Proceedings

of

ANNUAL STAFF CONFERENCE

SCHOOL OF AGRICULTURE

and

AGRICULTURAL EXPERIMENT STATION

AUBURN UNIVERSITY

July 5 - 7, 1961
Auburn, Alabama

The Challenge of Agricultural Adjustments to Our Educational Institutions

By

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Annual Staff Conference
July 5-7, 1961

Your program committee decided this year that this should be a home program with the exception of the keynoter and banquet speaker. I was delegated the responsibility of obtaining the keynoter. President Colvard of Mississippi State University and President Reitz of the University of Florida were suggested by the committee as acceptable keynoters.

The committee felt that a University President with recent professional agricultural experience would be best qualified to present "The Challenge of Agricultural Adjustments to our Educational Institutions". I concurred in this feeling and extended a personal invitation first to President Colvard and then to President Reitz.

When I found both committed, I contacted President Hilton of Iowa State University and obtained a qualified acceptance. Then, when he declined, your committee assigned the keynote responsibility to me.

I am more disappointed than any of you that we cannot have any one of these distinguished people on our program this year. Nevertheless, I am pleased at the opportunity to talk seriously with our entire staff at the beginning of our annual conference. Some of the things I will say may not be as directly appropriate to the theme of our conference as any one of their addresses would have been. Since I have neither read the statements that later participants will make nor have they read mine, you may finally conclude that I have not adequately keynoted your program. I hope, however, that all that I say will be appropriate to our family gathering.

Just before, during, or just after the conference each year, I hear that the question has again been raised, "Why do we have to have an annual conference?" There are at least three good answers.

Perhaps the first and most important stems from the numerical size of our staff, its wide geographic distribution, and the diversity of its teaching and research interests and responsibilities. Our academic staff, teaching and research, numbers more than 200. While it is true that most of us are Auburn residents, about 30 of us are located at outlying points scattered from the Tennessee Valley to the Gulf. Even at Auburn, we are housed in about 10 different buildings that may be as much as two miles apart. During most of the year, the dedicated teacher will devote most of his thoughts to the subjects that he teaches and the researcher will be deeply engrossed in his specific research. The more highly trained he is, the more restricted and specialized is his teaching or research interest apt to be. It is imperative, therefore, that we take time out from being geneticists and biochemists, home economists and foresters, pathologists and fish culturists, and dozens of other specialists, and think together about the broad aspects of the social and economic structure that makes our individual specialties possible.

The second reason is related to our younger or more recently appointed staff member. It is fine for him to develop departmental loyalties. It is important, however, for him to have an opportunity to learn something of the philosophies, objectives, and policies of the School and division of which his department is an integral part. I can think of no better way for him to get this indoctrination than to mingle with our entire academic staff during a conference of this sort.

The third reason is closely related to the second, but applies more directly to all of us. Under our system of departmentalization, I believe it is important that we have a time set aside to mingle with others in related disciplines and to think broadly with them. Not many years ago, I knew every secretary and every foreman on our staff on a personal basis. Today, I hope that I recognize every member of our academic staff, although there are many graduate students, some on appointment, I have never met. What I have admitted about myself must apply equally to other long time staff members.

I pause at this point to express appreciation to the staff of the School of Agriculture and the Agricultural Experiment Station System for the excellent services that you continue to perform for our students and for the people of Alabama and the Nation. In general, our teachers have an excellent reputation throughout the campus. Our researchers enjoy the confidence of the people. Many in both categories have earned National or even International reputations.

What shall our reactions be to these accomplishments? Will we become complacent? Will we deicde to coast for a while?

As teachers, are we keeping our course content up to date? In our desires to be recognized as "good guys", are any of us inadvertently getting the reputation around the campus as "crip course" teachers? Or, are any of us at the other extreme so interested in "beefing up" our course content that we make unreasonable demands on our students?

Then there are our majors and curricula. Have we found it easy to maintain the status quo and justify it? Or have we attempted to modify and adjust to meet the training needs of the present and future?

The same sorts of questions can appropriately be asked about our research work and of our researchers. Have any of us found it easier to work another year under an old outline than to write and defend a new outline that might be more appropriate to the solution of the problem? Has a group working on a particular commodity recommended drastic redirection of the program even if it should mean the elimination or down grading of our participation?

What is our attitude toward reporting our results? Do we find working in the laboratory or field so demanding or so intriguing that we unduly delay reporting valid results? Or do we recognize that we best serve our constituents when we issue popular reports as soon as we are reasonably sure of validity? Or that we enhance our personal scientific reputations by prompt reporting in professional journals or other technical media? On the other hand, are any of us "eager beavers" who publish inadequate data?

Who are our constituents and our clients? Not long ago we would have answered with one word -- farmers. Without neglecting our responsibilities to farmers directly, we know that our responsibilities today are to a much broader group. This group includes farmers, forest landowners, nurserymen, and many other classes of specialized producers; it includes a broad area now recognized as agribusiness or agri-industry; it includes sportsmen, home owners, and consumers.

The State Experiment Stations are required by law to spend a minimum of 20 per cent of all new Hatch funds on marketing research. The Market Economics Division of the USDA is a large research division of the Department. Did you know, however, that O. V. Wells has said that business has demanded that the USDA get out of marketing research? Or did you know that some segments of agribusiness in Alabama are reported to be suspicious of us? They are reported to fear that our long identification with producers through production research has biased us in favor of producers and that our marketing research in their field might be slanted.

This brings us to questions of public relations. Are our public relations good or bad? If they are good, can we afford to coast? If bad, how can they be corrected? Who makes public relations, good or bad? Are public relations the responsibility of one person or of each one of us?

What about our responsibilities to our students, our graduate students, and our newly appointed staff members in the areas of guidance and orientation?

In the classroom and on examination, do we do the best job that we can in creating an atmosphere of honesty and in administration to discourage those with a tendency toward dishonesty? In the employment of student assistants, we place a great burden of trust on the student and often subject him to temptation. In our relations with him, do we make him aware of this trust and of his responsibility with respect to time sheets and public property available to him?

Our graduate students have even greater trust placed in them and are subjected to even greater temptation. They come from a variety of institutions. Frequently, we entrust them with thousands or hundreds of thousands of dollars worth of public property. As their preceptors and advisers, do we early explain to them the heavy responsibility that accompanies their entrustment with public property?

As old-timers or department heads, do we make an effort to acquaint new staff members with institutional policy and School and Experiment Station philosophy?

I realize the danger in asking such leading questions for the very asking begs misinterpretation. No specific question is directed by me to any specific member of our staff. If we should ask and answer each question specifically, I am sure our total score would be good. If it could be bettered, however, it is encumbent on us to work to that end.

There is an old saying that nothing is certain but death and taxes. To these should be added a third element -- <u>change.</u> Change is more constantly imminent than death and is, I believe, more certain than taxes.

At the beginning of the second half of the twentieth century, Agriculture did a little stock-taking. There probably are few agricultural speakers who, during the early 1950's, failed to make at least one speech in which he boasted that there had been more changes and more progress in Agriculture during the past 50 years than during all of previous history. The net effect of this progress is good. Increased efficiency in agriculture has been a major factor in America's growth and assumption of world leadership.

Yet agricultural efficiency has come faster than has agricultural adjustment. Surpluses and the cost-price squeeze have been among the results. Our farmers have not shared in the postwar prosperity commensurate with other segments of the economy.

The Land-Grant College and other agricultural institutions have also been caught in the backwash. The organization and functioning of the Agricultural Extension Services have been sharply criticized. Enrollments in Schools of Agriculture have dropped or have not kept pace with enrollment increases in other fields. During a period when Federal appropriations for research and development have grown enormously, it has been increasingly difficult to obtain additional support for agricultural research.

In his presidential address to the Land-Grant College Association last fall, Chancellor Clifford Hardin (agricultural economist by training and a former Dean of Agriculture) stated, "As we pause in the year 1960 to take stock, we find that while the central theme of our mission has remained constant, the horizons of our challenge and opportunity as state universities and land-grant colleges have been greatly broadened. Generally, we have responded gracefully and willingly to the major stimuli of our society; we have, however, had our 'blind spots' and areas of 'foot-dragging' conservatism. We were slow in responding in the area of teacher education; we have sometimes been tardy in modernizing our curricula in such professional fields as agriculture, engineering, home economics, and business administration; not always have our faculties in arts and sciences permitted us to move with force and insight to meet a wide array of specific professional needs. And probably most, if not all, of our institutions are guilty of too much course proliferation and splinter specialization".

Speaking before the Council of Presidents at the same meeting, Dr. Jean Paul Mather, former president of the University of Massachusetts, made these revolutionary statements:

"I am still as convinced as I was when I left Massachusetts in April that for agricultural educational purposes including resident instruction, experiment stations and extension services, ultimate efficiency and progress would be accomplished with one agricultural college and related services for the whole six-state area of New England".

....

"And I grow increasingly weary of the thesis that six total land-grant programs are necessary in six state universities in this area just because the original hy-bred corn discovery and research happened in Connecticut. This is the thesis that Yankee ingenuity is so great that 'six times needed' expenditure is justified on a national welfare basis".

In 1948, there were 45,853 students in Schools of Agriculture and they constituted 11.7 per cent of the total Land-Grant College enrollment; in 1959, there were only 31,722 constituting 7.7. per cent.

At a National Agribusiness Symposium this spring, many significant statements were made concerning agricultural curricula. Dr. Karl Butler of Avco Corporation and former professor of Agricultural Economics at Cornell expressed the opinion that there is still too much specialization at the undergraduate level in Schools of Agriculture.

Dean Aldrich of the University of California charged that too many Land-Grant Colleges are turning our technicians as B.S. degree graduates in Agriculture. It was his thesis that two-year terminal courses should provide the technicians and that B.S. degrees should be based on broader training. Dean Andre of Iowa State agreed, as surprisingly did many representatives of industry.

