DDT
	Southern garden leafhopper	Suspected	DDT
Louisiana	Boll weevil	Proved	Chlorinated hydrocarbons
	Cabbage looper	Proved	DDT
	Cotton aphid	Suspected	BHC
Mississippi	Boll weevil	Proved	Chlorinated hydrocarbons
	Cotton aphid	Suspected	BHC
	Spider mites	Suspected	Organic phosphates
	Thrips	Suspected	Chlorinated hydrocarbons
South Carolina	Boll weevil	Proved	Chlorinated hydrocarbons
	Spider mites	Suspected	Sulfur and parathion
Texas	Boll weevil	Proved	Chlorinated hydrocarbons
	Onion thrips	Proved	Chlorinated hydrocarbons

[a] "Proved" in all cases refers to laboratory tests, confirmed in some cases by field tests.

have become resistant to some of the organic phosphorus materials brought into play upon indications of failure by the chlorinated hydrocarbons.

Needs and the Future

Fundamental research at several universities may answer a number of questions concerning insects' resistance to chlorinated hydrocarbon insecticides. It has already been found, for instance, that an enzyme, DDT-dehydrochlorinase, reduces DDT to a relatively nontoxic product. This enzyme is found in high concentrations in DDT-resistant flies, and also appears in other insects, such as the Mexican bean beetle, known to be difficult to control with DDT.

Entomologists are confident that expanded research programs will provide the answers to the growing resistance problems. More fundamental studies will prove valuable in fighting pests attacking all crops. Newsom, however, points out these immediate needs, in relation to cotton insect control:

- To determine if manipulating application methods and combinations of insecticides will prevent or delay development of resistance in cotton pests.
- To determine how insecticides kill insects. This information should aid in developing insecticides that will not allow resistance to develop rapidly or to economically important levels.
- To prepare toxicity curves for various insecticides on all pests and potential pests, using wherever possible test populations that have never been exposed to the insecticides. This information will permit detection of resistance when it first appears.
- To determine if reversion to susceptibility will occur when selection is relaxed by changing to an insecticide with a different mode of action. Study on this point has begun at LSU in cooperation with the Entomology Research Branch of USDA.

While chlorinated hydrocarbons are still the insecticides of choice for all but a few local areas in the cotton belt, growers have been alerted to what K. P. Ewing, in charge of the USDA's Cotton Insects Section, has termed "the number-one problem now facing cotton entomologists"—build-up of resistance in cotton pests. The future may require growers and the insecticide industry alike to accept drastic changes in recommendations, often on short notice. This is true not only for cotton pests, but for others as well. There can be no excuse in the future, concludes Newsom, for being caught as unprepared for the development of resistance in a pest as was the case with the boll weevil.

Profiting from Pesticide Sales

Drastic changes are called for if pesticides industry is to produce fair return on capital. Pre-tax profits on sales estimated at less than 4% for many formulators

WHEN IT COMES to earning a reasonable return on the capital that must be employed in business, what applies to a peanut stand or to a colossus like General Motors can be expected to apply to a company dealing in agricultural chemicals. Unfortunately, when current (1956) performance data for the pesticides industry are compared with those of a number of other industries, agricultural chemicals are found wanting.

Recognizing the reasons for this poor showing, and forcing the improvements that will rectify it, are urgent needs in the industry, says F. C. Shanaman, president of Pennsylvania Salt Mfg. Co., of Washington. Using the best data he could secure for an industry that suffers from a "great data famine," Shanaman constructed for registrants at the spring meeting of the National Agricultural Chemicals Association in San Francisco an unflattering picture of the average or typical pesticides firm. While some assumptions were necessary in the absence of statistics, the financial picture that emerged is considered reasonably representative of industry experience in recent years.