In this connection, a paragraph from a publication entitled "College Trained Manpower for Agribusiness" is of interest. I quote:

"It is not necessary to repeat the discussions that were held with all the companies, but a summary of one such meeting with the personnel staff will show the general thinking. This agricultural supply company was not particularly interested in, nor did it look for, graduates with an agricultural background. Too many graduates from agricultural colleges lack the type of training that would best fit them for jobs in this particular organization. It has been found that many jobs can be filled by people having almost any background by giving them additional on-the-job training. Many companies have comprehensive training programs, probably as a result of not being able to find the types of graduates that best fit their needs. They would just as soon recruit from liberal arts colleges as from colleges of agriculture. This might indicate that the training in most agricultural colleges is too narrow and that a broader background is more desirable, even though extensive subsequent training might be necessary. It is also possible that this is some reflection of the apparently poorer caliber of student who attends a college of agriculture."

The Chairman of the House of Representatives Subcommittee on Agricultural Appropriations was quoted a few years ago as saying that it might be a good thing to declare a moratorium on agricultural research in order to permit "demand to catch up with supply".

Dr. Willard W. Cochrane, advisor to Secretary Freeman, is quoted as having said in 1960, "I would like to stress this, too, that no matter how good a supply control program we might develop we would certainly wreck it if we continue to step up research and development in agriculture. In some way, I'm not completely clear on just how, we are going to have to learn how to control the inflow of new knowledge and new capital into agriculture".

In this day when interest in research and development is at an all-time high, financial support for agricultural research has increased slowly and moderately. In 1957, Federal, State, and private expenditures for agricultural research amounted to about $335 million. This was little more than 0.3 per cent of consumer expenditures for farm and forest products and compares unfavorably with the 3 per cent of gross income spent by progressive industries. As early as 1953, the National Science Foundation estimated that expenditures for all research in the United States amounted to 1.3 per cent of the gross national product.

A series of releases by the National Science Foundation provides an interesting insight into sources and expenditures of research funds in the United States.

I quote first from a 1959 speech by National Science Foundation's Dr. Robert B. Brode as follows:

"The current budget before Congress includes proposals for the expenditure of 7.5 billion for research and development. This is to be compared with 6.8 billion in 1959 and 5.5 billion in 1958. Approximately 10 per cent of our total Federal budget now goes to research and development. In many industries this support represents a major or critical portion of the research activity. Eighty-five per cent of the research and development of the aircraft industry is financed by the Government. Sixty per cent of the electrical equipment industry, 40 per cent of the communications industry, and 35 per cent of scientific instrument industry's research and development are supported by the

Government. Much of the research in industry is directed and controlled by the Government agencies that are effectively the purchasers of the research and development product. It is obvious that the impact of government on industrial research and development dominates much of our current technical development. Although the major part of this budget is associated with our national defense activities, there still remains a very substantial support for research and development carried on in the laboratories of our educational institutions. Excluding the support of such research centers as the Los Alamos Scientific Laboratory, the Argonne National Laboratory, the Applied Physics Laboratory, and others where the university acts only as a business manager, the Government spends a little less than one-tenth of its research and development budget in the universities.

"The Federal Government is now providing well over a half billion dollars for research in the universities and this support has been increasing at nearly twice the rate of growth of the general budget. The support of basic research in the universities has been a very substantial portion of this Federal program".

Now let's use data from three National Science Foundation releases for further comparison.

Agricultural Experiment Stations -- "Operating expenditures for separately budgeted or 'earmarked' research and development at the stations, including their associated agricultural colleges, rose from $76.2 million in fiscal year 1954 to 122.3 million in fiscal year 1958. The difference represents a 60-percent increase. In terms of total expenditures of colleges and universities for separately budgeted research and development, however, the stations and associated colleges of agriculture accounted for less in 1958 (16 percent) than in 1954 (19 percent).

"The State governments are the primary source of support for the research of the agricultural experiment stations and colleges. However, payments to the States from the Federal Government constitute the nucleus of support and the incentive for State and private support of agricultural research. In fiscal year 1958, Federal funds amounted to $34.5 million and non-Federal funds to 87.7 million.

"Much of the work in agricultural experiment stations and colleges has been applied research. Over the 4-year period, 1954-58, however, some shift of emphasis from applied to basic research has been evident. In fiscal year 1958, basic research accounted for 34 percent of total separately budgeted R&D expenditures in the agricultural experiment stations and agricultural colleges, in contrast to 24 percent reported as basic in fiscal year 1954.

Federal Contract Research Centers in Colleges and Universities -- "In 1958, separately budgeted or earmarked research and development expenditures in Federal contract centers managed by educational institutions amounted to $289.1 million, most of which was Federal support. Direct comparison with the 1954 survey of this type of institution is difficult to make. On the basis of the statistical data collected in the two surveys, however, it would appear that the 1958 expenditures were more than double those reported in the earlier survey. Over the same 4-year period, in contrast, the volume of separately budgeted research and development expenditures in colleges and universities proper and in the agricultural experiment stations each increased approximately 60 percent.

"The Federal Government's mounting concern for research and development in recent years has involved greater scope and complexity in research and development projects to meet military and civilian needs, involving heavier reliance on the research centers for resolution of problems. This becomes evident from the fact that in 1954 the research centers accounted for 32 percent of total separately budgeted research and development expenditures in colleges and universities, whereas in 1958 they accounted for 39 percent of such expenditures.

"In general, the centers may be characterized as having a flexible approach to research problems, requiring a wide variety of special facilities, often complex and costly, and the coordination of efforts of scientists and engineers from varying fields. Many of them operate within a framework conditioned by the security and defense needs of the Nation.

"Approximately 25 percent, or $70 million, of total research and development expenditures in research centers was reported as having been spent for basic research. Applied research and development each accounted for about 38 percent. In colleges and universities proper, the reverse was reported -- three-fourths of the total separately budgeted research and development expenditures were devoted to basic research, and the remaining one-fourth devoted to applied research and development."

Research and Development in American Industry -- "Funds for performance of research and development by industry totaled $9.4 billion in 1959, a 15-percent increase over 1958. The 1958-to-1959 increase was double the 1957-to-1958 increase and reflects the continued expansion of industrial R&D activities characterizing the past decade. In 1960 funds for industrial R&D performance are expected to reach $10 billion, according to estimates by industrial firms.

"Federally financed R&D performance by industry in 1959 amounted to $5.4 billion, exceeding the 1958 level by 17 percent. This $5.4 billion amounted to 57 percent of total industrial R&D funds. R&D performance financed by the companies themselves totaled $4.0 billion, an increase of 12 percent over the 1958 total.

"Funds for industrial basic research totaled $344 million, or 4 percent of the total of $9.4 billion for research and development."

In summary, the Federal Government spent $34.5 million in support of research and development at the State Experiment Stations in 1958, $289.1 million at College Contract Centers, and $5,4 billion (1959) with industry. While these comparisons may come as a shock to our friends in other divisions of many Land-Grant Colleges who covet the Agricultural Experiment Station programs, they are scant cause for comfort for the Experiment Stations that are confronted with problems far beyond their means to attack.

What does all this mean? To me it means simply that the necessity for agricultural adjustment is today challenging the Land-Grant College in all of its agricultural divisions. We too must adjust. We are fortunate that we at Auburn are being given an opportunity to make scientific adjustments through the institution's self-study program. We are well represented on the Steering Committee and on the Objectives Committee. We are in the process of establishing departmental and school committees. Let's not let this become a status study. Let's make it a means of adjusting to future needs and future opportunities.

The enormity of agricultural problems and the attacks on scientific agriculture have almost made some of us apologetic for our system that has contributed so much to America's greatness. Perhaps unknowingly, an Engineer and College President, Dr. Eric A. Walker, has done more than any recent agriculturist to restore our faith and pride in our system. I quote:

"Our problems today involve the establishment of policies and principles under which our universities can satisfy the legitimate claims made upon them for research without impairing, at the same time, their ability to discharge their basic responsibilities for the discovery, preservation, and dissemination of truth and knowledge -- without impairing, that is, those abilities that made university participation desirable and necessary in the first place. For the most part, these needed policies and principles involve the relations between the universities, on the one hand, and the Federal government, on the other. Dr. Charles Kidd, Chief of the Office of Program Planning of the National Institute of Health, phrased the basic question this way: 'Can the Government', he asked, 'get what it needs from the universities without distorting and controlling them?' I think the question should be slightly rephrased. I think it should read this way: '<u>How</u> can the government get what it needs without distorting and controlling the universities?' This is the central problem facing us today, as I see it.

"This year the Federal government will distribute about $750 million to educational institutions for research and development, and this amount is certain to be increased in the future. That's a lot of money. It cannot help but have a tremendous influence on our educational enterprise. How should it be distributed?

"To those institutions and individuals most likely to produce the best results? These funds are already concentrated in a relatively small number of institutions, and this policy would surely lead to an even greater concentration. This further concentration would lead to an even greater disparity in research competence and to an even greater degree of concentration, with the possible result that these institutions might become, in time, huge research centers with little connection with the teaching function, at least at the undergraduate level. Such institutions would approach the German ideal somewhat more closely than do most of our universities today in some respects.

"The alternative, of course, is to disperse the funds to a wide number of institutions in a deliberate attempt to develop a geographically diversified research competence. There exists today no mechanism through which such a dispersion could be made, and the creation of such a mechanism would run headlong into the established policy of allowing each separate agency to make its own contracts. Besides, on what basis would such a dispersion be made? And, if it were made, it would result, at least temporarily, in a loss of efficiency. Can we afford such a loss at this point in history?

"Then there is the matter of stabilization of effort. Almost by definition, short-term contracts deny the program continuity that basic research must have to produce really significant results. Such contracts create many problems for universities. The lack of long-term commitments raise serious questions concerning the application of the university's tenure provisions and leads to inequities in the pay schedule. Sudden fluctuations in support cause financial embarrassment and affects the over-all university operation, and the possibility of such fluctuations leads to protective measures that reduce the university's research competence. To realize the full value of the universities' participation in Federal programs of research, measures must be found for ensuring stability of effort. How can it be done?

"Finally, there is the matter of freedom of inquiry and of publication. Enough has probably already been written and said on the difficult matter of security classification and its effect on the progress of research. Here I will say only that, in scientific research, the best possible security lies not in secrecy, but in the maintenance of an energetic and productive research program. Freedom of inquiry -- <u>Lernfreiheit</u> -- was the heart of the German 'intellectual corporations', and it remains essential to scientific progress.

"Many other problems are involved in this partnership between the Federal government and the universities for the performance of research -- problems involving the balance of the research effort, problems involving the practical monopoly by the government in certain areas of research such as physics and mathematics, problems involving the payment of full costs to the institutions, problems involving the reduction of red tape, and the like. I am sure you are all familiar with most of these. But the over-all problem remains that of working out arrangements under which the government can secure the research assistance it needs from the universities without weakening the ability of the institutions to perform their essential educational functions or the unique qualities that led to university participation in the first place. The question remains, 'How can the government get what it needs without distorting or controlling the universities?'

"In casting around for models on which to base these arrangements, we have almost completely overlooked the oldest active program of this sort in the country. Yet, ironically, it is probably the most successful of them all. I'm speaking here of the Federal support program for agricultural research. Through this program, the Federal government has been providing research grants-in-aid to the agricultural experiment stations at our land-grant institutions continuously since 1887.

"The need in this area was one of the reasons Congress passed and Abraham Lincoln signed the Morrill Act almost 100 years ago. Neither a country nor a person can make much progress when he must spend most of his productive energies in feeding himself. One hundred years ago, a farm worker could raise enough food to feed only himself and four other people. Since these four other people included his wife, his children, his grandparents, and those people who were unable or unwilling to work, there weren't many people left in the country to get on with the business of carving a civilization out of the American wilderness.

"The land-grant colleges, consequently, were charged with teaching, among other things, 'scientific farming'. They soon found, however, that they didn't have very much to teach. There had been very little research to develop a scientific body of knowledge in the field. Farmers were then, as they are today, essentially small businessmen who had neither the resources nor the time nor the skill for this research. Since the development of this knowledge was clearly in the national interest, Congress passed the Hatch Act to provide support for '.... original and other researches, investigations, and experiments dealing directly with and contributing to the establishment and maintenance of a permanent and effective agricultural industry ..... including researches basic to the problems of agriculture in its broadest aspects .....'

"Most of you in this audience know how it works. A part of the funds appropriated by Congress for this purpose is distributed evenly among the 50 states, while the rest is allocated according to plans submitted for regional, inter-state research and to the relative size of the rural and farm populations within the several states. This last year, about $31 million were distributed among the states in this fashion.

"The land-grant institutions have a wide degree of freedom in the use of these funds, since they are restricted only by the provisions of the Hatch Act of 1955, which pulled together most of the previous legislation relating to agricultural research. Programs supported by these funds are initiated by plans outlined within the institution by the directors of the experiment stations, and these directors are solely responsible for the administration and guidance of the research. The funds may be used for basic research, as in the case of biological science, or for applied research. The directors may -- in fact, are encouraged to -- pool their resources with other experiment stations in order to attack regional problems, and the funds may be used for research carried out in cooperation with support from 'other appropriate agencies and individuals'. These 'other' sources include not only industrial organizations and private individuals but also state governments. In fact, most of the Federal funds must be matched, on a dollar-to-dollar basis, by 'non-federal' funds. The effect of this Federal 'seed corn' is seen in the fact that the total expenditures at the agricultural experiment stations was about $115 million in 1959, or more than three times the amount available through Federal funds alone. This flexibility makes it possible for the experiment stations to accept industrial grants for applied research without upsetting the balance of the over-all program.

"How successful has this program been? No other nation in the world even approaches America in agricultural productivity. In 1910, almost one-third of our labor force -- almost 11-1/2 million people -- were required to produce enough food for our population of 92 million. In 1957, only about 10 per cent of our labor force -- fewer than seven million workers -- not only produced enough food to feed our population of more than 170 million people better than any other people in the world but also to create, at the same time, an embarrassing surplus. The increase in efficiency of American farmers -- that is, the output per manhour -- has almost doubled that of manufacturing workers. Russia may -- or may not -- be ahead of us in rocket research and development, but the record in agricultural production is absolutely clear. In Russia today, a Soviet farmer can produce enough to feed himself and only four other people, which just about matches our productivity of a century ago. Today, the American farmer produces enough to feed himself and 24 other people.

"Examples of individual successes seem almost unbelievable. Two years ago, Zvi Griliches, a University of Chicago economist, made a careful study to associate the expenditures for hybrid-corn research with the 'realized social rate of return' on those expenditures. As reported in the Journal of Political Economy for October of 1958, this study showed that '..... at least 700 per cent per year was being earned, as of 1955, on the average dollar invested in hybrid-corn research' between 1910 and 1955.

"In California, a machine that will pick 100 tons of tomatoes a day has been developed. Using a crew of 13, it replaces about 60 hand pickers to cut the cost of harvesting from $10 to $2 or $3 per acre. The machine is adapted to once-over picking only, and, for maximum effectiveness, tomatoes will have to be developed that mature uniformly on the vine. The agricultural research people expect to have this difficult problem solved by 1962 or 1963.

"Dicoumarol, the chemical to which President Eisenhower, Lyndon Johnson, and many people with histories of heart conditions owe their present good health, was discovered through agricultural research with cattle. Soil research at an agricultural experiment station gave the world streptomycin. The list could be multiplied almost endlessly.

"In simple fact, the record of the experiment stations is a tremendous one. And they have achieved this record through a system that places program initiative and direction in local hands and provides built-in program continuity. Further, the research effort carried out through this system is totally integrated with the instructional programs of the institutions involved and has strengthened, rather than weakened, them. In fact, the agricultural experiment stations must, by law, be departments of the institutions in which they are located.

"In this program, it is clear, both the government and the universities have been well served. It could provide us with the model we are looking for."

I conclude this talk by quoting directly the concluding statements that I believe that President Colvard would have made had he been your keynoter:

"Almost every president has said at one time or another that the threefold commitment of the land-grant university is to teaching, to research, and to public service -- to the dissemination of knowledge, to the discovery of knowledge, and to service -- or, in short, to knowledge and its use.

"The broad challenge that I would like to leave with you is that we make this threefold commitment equal to the needs of our time. We must identify and understand those persistent forces that have created our progress, our adjustments and our problems. We must seek a sense of direction by projecting these needs and forces into the future. This means that we must also adjust our educational programs. I am happy that progress is being made in this direction.

"First, let's take a look at our teaching -- As many of the people and functions of the farm have moved to the factory, the content of our undergraduate programs has changed. We have probably been a little slow to recognize the changed character of the demand for the baccalaureate graduates of our colleges of agriculture. A decline in agricultural enrollment in our institutions has given us much concern. This has occurred at a time when demands for specialized personnel in society have been increasing. It has occurred at a time when there has been a scarcity of managerial personnel on the farm and in the factory, a scarcity of both biological and physical scientists in the nation, a scarcity of personnel trained in the use of capital in agriculturally related pursuits, and a scarcity of people competent of comprehending the broad adjustments and opportunities in our changing society. This decline in enrollment has also occurred at a time when young people were excited about science and engineering in general and at a time when rewards for business skills were very great. It seems inconsistent that enrollment should decline under these conditions, but it did. It may be that we were slow to adjust our teaching programs to the needs of the times and to communicate the correct and exciting image of modern agriculture to our high school graduates. At any rate, the content of our undergraduate teaching programs is changing or should have changed.

"Our first specific challenge is to see to it that our teaching programs are up to date, that they discover what each young person can do in our society, that they give him a broad vision as to his opportunities, build solid foundations of knowledge under his dreams, and instill in him a commitment to purpose, to morality and to service.

"The second great challenge to our universities is to engage actively in research, to discover and measure the forces which create our progress and change, to suggest opportunities for adjustments to those people involved, and to build up a sufficient backlog of knowledge to keep this nation strong in a time when the whole world is becoming research minded. Research is the fountainhead of our progress. We must have more of it.

"Today research is highly specialized and compartmentalized. The individual researcher or department recognizes the need for the talents of other disciplines. Statistics, economics, and social sciences have been broken down into subdisciplines, but at the same time they have become companions of biological and physical sciences in the solution of many problems. We need more fundamental research. It must be done by specialists. But this also requires the breaking down and cutting across departmental and school barriers in order to organize effective research teams.

"The third challenge is to see that the extension or service phases of our efforts give the people authoritative and up-to-date information required for sound decisions in this fast-moving era.

"The content and methods of our extension programs have changed as much as they have in research and teaching. As farmers and farm industries have become more specialized there has been a tendency for the talents of specialists to be in greater demand than the talents of generalists. As the research programs have given more emphasis to basic principles, the interpreters have needed more advanced training. Likewise, there has been greater emphasis on management and adjustments. In my opinion, we will be required to give much more attention to these areas. The extension worker of today must be able to interpret scientific knowledge unknown when he or she was in college. This imposes some real problems in the coordination and management of an array of talent and staff employed by the major divisions of colleges of agriculture. More and more extension directors are realizing that training as well as tools may become obsolete.

"As my fourth and final challenge to educational institutions as we move into our second century, may I suggest added emphasis on a fourth dimension to our traditional three-fold commitment of discovering knowledge, disseminating knowledge and rendering service. In my opinion, we must place greater emphasis on mobilizing knowledge -- or mobilizing ideas. The word "mobilize" means to assemble and make ready for use. Our educational system has developed many creative minds. Only a small percentage of them are in the cloistered halls of colleges and universities. They may be farmers, commodity leaders, farm organization leaders, legislators, or buisness and professional men. If the university is to be 'in the midst of real life and saturated with it', as the contemporary philosopher, Jose Ortega, has said they should be, here is one avenue to breadth of knowledge and experience which is promising".