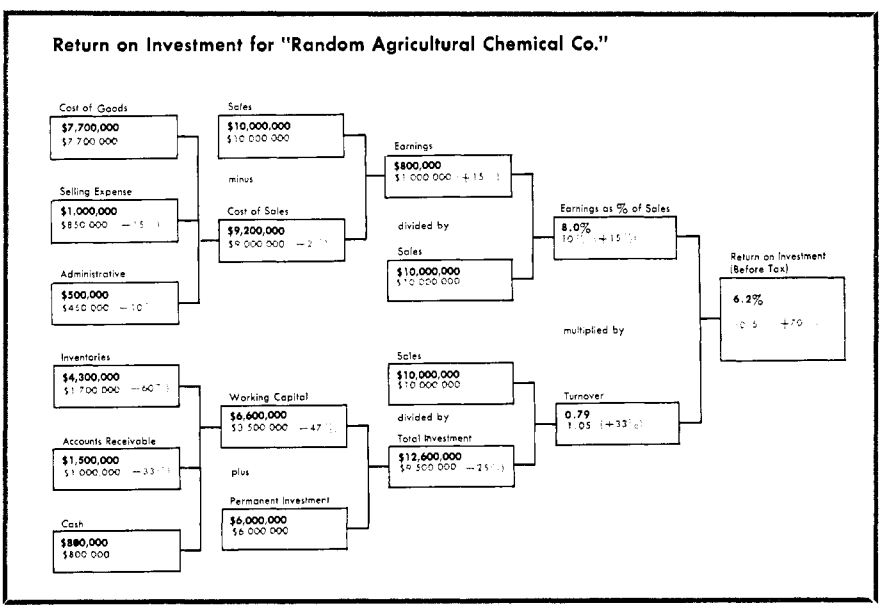
The Sore Spots

As Figure 1 indicates, the pesticides industry suffers from having too much of its money tied up in accounts receivable and inventories. As a result, it winds up with an exceptionally high ratio of current assets to total assets, a low turnover rate, and—the ultimate yardstick of effectiveness—a low return on investment. It is noteworthy that in all of these areas, the industry compares unfavorably with the over-all chemical industry of which it is a part.

Shanaman estimates that more than 50% of national formulators are earning less than 4% on sales before taxes. Out-of-pocket costs are probably 70 to 90 cents on every sales dollar, leaving little to cover fixed costs and provide a profit. Total capital requirements are high—averaging between 70 and 75 cents for each sales dollar—with the major investment not in plant and equipment but in current assets, chiefly inventories and accounts receivable.

Because of the seasonal nature of the business, large inventories may accumulate in raw materials, packages, labels, intermediates and concentrates, and finished products. Consignment practices related to these inventories and compounded at all levels from the basic manufacturer down to the dealer increase the number of dollars