Keynote address -- delivered at 1:20 P.M. (Opening Session) July 5, 1961

RECENT ECONOMIC AND SOCIAL CHANGES IN ALABAMA AGRICULTURE AND RELATED AREAS *

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The history of America has been a story of growth and development; it has been a story of change and adjustment. In no phase of American life has this been more evident than in American agriculture. Throughout the history of this country, and particularly during recent years, we have seen a tremendous growth in U. S. population, a rapidly increasing production capacity of both agriculture and industry, widespread advances in science and technology, a shift from a predominately rural economy to an agricultural-industrial economy, a relatively high standard of living for many segments of the population, and a present-day demand for even higher economic and social benefits for all of our citizenry. To what extent has the Southern Region of the United States, and particularly the State of Alabama, shared in these changes and trends? To what extent have we adjusted our teaching, research, and (Extension) educational programs and activities to meet these changes and trends? And, to what extent do these changes and trends mean additional adjustments in our several programs and activities in the future? To all of us, the answers to these kinds of questions are of major concern.

The Southern Region of the United States has long been and still is one of the nation's major agricultural areas.1/ During recent years, expanding business

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*Presented before annual staff conference of the School of Agriculture and Agricultural Experiment Station at Auburn University, Auburn, Alabama, on July 5, 1961. Conference Theme: "Impact of Recent Economic and Social Changes on Agricultural Research and Education."

Revised: July 10, 1961

1/ For a detailed description and summary of recent changes in Southern agriculture, see "Southern Agriculture: Recent Trends, Current Status, and Future Prospects." Special Report. Agricultural Experiment Station of Auburn University, Auburn, Alabama, June 1961.

and industrial developments and activities in this region have both aided in solving old problems and in creating new problems in the area. This has been particularly true with respect to the development and use of the basic resources of the region.

Major concern at this conference is with recent social and economic changes in Alabama, and particularly with the impact of these changes on agricultural research and education. This means that our interests are not only with agriculture, agricultural problems, and farm people, but also with the State's total economy and its total population.

Recent changes in Alabama agriculture have been influenced by both farm and nonfarm factors. The effects of these changes have been reflected in both farm and nonfarm sectors of the State's economy.

Among the many changes that have taken place have been changes in population and its characteristics, and changes on farms in land use, in enterprise combinations, in production practices, in levels of output, in capital and managerial requirements, in sources and levels of income, and in levels of living. 2/

Human resources—the people—are regarded by many as the most important single resource in any area. Certainly, this is a key resource. Together with human resources, all other resources are developed and used by people and for people. In the final analysis, returns can be measured in either physical or economic returns, but in either case, for returns to be meaningful, they must be consistent with social goals. They must satisfy human wants and desires. And these wants and desires are the sum total of those of all segments of the economy—

2/ For a detailed description and summary of recent changes in Alabama agriculture, see "Changes and Trends in Alabama Agriculture and Related Data Since 1920." Special Report. Agricultural Experiment Station of Auburn University, Auburn, Alabama, February 1961.

Also, for a summary of major recent changes in Alabama agriculture and related data by counties and economic areas, see "Changes in Alabama Agriculture and Related Data, 1950 to 1960." Special Report. Agricultural Experiment Station of Auburn University, Auburn, Alabama, June 1961.

business, industry, and agriculture.

In terms of the changing complexion of the State's population, we, as a Land-Grant University, may wish to go back to about 1860 when the Land-Grant Institutions were first established, and review some of the changes and trends that have taken place in Alabama's population since that time.

Slide 1 - Total Population

Increase from 1.0 million to 3.3 million during past 100 years. There has been an almost constant rate of increase throughout this period.

Total population breaks down into urban and rural population.

Slide 2 - Urban and Rural Population

A century ago, practically all of Alabama's population was rural population. Rural population increased in absolute numbers until about 1940; since then, it has decreased. Increase in total population in recent decades has been due mainly to increases in urban population. Today, Alabama's population is more urban than rural. Rural population has declined from almost 100% to only 45% of the total.

Rural population breaks down into rural-farm and rural-nonfarm population.

Slide 3 - Urban, Rural-Farm, and Rural-Nonfarm Population

A century ago, practically all of Alabama's population was rural-farm population. Rural-farm population increased in absolute numbers until about 1910, and remained at that level until about 1940; but, since 1940, it has decreased at a rapid rate. Since 1940, both rural-nonfarm and urban population have increased. These increases have more than offset the decrease in rural-farm population. Rural-farm population today represents only 15% of the State's total population. Rural-farm population today represents 1/3 of the rural population; the remaining 2/3 of rural population is nonfarm.

To summarize the picture of the State's current population as shown by the

1960 Census, we need to look at population in its several distinct parts.

Slide 4 - Total Population in 1960

The largest segment of Alabama's population today is urban; this represents 55% of the total. The next largest segment is rural-nonfarm, which makes up 30% of the total. The remaining 15% of the State's population is rural-farm population. Half of this segment is on commercial farms and 1/2 on part-time farms.

From the standpoint of the Land-Grant University, this particular breakdown of the State's population has many implications—implications for teaching, for research, and for (Extension) education.

In addition to our concern with numbers of people, one other item available from the Census should be of interest to us. This is in reference to the sex and age distribution of the State's population.

Slide 5 - Population Pyramid

Ten years ago, Alabama's population was well distributed with respect to age groups. In 1960, however, Alabama's population pyramid presented quite a different picture. The picture shown for 1960 is described by Sociologists as being the characteristic picture of a low-income area. It should be emphasized that this picture is of total population. The State's urban population looks more like the situation shown for 1950; whereas, the State's rural population, and particularly the rural-farm population, shows even more pronounced distortions than the average shown for 1960.

Many younger people in the 20 to 40-year age categories have migrated out of the State during the past 10 years. This results in a shortage of people in the working years relative to the number of children and older persons. Actually there are fewer people in the employable age range (20 to 40 years) than in either the younger or older age ranges, (1,388,000 from 0 to 20 years of age; 816,000 from 20 to 40 years of age; 1,064,000 from 40 years of age and over).

From the standpoint of the Land-Grant University, this particular picture of Alabama's population has even more implications—implications for teaching, research, and (Extension) education.

In terms of the changing complexion of the State's agriculture, we, as a Land-Grant University, may again wish to go back to about 1860 and review some of the more significant changes and trends that have occurred in Alabama agriculture during this 100-year period.

Slide 6 - Land in Farms

During the past century, the amount of land in farms in Alabama has been relatively constant, at about 20 million acres. There was some decrease following the Civil War and during the depression of the 1930's. Currently, the amount of land in farms is again decreasing. We are now at the lowest point in almost 100 years.

Slide 7 - Number of Farms

As agriculture was developed, as new lands were opened up, and as farm population increased from 1860 to about 1910, the number of farms in Alabama increased. Between 1910 and 1940, when farm population was relatively stable, number of farms remained relatively stable. Since 1940, number of farms, like farm population, has been declining at a rapid rate. Throughout this 100-year period, the amount of land in farms has remained relatively stable. Number of farms, therefore, has been primarily a function of the size of the rural-farm population. In Alabama today, there are only 116,000 farms. This is the smallest number of farms we have had since prior to the 1880's.

Slide 8 - Proportion of Tenancy

During the 1930's, 2/3 of Alabama's farms were operated by tenants. Today, less than 30% are tenant-operated. This means that more than 70% are owner-operated. During the 1930's, 1/4 of Alabama's farms were operated by sharecroppers. This particular tenure group has about disappeared in Alabama. Less than 10% of Alabama's farmers in 1960 were sharecroppers.

Slide 9 - Age of Farm Operators

During the past 20 years, the average age of Alabama's farm operators has increased 6 years. At present, the average age is 51 years. More important, the percentage of young farmers is decreasing. In 1930, nearly a third of Alabama's farm operators were under 35 years of age. Today, less than 10 per cent are under 35 years of age. At the other end of the scale, less than 10% were over 65 years of age in 1930; whereas, almost 20% were over 65 years of age in 1960.

Slide 10 - Size of Farms

Farm sizes decreased as number of farms increased from 1860 to the 1930's; since then, the average size of farm has increased as number of farms has decreased. Today, Alabama's average farm size is about 143 acres. This is about the same average size as in the 1880's. All of Alabama's farms are not commercial farms, nor has the number of commercial farms increased in Alabama in recent years.

Slide 11 - Types of Farms

Ten years ago, more than 3/4 of Alabama's farms were commercial; the remaining 1/4 were part-time. Today, only 1/2 are commercial; the other 1/2 are part-time. Commercial farmers have decreased during the past 10 years both in absolute numbers and relative to the total. Part-time farmers have increased both absolutely and relative to the total. By definition, all part-time farmers have gross incomes from the sale of agricultural products of less than $2,500 per year. This means that this 1/2 of Alabama's farmers are so-called low-income farmers.

What about the income position of Alabama's commercial farmers?

Slide 12 - Commercial Farms by Economic Class

Ten years ago, more than 80% of Alabama's commercial farms were low-income farms (gross income of less than $2,500 per farm). This represented a total of 95,000 out of 118,000 commercial farms. Today, Alabama has only 24,000 commercial farms in the low-income category. This represents a tremendous reduction over the past 10 years. But, despite this reduction in number, 42% of the State's total commercial farms are still classified as low-income farms. Thus, of all farms in the State (commercial and part-time) in 1960, nearly 3/4 are low-income farms.

Slide 13 - Value Farm Land and Buildings

Value of farm land and buildings per acre has increased from less than $30 to more than $90 per acre during the past 2 decades—a 200% increase. Value of farm land and buildings per farm during the same period increased from less than $2,000 to about $12,000—a 500% increase. The increased value per farm has been due partly to increased value per acre, but more important to increased size of farms.

Slide 14 - Cropland Harvested

From 1900 to 1940, cropland harvested in Alabama was relatively stable at about 7 million acres. Since 1940, the acreage of cropland harvested has been decreasing at a rapid rate. We now have (1960) only 3.7 million acres of cropland harvested in the State. This is about half the amount we had 20 years ago.

With the recent emphasis on livestock, we might expect this decrease in cropland harvested to be going into pasture land.

Slide 15 - Land Pastured

The amount of farm land in pasture in Alabama was relatively stable at about 4 million acres up until 1940. Livestock developments in Alabama began gaining momentum at about this time. Thus, land pastured began to increase. By 1950, Alabama's land pastured had increased to 7 million acres. But, during the past 10 years, there has been little change in the amount of land pastured in the State.

Since the decreased cropland harvested in recent years did not go into pasture land, we might expect to see it go into farm woodland.

Slide 16 - Farm Woodland

Census data on farm woodland acreage indicated a decrease rather than an increase during recent years. Farm woodland acreage at present, however, is above the low point in acreage of the 1930's.

In terms of the over-all land use pattern of the State, these data indicate that, in recent years, Alabama has lost 4.5 million acres of land in farms. After adjusting for inter-farm changes in land use, this 4.5 million-acre farm land loss results in a net loss of about 2 million acres of cropland harvested and about 2 million acres of farm woodland. Pasture acreage has changed little during this period. The over-all loss of farm land in Alabama during recent years has gone into expanding holdings of public and private agencies and groups such as cities, highways, military reservations, airports, commercial forests, and other nonfarm uses.

Most of the discussion thus far has been concerned with Alabama's people and the State's over-all farm land use. The next several slides will provide a general picture of recent changes in and the present status of major crop and livestock enterprises in the State. These slides will provide indications and measures of increased efficiencies in the production, marketing, and utilization of Alabama farm products. In many of these improvements, the Land-Grant University has played a prominent role in the past. These slides also will provide indications of areas in which many problems and opportunities still exist. It is in these areas that we, as a Land-Grant University, should be most interested at this conference. It is in these areas that the impacts of the recent past and the current situation are most important from the standpoint of the Land-Grant University's future teaching, research, and (Extension) educational activities.

<u>Slide 17</u> - Cotton

<u>Slide 18</u> - Peanuts

<u>Slide 19</u> - Cowpeas (Peas)

<u>Slide 20</u> - Soybeans (Beans)

<u>Slide 21</u> - Irish Potatoes

<u>Slide 22</u> - Sweetpotatoes

<u>Slide 23</u> - Corn

<u>Slide 24</u> - Oats (Harvested)

<u>Slide 25</u> - Wheat (Harvested)

<u>Slide 26</u> - All Hay

<u>Slide 27</u> - Cowpea Hay

<u>Slide 28</u> - Soybean Hay

<u>Slide 29</u> - Lespedeza Hay

<u>Slide 30</u> - Alfalfa Hay

<u>Slide 31</u> - Fertilizer Used on Farms

<u>Slide 32</u> - Workstock vs. Tractors

<u>Slide 33</u> - All Cattle

<u>Slide 34</u> - Cattle Marketings

Slide 35 - Milk Cows

Slide 36 - Milk Production Per Cow

Slide 37 - Milk Production and Marketings

Slide 38 - Hogs

Slide 39 - Hog Marketings and Slaughter

Slide 40 - Sheep

Slide 41 - Chickens (excluding broilers)

Slide 42 - Eggs Produced and Sold

Slide 43 - Broilers

Slide 44 - Turkeys

Slide 45 - Cash Farm Receipts

Slide 46 - Gross Farm Income

Slide 47 - Net Farm Income

Slide 48 - Realized Gross Farm Income

Slide 49 - Realized Gross vs. Realized Net Farm Income

Slide 50 - Realized Gross, Total Cost, and Net Cash Farm Income

Slide 51 - Gross Farm Income Per Capita of Farm Population

Slide 52 - Net Farm Income Per Capita of Farm Population

Slide 53 - Farm Operator Off-Farm Work

Slide 54 - Total Net Income Per Capita of Farm Population

Slide 55 - Farm vs. Nonfarm Total Net Income Per Capita

Slide 56 - Total Net Income Per Capita in Alabama, South, and United States

In summarizing the data shown on this series of slides, we can say that, comparing Alabama agriculture today with the State's agriculture in the 1930's, farm population has decreased 63 per cent while the State's total population has increased 23 per cent. Cropland harvested has decreased from 7.1 million to approximately 3.7 million acres. Number of farms has decreased 55 per cent, and number of tenants has decreased 81 per cent. These changes have resulted in an average size of farm more than double that of the 1930's.

Fertilizer used per acre has more than doubled. Tractors on farms have increased from less than 5,000 to more than 70,000. Use of new and improved varieties of crops, new and improved insect and disease control measures, improved cultural practices, and other technological and scientific developments has resulted in increased crop yields per acre, increased productivity of agricultural workers, and increased over-all production efficiency.

While decreasing the acreage of cropland harvested, Alabama farmers have expanded farm woodland acreage from 6.5 million to about 8.0 million acres. In addition, pasture acreage has expanded from 4.1 million to about 7.0 million acres.

Numbers of all major classes of productive livestock have increased. These changes, combined with better breeding, feeding, and management, have resulted in a tremendous increase in the net production of all major classes of livestock and livestock products in the State in recent years.

Charges and improvements in crop and livestock production, and changes and shifts in farm enterprises, have produced significant changes in sources of cash farm receipts from marketings. Cotton, which formerly made up two-thirds of Alabama's cash farm receipts, has declined to about one-fourth of the total in recent years.

All crops contributed more than 80 per cent of total cash farm receipts in the 1930's; in recent years, all crops have contributed less than 50 per cent of the total. While cash crops were declining in relative importance as a farm income producer, livestock and livestock products increased from less than 20 per cent to more than 50 per cent of the total.

With fewer farms sharing the total cash receipts from farming in Alabama in recent years, per capita cash farm receipts have increased. With higher incomes, levels of living of farm people in Alabama have vastly improved. During the 10-year period between 1945 and 1954, for example, the family level-of-living index for Alabama farm operators more than doubled. This is reflected in an increased percentage of farm families reporting electricity, running water, telephones, home freezers, and other new and improved farm and home facilities.

In terms of manpower, there has been a big decrease in the number of workers engaged in agricultural production and a corresponding increase in the number of workers engaged in farm supply, service, and marketing areas. These changes, in part, reflect the efforts of the State's agricultural industry to take full advantage of scientific and modern technological developments made available through research and education.

Recent changes and trends in the State's agriculture emphasize that Alabama agriculture is rapidly changing from a way of life to a commercial business operation. Scientific and technological improvements and developments are being widely adopted where economically feasible.

Individual farms are becoming larger, more mechanized, more specialized, more commercialized, and with higher capital and managerial requirements. With fewer farms and fewer farm people, Alabama's agriculture is becoming more efficient and more productive.

Despite agriculture's recent achievements in physical efficiency, in lowering costs of production, and in maintaining a high level of output, agriculture's net farm income (in Alabama, in the Southern Region, and in the nation as a whole) has been declining. Under the American system, we normally expect to receive an appropriate reward for the type of success that agriculture has experienced. The success of American agriculture has produced such a reward. But the recipient of the reward in recent years has been the average American consumer and not the average American farmer.

Despite the recent changes and trends in Alabama agriculture and despite the tremendous progress that has been made in improving productivity, efficiency, incomes, and levels of living, Alabama is still characteristically an area of small farm operating units. More than three-fourths of the farms in the State have less than 25 acres of cropland.

These small units long have been, and still are, the State's big problem units. Many of these units are characterized by poor utilization of productive resources, low production rates, and low levels of farm income. Largely because of economic and managerial limitations, these small units have not made full and effective use of many of the scientific and technological developments that have occurred in recent years. The adoption and efficient use of these developments often involve major adjustments on individual farms. They usually require additional capital, an item which is nearly always in short supply on small farms.

These small farmers constitute the big problem group in Alabama that is today faced with the decision of whether to convert from crop to livestock farming, or to supplement present cash crops with livestock, or to cease agricultural production entirely and find other sources of employment and family income. If their decision is to make a change, then, they are faced with the problems of making the necessary adjustments in the organization, operation, and management of their farms and other resources in order to attain their objectives.

A major part of the responsibility for overcoming these problems and obstacles must be borne by the farmer himself. This, however, does not lessen the tremendous responsibilities that research, educational, credit, and governmental institutions have to the farmer in guiding, directing, and assisting him to overcome any problem or obstacle that may stand in the way of more efficient and more profitable farming.

If Alabama agriculture is to successfully meet the competition of the future, and if it is to continue to grow as a commercial business industry, the additional changes that will occur over the next two or three decades will have to be far greater than were those of the past two or three decades. The basis for these changes and adjustments in the future will be largely dependent upon expanded research, educational, and action programs in agriculture and in related areas. The future development and use of Alabama's rural resources will be a major determinant of the ability of the State's agriculture to meet competition in the future.

The trend toward bigness is evident in all segments of our economy. All business concerns eventually seek the size of operation which will yield them the highest return on their investment and for their labor. Farmers, as businessmen, are today expanding and must continue to expand their size of operations for these same reasons.

In the future, any material increases in production and income for farm workers in Alabama will largely depend upon (1) providing more land, livestock, machinery, fertilizer, and other capital items per farm worker, and (2) providing more opportunities for nonfarm work for the young people who grow up on farms but who will not be needed in farm occupations, and for the workers who will be released from agriculture as mechanization and other improvements gain momentum.

If the job facing Alabama agriculture is to be done, those who remain in farming must become even larger in size, more specialized, more highly mechanized, and more efficient. This raises important public policy issues. One of the most important is whether future policy programs will make it easier for farm people to choose between continuing in agriculture or accepting employment in other sectors of the economy.

Our principal concern should not be how to stop the decline in number of farms, or how to slow up the increase in the size of farms that remain. Instead, we should be concerned with (1) doing the very best job possible on those farms that have adequate resources to support farm families, and (2) making possible a transfer or combination of resources on those farms that have inadequate resources to support farm families.