Figure 2



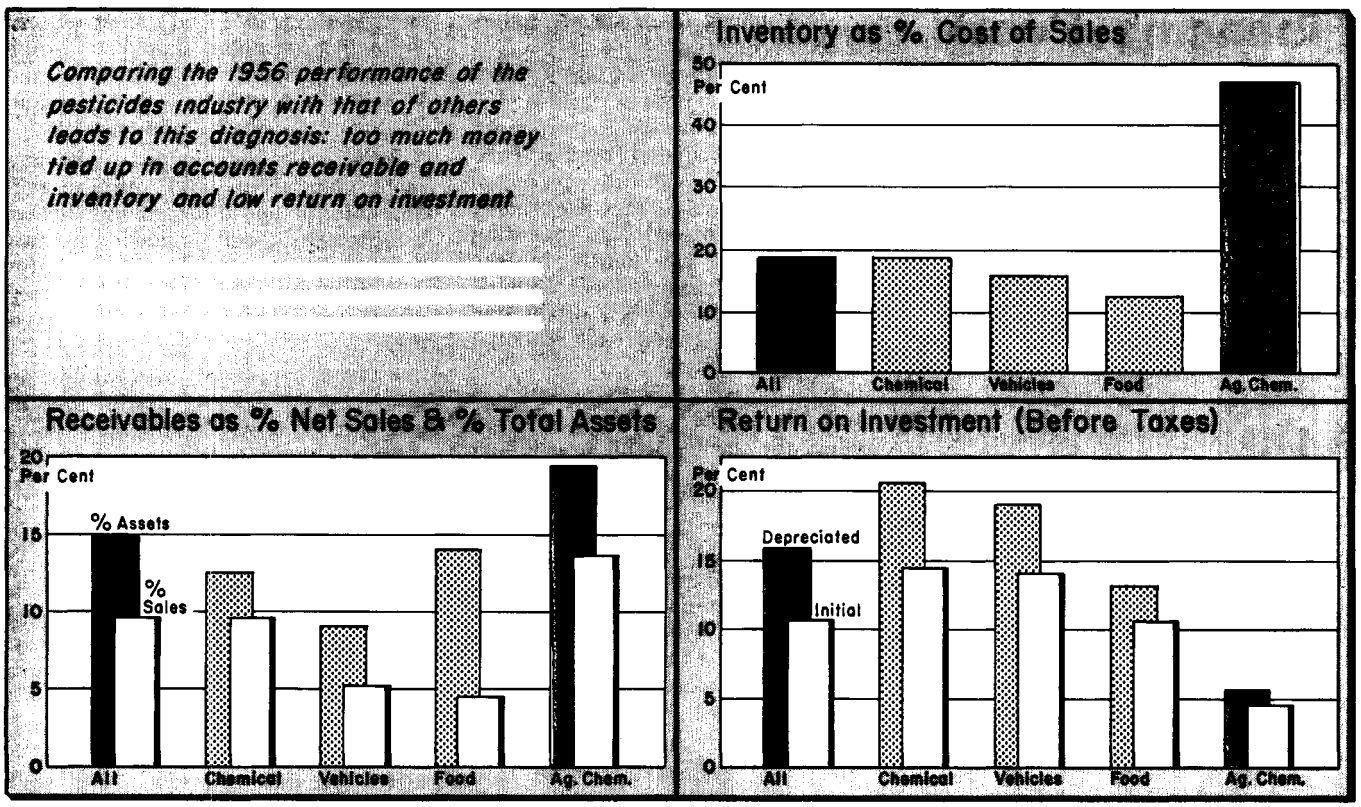


Figure 1

tied up, the cost of goods sold, and the proliferation of paper work.

Major abuses are evident in the handling of accounts receivable. Terms of 30 days net are the exception rather than the rule. Even on shipments that carry 30-day terms, payment is frequently, by agreement, not required for 60, 90, 120 days, or even a longer period. In other instances, invoicing may be delayed for as long as 120 days after shipment, and after making use of such liberal credit, the buyer still has 30 days in which to pay. Industry use of "crop terms," although not widespread in the past, now seems unfortunately to be growing. This practice calls for invoicing at time of shipment, but payment is delayed until the end of the season when the customer has sold the crop for which the seller's goods have been purchased.

Even for manufacturers of products enjoying relatively high profit margins, soft credit terms are hard to justify. One analyst has stated that a product showing a 40% margin provides only 10% return on investment after four months on the seller's books as a receivable. In many cases, says Shanaman, it probably would be better business judgment to risk loss of a sale rather than carry excessive inventory or grant such liberal credit terms that they would be difficult to duplicate at commercial lending institutions.

As the industry or the individual company seeks to improve the relationships among its sales, profits, and capital investment, emphasis on sales volume alone will not guarantee a satisfactory profit. While bigness in agricultural chemicals is sometimes desirable, it is not necessarily a panacea for what may be wrong, nor will it necessarily produce a satisfactory return on investment.

Possible Remedies

While some improvement may be gained through decreased costs, increased prices, or increased sales, the big areas for improvement in the pesticides industry lie in better inventory control, reduced accounts receivable, better use of generated cash, and more careful consideration of additions to fixed capital. Furthermore, in an industry in which product obsolescence is extremely important, good practice demands taking rapid write-offs wherever possible on newer-type pesticides. Research expenses in some agricultural chemical operations run as high as 7% of sales (2% for the chemical industry as a whole), including the cost of establishing tolerances under the Miller Amendment. Research and legal expenses must be taken into account if a firm is to know its actual earnings on agricultural chemicals.

Figure 2 is a Du Pont-type chart for return on capital employed, as described in *Chemical and Engineering News* (Sept. 5, 1955). This chart shows that for a typical agricultural chemicals firm in 1956, a sales volume of $10 million produced earnings of 8% on sales. With capital investment of $12.6 million, indicating a turnover of 0.79, the resultant return on investment is a relatively low 6.2%. The return in industry at large in 1956 was actually some 50% above this.

The colored figures in the chart show changes which could be made to bring the typical pesticides company into line with the average for all industries with respect to return on investment. To effect such drastic changes, better management extended right down the line would be good medicine, and probably the only sure cure for the industry's ailments.

Regardless of the inherent volatility of the pesticides industry, says Shanaman, the industry can and should judge itself professionally by the same yardsticks used by contemporary industries in or out of the chemical field. The industry has been immature, but there is no compelling reason for it to remain so. Maturity, however, will require more accuracy and somewhat less emotion in charting a course for the future. A commitment to do better in the area of return on dollars employed is essential. The required surgery can be done, says Shanaman. In time it will have to be done, or many companies in the industry will not survive.

Financing Pesticide Purchases

Prudent financing for the user, sound credit practices to benefit both user and manufacturer are important fiscal needs of the pesticides industry

MONEY AND CREDIT policies have given the pesticides industry some of its most troublesome times. Abuses in the use of credit extended by manufacturers have sometimes led to near-disaster, and the failure of lending agencies to investigate fully before financing farming operations has often resulted in trouble for all concerned. Doubtful fiscal practices affecting the industry have added to its difficulties in securing a fair profit on its capital investment (see page 246).

Fortunately, much of the trouble seems to be past. And if the industry acts on the information and advice proffered last month at the National Agricultural Chemicals Association's spring meeting in San Francisco, money matters may lose their standing as a hazard on the pesticides course.