If Alabama's commercial agriculture becomes fully adjusted to the technological and scientific possibilities that exist today, and if it successfully meets the competition of the future, the total number of farms in Alabama in 1975 will have to be reduced to less than half the number that exists today. Production per worker in agriculture will have to be 4 or 5 times larger than today. Capital used per worker in agriculture will have to be 8 to 10 times greater than the amount used today. These types of changes will have a major impact on future agricultural research and educational programs.

If Alabama fails to produce through research, if it fails to convey through education, and if it fails to adapt and adopt through practice, those scientific and technological developments which will be necessary for Alabama to successfully compete with other areas of the country, then, much of the agriculture in Alabama in 1975 may continue to consist of small, inefficient, poorly managed operations with small volume, low quality production, sold for low prices and resulting in low incomes and low standards of living for many of the State's farm people.

If Alabama's farm people are to reach a favorable income situation in the future, the implications of today's great scientific and technological breakthrough must be understood and appropriate adjustments made.

The objective in commercial agriculture, as in any other business, is production for the market. Success in commercial agriculture, as in any other business, is in terms of profits or net returns to producers. If the farmer of today is to be the producer of tomorrow, he not only needs to build up and conserve his productive resources for tomorrow's use, but he must in some way be able to extract from his efforts today a reasonable profit or net income.

Our task as a Land-Grant Institution is to define this problem of adjustment both on and off the farm, to discover the alternative ways in which the adjustment can be accomplished, and to develop our teaching, research, (Extension) educational, service, and other programs as an aid in the adjustment process.

NOTE

The data on which this paper and the slides shown were based are reported in a series of publications recently prepared by the Department of Agricultural Economics, Auburn University, Auburn, Alabama. These reports are available upon request, as follows:

1. Southern Agriculture: Recent Trends, Current Status, and Future Prospects.

2. Changes and Trends in Alabama Agriculture and Related Data Since 1920.

3. Changes in Alabama Agriculture and Related Data, 1950 to 1960 (by Economic Areas and by Counties).

AN EXTENSION PROGRAM TO MEET PRESENT DAY NEEDS

FRED R. ROBERTSON, DIRECTOR (ACTING)
COOPERATIVE EXTENSION SERVICE, AUBURN UNIVERSITY

The Cooperative Extension Service was the last of the three major agricultural divisions of the Land Grant College System to be created by national legislation. It was created to meet an educational need that was not being met under existing conditions. There was a recognized need for an informal educational service which would take the results of research, "on subjects relating to agriculture and home economics," to people who could apply these results in improving their welfare.

I believe also that other factors were involved in influencing the decisions by the Congress to create an Extension Service through passage of the Smith-Lever Act. Among the most compelling factors was the fact that technology was not being applied to agricultural production to the desired degree. The results of the lack of use of technology was reflected in the productivity of the nation's agriculture. Prior to World War I, which corresponds closely to the date of the passage of the Smith-Lever Act creating the Extension Service, total national output of food and fiber was increased mainly by bringing additional land into cultivation. Improvements in agriculture up to this time barely succeeded in offsetting the decline in soil productivity that resulted from having the land under plow.

Summary of talk presented at the Annual Staff Meeting of Agricultural Experiment Station and School of Agriculture, Auburn University, July 5, 1961.

Following World War I, two significant events took place in agriculture which set the stage for the technological explosion which has provided us with the blessed abundance of food and fiber. One was the application of mechanical power to farming which released millions of acres to produce feed for people rather than for horses and mules. The other was the action taken by State and Federal governments to expand research and educational programs. We should never forget, nor allow the general public to forget, that all of the progress that we have made in agricultural productivity has been due to our ability to combine research and education into effective active programs.

Out of these new developments in agriculture grew an agricultural industry that is unequalled anywhere in the world. However, it has brought problems as well as blessings. Increased output has been achieved because of our ability to substitute capital for labor in one form or another. Thus we have created for ourselves a new set of problems and it is up to teaching, research and Extension to work together and find ways and means of working our way out of this new dilemma. In short, each of us must adapt our programs to meet the needs of today's agricultural industry.

Some of the factors affecting the direction of future Extension programs are (1) changes in residence patterns (rural and urban), (2) a rising educational level (all groups) and (3) a rise in the general level of living of people.

Extension programs in the future must be aimed at a continuation of improvements in production and quality of agriculture. This direction is correct but not sufficient within itself. An Extension

Service that considers improved technology and higher agricultural productivity as being sufficient is not making its proper contribution to the total agricultural economy. Such an approach will not increase farm income in the long-run, does not encourage the agricultural industry to make its full contribution to economic growth, and worst of all, it would unwittingly contribute to a distrust of new agricultural technology which is now held and voiced by some people in the nation. Such a viewpoint, if widely held, could endanger the future of agricultural teaching and research, agricultural Extension, and even curtail economic growth which Alabama and the nation must have to survive.

Therefore, it is rather obvious that Extension programs must be expanded to encompass many other areas so that the general public can appraise the agriculture industry from an enlightened point of view. It seems to me this is a requisite that must be taken into consideration if we are to maintain our place in society and the national economy. Major requirement for future Extension Programs is a very high degree of competence and proficiency in numerous subject matter areas. We must constantly bear in mind that the only commodity we have to sell is education. People have many sources of information--some good and some bad. Consequently, our product must be a good one; properly packaged, designed and presented to meet the needs of our time. If we are as smart as we ought to be, we will provide the right kind and size of package.

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DEVELOPING AN AGRICULTURAL TEACHING PROGRAM TO SERVE PRESENT DAY NEEDS

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and Agricultural Experiment Station

Mr. Lanham has given us a good background for this subject. It is not my intention to review his paper or the data he presented, but we cannot fail to be impressed by the magnitude of the changes that have occurred in Agriculture throughout the Nation within the past generation. Neither can we afford the comfort of ignoring these changes and adopting the attitude that they will have no effect on our teaching programs. At the same time, we must grard against two extreme attitudes -- an attitude on the part of some who see in the changes a need for junking our entire program as inadequate for our needs and the belief on the part of others that the decline in farm population *per se* presages a diminution in the need for agricultural curricula.

Certainly, agriculture in the United States, in the Southeast, and in Alabama has undergone changes almost beyond imagination within the past quarter of a century. These changes have been caused by, accompanied by, or have resulted in shifts in social and economic patterns including population shifts and farm size; mechanization and, consequently, the farm labor situation; cropping systems and crops themselves; livestock and livestock enterprises; farming practices; and the whole complex of agri-business. The change has been tremendous and Mr. Lanham predicts with justification that "the additional changes that will occur over the next two or three decades will have to be far greater than were those of the past two or three decades if Alabama agriculture is to successfully meet the competition of the future and to continue to grow as a commercial business industry".

The changes that have occurred in Alabama agriculture have occurred so rapidly in recent decades that we seldom stop to think or even care as to which have been cause and which have been effect. Actually, we, in the Experiment Station, are pleased that we have been a causative agent for many of these changes. For example, in our generation we have seen and have been a part of the vast corn improvement program resulting from combining Experiment Station developed hybrids with Experiment Station practices. In Alabama, this has resulted in doubling the corn yield per acre within the past fifteen years and we are beginning to see equally as startling changes in other areas of agriculture triggered by the findings of Experiment Station personnel.

Though the Experiment Station is not immune from critics that its thinking is archaic -- at times, even sterile, -- and that it is overly subject to the laws of inertia, one has only to compare research techniques, projects, equipment, and even attitudes and concepts of today with those of a generation ago, to realize that research has changed in about the same order of magnitude as agriculture itself.

Presented at the Annual Conference of the Auburn University School of Agriculture and Agricultural Experiment Station at Auburn, Alabama, July 5, 1961

This generation has also witnessed changes in agricultural teaching programs and problems in teaching. Some of these changes are just as great, though perhaps not as greatly appreciated, as those summarized by Mr. Lanham. Certainly, the changes delineated by him have created tremendous problems as well as challenges to the agricultural teaching program, but I think it is doubtful that this generation has experienced anything like as great a change in what is called the "curriculum", either as to subject matter or teaching methods and techniques as we have seen in research.

One of the major evidences of change in agriculture during this decade has been in student numbers. In the fall of 1948, for example, undergraduate enrollment in agriculture in the land-grant colleges reached an all-time high of almost 49,000 students. From this peak, agricultural enrollment declined to 32,000 in 1960, which is a decrease of thirty percent. At the same time, agricultural enrollment as a percentage of total undergraduate enrollment at land-grant colleges decreased from about twelve percent in 1948 to about seven percent in 1960.

At Auburn, corresponding figures are: an enrollment of about 900 in the fall of 1948 to 492 in 1960 -- a decrease of over forty percent. In terms of total undergraduate enrollment, agricultural students represented about twelve percent of the college enrollment in 1948 and slightly over six percent in 1960.

Total enrollment figures, however, do not give a true picture of the decrease which has been much greater with some curricula than others. A breakdown in curriculum enrollment for 1948 is not available, but some decrease in all curriculum occurred by 1960. Enrollment figures for the fall quarters of 1960 and 1950 show the following comparisons:

Enrollment	1950	1960	Change (Percent)
Total Enrollment	760	492	-35
Agricultural Science	463	139	-70
Agricultural Administration	50	40	-20
Agricultural Engineering	77	36	-53
Forestry	109	212	+94
Ornamental Horticulture	38	25	-34
Biological Sciences	23	40	+74

In the 1961 winter quarter commencement no degree was awarded in Agricultural Science. This, I believe, may have been the first commencement program in the history of Auburn's Agricultural Science curriculum that this has occurred.

Enrollment in the School of Agriculture at Auburn seems to have stabilized within the past few years and there seems to be some indication of a slight increase. For example, the average enrollment for the fall, winter, and spring quarters for the past three years was 447 for 1960-61, 434 for 1959-60, and 445 for 1958-59. New freshmen enrollment in the fall of 1960 was about 122 -- the highest in any recent year and the 1961 summer enrollment of 36 new freshmen was the greatest in a number of years.

I think it might be well to mention that the increase in graduate enrollment in our departments has about equalled the percentage decrease in undergraduate enrollment. Actually, enrollment of graduate students is about 1/4 as great as undergraduate enrollment. It may be of some interest to know that of the graduate students at Auburn working toward a degree requiring a thesis or dissertation, about twenty-five percent are in the School of Agriculture.

In spite of the substantial increase in graduate enrollment, it is my opinion that the most serious problem we face in personnel needs in the coming decade will be in this area of graduate instruction, not only in numbers but in academic qualifications. One needs only to look at the undergraduate records of students who apply for admission to the graduate schools to see how serious is this problem of academic deficiencies on the part of many graduate students.

I have dwelt at length on the problem of enrollment numbers because this problem is not only serious from the standpoint of teaching, but it may be related, and even partially caused, by types of curricula that are available to students in agriculture both at Auburn and elsewhere.

As stated earlier, there have been many noticeable changes in agricultural curricula over the years -- there undoubtedly will be many others. "What should the agricultural curriculum include?" is a question that was debated before the passage of the Morrill Act and has been a subject of discussion at meetings of the Land-Grant College Association from the beginning of its history. Discussions as to the place of the technical, as contrasted to the humanities; the practical versus the theoretical; and whether the curriculum should be specialized or general; are as old as agricultural colleges, and the discussions of fifty years ago are repeated with equal vigor today and almost in the same words. In a paper by Wayne D. Rasmussen of the United States Department of Agriculture entitled "Liberal Education and Agriculture", Auburn's William Leroy Broun is quoted as having expressed the following opinion in his presidential address in 1892 before the Sixth Annual Convention of the Association of American Agricultural Colleges and Experiment Stations, "that the function of the college was not to make farmers of its students but to make men with education brains and skilled hands, ready to turn to whatever vocation they best fitted. He argued that there was no place for the narrowness of some of the classicists who contended that an agricultural college did not fit into the American system of education, nor was there a place favoring only empirical, technical instruction to the exclusion of liberal education. Both cultural and technical education are necessary."

In the early days of the agricultural colleges, much emphasis was placed on the acquisition of skills, and many colleges had a compulsory manual labor requirement in the agricultural curriculum. This was required by law at Michigan State College as well as in a number of other states. Although such emphasis on manual labor has long disappeared, some colleges still require a certain amount of farm experience before a student can get an agricultural degree.

Too, there is still a tendency in most of our agricultural colleges to impose such requirements through courses that devote an undue amount of time to the acquisition of skills. This is in spite of the fact that most employers profess a desire for employees who have good fundamental training with an understanding of human nature and the ability to express themselves well.

It would seem that the first step that needs to be taken by those who plan a teaching program to fit our current and future needs, is to consider who we are training and for what we are training them. It is obvious that we are not training all of our students for production careers, either as farmers, or foresters, or engineers. We have never had any large percentage of our Agricultural Science graduates returning to the farm, although I believe our percentage of students returning to the farm in the past decade has been greater than at any time in the history of Auburn University. I do believe there is a tendency on the part of many colleges to under-emphasize their responsibilities to educate students for a farm career. In spite of the decline in farm population, there never has been a period when the farmer has had greater need for good agricultural training. Certainly, the commercial farmer whose capital investment amounts to today's figures needs the best of agricultural training. But he needs to be more than a good technician in his own production field. He must also know marketing, management, machinery, and a host of other subjects if he is to stay in business. Equally important, perhaps, he must be able to speak authoritatively for agriculture so that his voice will be heard and his views respected, for the farmer as a group no longer has the political influence he once had.

I think our curricula should take recognition of this fact and provide subjects that will be helpful in solving this problem. Some of these subjects are literature, writing, group discussion, philosophy, ethics, and logic; others include the social sciences such as sociology, psychology, political science or government, history, and public policy. I do not propose that we introduce an aura of dilattanteism into our curricula, but some of these subjects can be an essential part of the education of our students as we move into the future. In general, our Ag students enter college with little background or interest in these subjects and unless they are given some formal training in these areas of knowledge while they are in college, they will unlikely acquire it in later life.

In planning a teaching program to meet our present and immediate future needs, I think we should give careful thought as to the degree of specialization that is offered at the undergraduate level. We at Auburn, for example, offer degrees in six different curricula. Within these curricula, majors are offered in eleven distinct areas, giving a total of fifteen separate printed courses of study. In most of these courses of study, fewer than ten students are registered and in only two cases were more than ten seniors or juniors registered in a particular major at any time during the past year. At the sophomore level, only in the fall quarter did our majors include more than two cases where ten or more students were registered in a single major. This situation raises three questions: (1) Can we afford the cost of what amounts almost to individual instruction? (2) Are our classes too small for most effective instruction? and (3) What is the relationship between the student's undergraduate major and his post graduate activities? While I will not try to answer the last two questions, I think we must face the inevitable fact that we cannot afford the costs of some of our majors. This opinion has been given particular expression in the New England States where college administrators are talking of regionalization of entire areas of agriculture.

Many of the colleges of agriculture in the United States, faced with the problem of many separate majors, have adopted a three-curriculum program in agriculture -- business, technology, and science. My impression is that they have only tripled their majors by dividing each one that formerly existed into three parts giving three majors where one formerly existed. While I do not believe that we can set up a common curriculum in the School of Agriculture that will include Forestry, Ornamental Horticulture, Engineering, and Biological Sciences with the more general agriculture programs, I do believe that there is a core of subjects beyond English composition, military, P.E., and the basic sciences that each graduate might be expected to have taken. Within the general field of agriculture, it might be well to provide two major areas of business and technology where the students in each area have a broad base of common subjects and reasonably wide latitude in the choice of electives.

Then, because of the critical need for graduates trained beyond the baccalaureate, it is my impression that we need to direct the attention of our more capable students to possibilities of graduate studies early in their career at Auburn. Here again, a curriculum designed for this purpose which includes a heavy concentration in the basic sciences and electives within the student's area of interest, may be desirable.

The programs, as you see, would involve a student-faculty relationship beyond that which has been in existence at Auburn in the past. The importance of this may be seen from a review of the progress of the 121 new freshmen who entered in the fall of 1960: Of this number, thirty-nine or thirty-two percent failed to complete the spring quarter. Of those who did not complete the spring quarter, seventeen were dropped for failure to pass five hours -- sixteen at the end of the fall quarter and one at the end of the winter quarter. The remaining twenty-two students who did not complete the spring quarter either transferred to other schools on the campus or voluntarily withdrew from Auburn. Some of these students were subsequently suspended at the end of the spring quarter when the sixty percent rule was applied. Thirty of the fall quarter's 121 entering freshmen were suspended at the end of the spring quarter for failure either to pass sixty percent of the credits they attempted or earn sixty percent as many grade points as they attempted in hours. So, altogether, over forty percent of the 121 freshmen were dropped for academic deficiencies during the year. Now, these were not all poor college prospects. Actually, the agriculture students entering in the fall of 1960 had placement scores that were quite satisfactory as compared to the other students entering Auburn in that quarter. The 121 students had an average score of about 5.4 (decile scale) for all tests. This would place them slightly above average compared to other entering freshmen in their class. In general, the poorest students were dropped first. Of the students who were dropped at the end of their first quarter, thirteen of the sixteen were below average on placement scores, but many of the students having placement scores in the sixth, seventh, and eighth deciles, had academic difficulty leading to academic suspension sometime during the year.

As we plan for developing an agricultural teaching program for the decade ahead, we are faced with two factors that were not in the picture five years ago -- new and adequate teaching facilities in most of our areas and the Auburn Self Study. Neither can be an advantage if we do not accept them as challenges, but both can contribute greatly to the improvement of our teaching program if we make full use of them. The Self Study will give us a chance to assess our problems and responsibilities to develop teaching programs in keeping with our needs. If we are satisfied with our present programs and methods, our new facilities will add little, other than convenience and comfort. I know, however, that these new facilities will add tremendously to an already excellent program of teaching in the School of Agriculture. I have had the thrilling experience of hearing many of our faculty tell of plans to introduce new subject matter and techniques that have been essentially out of the question in the past into our existing courses.

I would like to close by quoting a statement made by Dean S.W. Fletcher of Pennsylvania State College, which I think presents the challenge in developing a program of teaching for this decade just as it did when it was made in 1940.

"The point at issue is not broad versus specialized training, but whether the admittedly excellent technological curricula in the schools of agriculture also prepare the students equally well to meet the social problems which arise in their professional activities. The public has a right to expect that graduates of the colleges of agriculture will be more than good technicians."

DEVELOPING AN AGRICULTURAL RESEARCH PROGRAM TO MEET PRESENT DAY NEEDS

by

Coyt Wilson

The title of this talk implies that an agricultural research program is something that can be developed in a relatively short time. It also implies that present day needs are strikingly different from those of a few months or years ago. There is some truth in both ideas, but we must remember that over-all research needs do not remain static for a number of years and then suddenly change. Neither do research programs. Both are changing constantly. The information from last year's census brings into sharper focus certain facts that must be considered in planning agricultural research. But, 1961 is not to be regarded as a termination point for a program that has grown obsolete and the beginning point for a radically new and more dynamic program designed to serve entirely new needs of Alabama people.

On the other hand, we are not, and cannot afford to be satisfied with the status quo. Change we must and change we will, but the changes will be gradual and the development will never be complete. I do not wish to belabor this point, but I will remind you that we are bound to some extent by history, by the talents and skills possessed by the staff, and by the kinds of research facilities that we have. We are also bound to some extent by laws, rules and regulations. We have more "red tape" than ever before and some of us have developed considerable skill in its manufacture. There is no danger of the supply running short.