Root of the money problem lies in agriculture's technological revolution, during which machinery and chemicals—requiring increased capital—have contributed immensely to the farmer's productivity. As Earl Coke of Bank of America told the NAC, money has been substituted for labor and land in the production process.

No agricultural activity demonstrates this substitution more forcefully than the use of chemicals. Last year, more than six times as much fertilizer (N, P_2O_5, and K_2O) was applied as in 1920. In pesticides, farmers' expenditures have increased 20-fold since 1920. The estimated $400 million farmers spent last year to purchase pesticides, says Coke, points up the need for money to obtain efficient crop and livestock production.

While capital requirements of agriculture have increased rapidly in recent years, and money is now generally in tight supply because of excessive demands throughout the economy, there is no shortage of credit and financing for agriculture and its closely allied industries. It is even possible, Coke thinks, that financing is too easily available; still more care should be exercised by lending institutions in providing money for seasonal production requirements.

Before a lender enters into a financial relationship with a farmer, the anticipated cash outlay for expenses, as well as anticipated returns from sales, should be carefully projected through the season. In Coke's bank, this is done through an operating budget worked out jointly by the farmer and a lending officer or agricultural field man. Each production expense is itemized, and all potential income is calculated.

If such an analysis does not indicate a probable payout, with a reasonable cushion, the banker should withdraw. Once a bank is committed to financing a farmer's seasonal requirements, however, there is no turning back. To stop in midstream may not only bring disaster to the borrower, but may also make the lender himself an unwilling partner in a distressed business. Furthermore, the commitment should cover *all* out-of-pocket costs of production. Experience has demonstrated the folly of neglecting to provide for all items necessary for efficient production, such as pesticides and fertilizers.

With farm credit widely available from commercial lenders, and farmers using such credit extensively, the agricultural chemicals industry must examine its credit practices very closely to make certain that they are sound. Coke told AG AND FOOD that "double credit" is a reality in many places now, with farmers financing their complete operations through bank loans, but still buying materials and services on the cuff. Credit wisdom on the part of the pesticide or fertilizer manufacturer calls for close scrutiny to prevent double credit.

Giving added emphasis to the dangers in loose credit practices, J. A. Walker of Standard Oil Co. (Calif.) told the conference that credit in itself will not automatically generate sales and profits.

Any marketing program that, instead of merchandising products and services, depends upon credit concessions, is on dangerous ground, Walker warns. If credit is to be used profitably, achieving its objective of gaining a maximum sales advantage with a minimum capital outlay and reasonable costs, it must embody five essentials:

- Sound and workable credit policy. A tough marketing situation can never be permanently overcome through longer terms, loose credit analysis, or lax collection effort. Such practices lead to credit abuses that can threaten the soundness of a firm's financial program. Credit policy should stem from top management, be consistent, and be fully understood by the sales and credit personnel who administer it.
- Factual credit analysis. Management must secure and appraise reliable information to determine whether a customer's credit is good. It must be found a reasonable substitute for cash to justify the risk of delivering merchandise without immediate payment.
- Maintenance of receivables in sound condition. When turnover of accounts is active, and money flows regularly through them, sales outlets are kept open. Past due receivables, on the other hand, represent potential or actual blocks to further sales. By keeping the accounts of customers current, suppliers can spend more time in productive sales effort, developing new customers and new business. Collection costs are minimized and losses are reduced.
- Healthy customer relations. Credit skillfully administered is a rich source of customer good will and loyalty, which wise credit management translates into new and continued patronage. While it requires diplomacy, a credit situation well handled is a selling triumph.
- Favorable management climate. Company officers must create and maintain an atmosphere that will encourage effective credit administration. When top management emphasis is lacking, salesmen may take less seriously the terms of sale or the requirement for collection within those terms.

Sound credit, Walker observes, is an integral part of good business management. If the essentials are met, and if the opportunities and possibilities—as well as the limitations—of credit are recognized, administration of credit for the purchase of pesticides will contribute to the progress of the agricultural chemicals industry.

Forest Market For Fertilizer

A large new area for plant food, but it may be 10 to 15 years before this market can be realized

HOW LONG before the fertilizer industry can realize the tremendous potential market promised by re-

cent studies on forest fertilization? It will be at least five years before fertilizer is used commercially in Pacific Northwest forests, say research workers in that area's timber industry. However, they do predict that in 10 to 15 years, fertilization will become a standard tool for forest managers, as it now is for farm managers.

These are the conclusions reached by Michael Nelson* of Oregon State College in a survey of the timber industry's position on fertilization. Nelson's survey was sponsored by Chemical & Industrial Corp.

Biggest obstacle to overcome before this market can be won is the lack of research data showing measurable responses of trees to the addition of nutrients. Before 1948, practically no work on forest fertilization had been done. About 1950 several projects were started, and studies are now in progress at many spots all over the country. In the Pacific Northwest, Weyerhaeuser and McMillan Bloedel Co. in British Columbia are among the timber companies giving serious research attention to tree feeding. Also in that area, the University of Washington, Oregon State College, and the Forest Industries Nursery (in Nisqually, Wash.) have active programs. Elsewhere, research on forest fertilization is in progress at Purdue, Wisconsin, Rutgers, New York State College of Forestry, North Carolina, and Georgia.

The lumber industry's interest in fertilization embraces five different production goals:

- Improvement in size and vitality of nursery stock for planting out
- Improvement in initial growth of one- and two-year-old trees when planted out
- Increase in the volume of timber produced in a given time from mature forest trees
- Increase in tree seed production
- Thinning of regrowth trees

Of these categories, the third is the one which could mean the most substantial new market for fertilizer. Many tree nurseries already use fertilizer routinely, and the potential increase in fertilizer use in their operations would have a negligible effect on the total market for fertilizer, at least in the Pacific Northwest. In planting out seedling trees, use of fertilizer has shown impressive results, and as more virgin forests are cut, shifting emphasis to more tree farming, this market could become important. Fertilizing at planting time is thought to reduce the time between cuttings by a year or two.

Tree seed production is another field of some promise. Where a forest area is cut clear, fertilizer can play a big role in natural reseeding. In one experiment, Weyerhaeuser foresters achieved through the use of fertilizer a 1000% increase in seed production on the edges of a burned out area. Bigger production of seeds plus the encouragement of seed production every year (instead of every three or four) means that trees are given a chance to establish themselves in a cleared area before brush takes over.

Fertilization with nitrogen has been shown to perform thinning of regrowth trees. The larger trees respond rapidly to nitrogen, suppressing the intermediate-size trees.

So far most experimental work on fertilization of mature stands has been with nitrogen, but it is likely that some response can be obtained from potassium and phosphorus also. Results from last fall's application of 12-12-12 at Rutgers should prove interesting in that connection.

Forest soils in the Pacific Northwest appear to have no deficiency in potassium, and in experiments there trees have shown response to potassium additions. Most soils in that area are deficient in phosphorus, but trees have not always responded to it. A problem with phosphorus is its low mobility in soils—it leaches slowly and is therefore slow to reach the root zone. Because of this property, surface spreading of phosphorus fertilizers may not give satisfactory results. One suggestion is that phosphorus materials be placed around the roots of one- and two-year seedlings at planting out.

Using results obtained with nitrogen application at the University of Washington, Dr. Nelson calculates that applying 100 pounds per acre each year for 100 years can return a profit of $1966 per acre in extra timber. This profit is over and above interest that could have been earned through long-term investment of the money required.

Mode of application becomes a problem with nitrogen, since at present the only feasible way to apply this, or any fertilizer, to mature stands is from the air. To reduce the number of applications because of the high cost of aerial spreading, heavy applications of high-analysis materials must be used. However, nitrogen's propensity to leach out of the top soil quickly reduces the time it is available to the tree. For this reason, a slowly available form of nitrogen, such as urea-formaldehyde, may have the advantage.

One potential use of fertilizer is in thinning regrowth trees

Forest Ownership

About 15% (6 million acres) of the total commercial forest in Washington and Oregon is owned by 32 owners with over 50,000 acres each. The U. S. Government owns about 26 million acres and the remainder—nearly 20 million acres— is owned by 83,900 individuals.

The 32 large owners tend to acquire high-quality stands, avoiding purchase of the poorer-quality stands that would benefit most from fertilizer use. This fact may hold back use of fertilizer by the large lumber and pulp companies. Government-owned forest land offers the greatest single potential market for fertilizer, but the U. S. Forest Service has shown little interest in fertilizer beyond what it now uses in its nurseries. Much of the Forest Service acreage is located in rough, high-altitude country, however, which means that the cost of getting logs to market is high. Thus, stimulation of forest growth with fertilizer in areas more handy to markets could prove to be the more profitable way to maintain or increase the supply of logs.

These considerations apply to the Northwest's timber, but that area boasts nearly 37% of the nation's standing saw timber. The go-slow attitude there will doubtless forestall any immediate boom in fertilizer demand from forest managers. In the long run, not only must fertilizer use in forests depend on research results, but it will also depend on such other factors as the future price of lumber, the price of fertilizer and its application, and the salesmanship of the fertilizer industry.

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