By way of review I would like to remind you that since 1883 Alabama's agricultural research program has been constantly changing to meet changing needs. We have sincerely tried to concentrate our limited research resources on the problems that were most pressing at the moment. For many years our most pressing problem was low production. Therefore, we concentrated in earlier years on production practices that would result in higher yields per acre. As the public became more quality conscious, we began to give more emphasis to the quality of the product being offered for sale. We recognized the need for a variety of cotton superior to Half and Half and through research we found several such varieties. Through research we learned that Dixie Runner peanuts possessed quality factors demanded by the end users and consumers, and with this information we contributed to the salvation of the peanut industry in Alabama. Acreage controls, made necessary by surpluses, placed limits on the amount of income individual farmers could realize from cotton and created a need for information on the possibilities of adding other enterprises to the farm operation. As a result of these needs, we expanded our research on horticultural crops, on soybeans, and on livestock.

Since World War II labor has become increasingly scarce on Alabama farms. As this problem came into focus, we increased our research on mechanization of production and harvesting practices. Many other examples could be cited, but these are sufficient to show that our program does change with the changing times.

However, the adjustments that we will have to make in the future are likely to be quite different from those we have had to make in the past. The characteristics of the public that we serve are changing rapidly. The interests of the people, their problems and their opportunities for using new information are changing at a rapid rate.

Agriculture is no longer synonymous with farming. Today's agriculture involves far more than the production of crops or livestock on a given area of land. We have recognized this for some time, and we have struggled to find a more descriptive term for this extremely complex relationship between farmers, and those who provide him with materials or services. Agribusiness is the best we have been able to coin so far, but this is not a very satisfying word. Until we do find a better term, the important thing to remember is that it is no longer possible to differentiate clearly between agricultural research and other types of research such as that done by industry or medicine.

I do not believe that any of us can visualize clearly at this time how much of an impact the changing social picture will have on our research program. We have been accustomed to doing research on more or less specific problems to obtain information that an individual farmer could use or not use as he saw fit. This may not be sufficient in the future. Acreage controls often make it impossible for a farmer to adjust to the scale needed for greatest economy. Lack of markets may prevent a farmer from growing a crop that is adapted to his land. Group decisions and actions are often necessary to develop an improved economy. All of these things point to the fact that individual farmers are losing the opportunity and the right to chart their own course. More and more they are being forced to become cogs in community or area-wide schemes. It can be argued that this is good. There is abundant evidence that progress is more rapid where people work together. Personally, I believe in cooperation, but I would like for it to be voluntary. I am of the opinion that we are losing this freedom very fast. It appears that we are working toward an economy and social structure that is planned and directed from the "top down", rather than one that is built from the "bottom up" by decisions and actions of individuals or groups cooperating on a voluntary basis. This "top-level" planning is not limited to that done by the Federal Government. It is found at the state, county, and community level. It is justified on the basis of necessity. I hope that it is good; at least I see no alternative. I feel sure that it will increase during the coming years.

If this is true, we can expect the functions of our Agricultural Experiment Station to change radically. We will do research in areas that are new to us. We will have thrust upon us new responsibilities. As an aid to sound planning we will need specific and current information on the human and physical resources in the various areas and regions of the state; we will need more information on the economics of various enterprises and combinations of enterprises; and we will need much more information than we now have on such things as group financing, organization and administration of planning groups, changes needed in the laws under which we live and methods of motivating people. We will join with others in studies on methods by which this kind of information may be put to use. We will be involved in development and maybe, in policy making. From the standpoint of the general welfare, these changes should prove to be good, but the transition will be difficult for many of us.

I think that all of us will agree that an adequate agricultural research program is one that serves the needs of the part-time farmer, the rural resident who does not farm, the urban dweller, and the full time farmer. Developing such a program is not as difficult as it might appear. Differences among these groups are not as pronounced as they were a few years ago. Some needs are common to all groups. The urban resident who grows roses as a hobby needs information on soils and fertilizer just as much as the full time farmer who grows soybeans for sale. All families are interested in such things as establishment and maintenance of lawns and ornamental shrubs, control of weeds insects, plant diseases, and household pests. In many other areas the research needs are similar. The farmer and the white collar worker wear different types of clothing, but each one needs information on materials and finishes used in making his clothes. Their eating habits are different, but each one wants to know how to obtain the best food at the lowest cost. In one case the food may be produced and processed on the farm; in the other it may be selected from the variety offered by a supermarket.

Urban and rural residents share many problems that are not closely related to agriculture. Whether a family lives in the country or in town, the husband and wife need information on financial problems related to insurance, sources of credit, debt retirement and investments. They also need information on child development, mental health, and use of leisure time. Agricultural Experiment Stations cannot and should not assume full responsibility for answering all of these questions, but we should seek and find more effective means of cooperating with researchers in other areas.

For the production of crops and livestock research needs are certain to increase even though the number of farms and farmers decrease. As the size of farms increases and as the amount of capital invested increases, the demand for information and methods of reducing costs will increase. Not long ago I heard Rhea Blake say that with all the research that has been done on cotton insects, diseases and chemical weed control, these pests still increase the cost of producing cotton by 12 cents per pound. So, even though we have a surplus of cotton, we must intensify our production research on this crop in order to develop more efficient production practices. This is equally true for every agricultural product that we produce. Commercial beef production in Alabama must become far more efficient if we are to meet competition. Few, if any, commercial cattlemen average more than 200 pounds of beef per year. With land values rising year by year, we are rapidly approaching the time when we cannot afford to graze cattle in this state unless we can find a way of increasing the returns that we get from grazing. We have all seen reports from other states of 1,000 to 1,500 pounds of beef per acre produced on grazing. As far as I know, our record in Alabama is about 800 pounds per acre. This was obtained on a Coastal-Crimson pasture here at the Main Station several years ago and has not yet been repeated. To finish our beef we have to keep the animals in the feed lot for about 1/3 of a year. Within the next few years we must learn how to produce beef more efficiently. Otherwise, we will be eating beef produced in other areas or we will be eating some other form of protein. Every product that we produce faces competition from other sources or from substitutes. The economic and social changes that are occurring intensify rather than diminish our needs for research on efficiency of production.

In many areas the impact of social and economic changes on our research program is even more easy to see. Water systems and electri-- city in rural homes enable the housewife to use many of the conveniences that were limited to urban houses a few years ago. The use of pig parlors and milking parlors has increased repidly during the last 10 years. All of these developments have intensified the problems of disposing of farm waste. The problem is pressing now and will become more pressing in the very near future.

More and more chemicals are being used in the production of crops and livestock, for the protection of stored products, in processing of agricultural products and for supplementing or preserving human food and animal feeds. It seems to be generally agreed that industry is responsible for producing and making preliminary evaluations of these chemicals and that Experiment Stations are responsible for developing recommendations for their use. This division of responsibility worked pretty well in the past, but the situation is changing rapidly. Chemicals are absolutely essential for production and protection of agricultural products; industry is anxious to supply them; but the public must be protected from harmful effects. Therefore, we must determine through research safe and effective ways of using chemicals. To do this it is necessary to screen a tremendous number of materials under a wide variety of conditions. The program must include tests with various carriers, on rates of application and on frequency of application. Finally, someone must determine the amount of control that is obtained, the hazzards involved, and the residue that remains after use. The job is too big for any single organization or agency. As a result of these pressures, we are in danger of becoming a routine testing station. Our research program must meet the needs of the times, but I think we must find a way of determining how far we can go in testing proprietary compounds and in making routine determination of the residues that persist in agricultural products following their use.

In developing a research program to meet today's needs, we must place more emphasis on utilization and marketing research. It is no longer enough to "make two blades of grass grow where one grew before." We must also determine through research the best ways of converting these two blades of grass into cash. This is not an easy thing to do. Results from marketing research, like those from other types of research, must be used in order to create wealth. This means that our research must not only show what can be done, it must also show what can be done at a profit. Our research on Alayam products and on improved methods of making jelly and jam yielded good information, but it has not been used. Our research on marketing of livestock and livestock products and on poultry and poultry products has been well planned and thoroughly done, but I do not believe that we have affected to any extent the marketing of these products. We have done some excellent research on peanut storage, but I am afraid that we overlooked the fact that peanuts should be used instead of being stored. We need information on the biochemical changes that occur during storage, but we also need information that can be used to increase the consumption of peanuts. In my opinion, our experiences in these areas show the necessity of combining in some way research and development. In order to do this we probably will find that we must work closer than ever with such agencies as the Chamber of Commerce and the State Planning and Industrial Development Board.

Quality improvement is just as essential for each of our agricultural products as more efficient production practices. Quality is a broad and often vague term. It is difficult, therefore, to talk of quality improvement in general terms. Quality of a given product is related to genetics, production and harvesting practices and processing. To some extent every agricultural scientist is concerned with quality improvement, and it behooves each of us to remember that the crop, animal or product on which we are working will be replaced by a substitute unless quality is continually improved.

We hear a lot about the problems that will be created by an expanding population. It has been estimated that progress in agriculture must be 30 per cent faster between now and 1975 than it has been for the past 20 years in order to "stay even". If this is true, the problem of conserving our natural resources will be intensified. Production of food and fiber will have first claim on land and water, but the demands for land, water, wild life and forests for recreational purposes will be much greater. In the first place, there will be more people using these resources for this purpose. In the second place, the people are likely to have more time to devote to recreational activities. Interest in the possibilities of multiple use is almost certain to increase. I think that the public, and to some extent, agricultural research workers have thought of conservation in terms of soil erosion, forest fire control and bag and creel limits. This concept must be changed. All of us must realize that true conservation revolves around the idea of best use. Research in conservation must be directed toward this end if the needs of all the people are to be served.

In conclusion, I would say that basically our goals remain the same. Since 1883 the Agricultural Experiment Station of this State has been dedicated to:

1. Developing more efficient production, harvesting and marketing practices for agricultural products.
2. Improving the quality of agricultural products.
3. Conserving our physical and human resources.
4. Making farm life more attractive and rewarding.

We shift emphasis; we change our methods; we work with different people and with people under different circumstances; and we constantly redefine our short term objectives. But, we have never lost sight of the opportunities of making Alabama a greater State by providing through research the information necessary for improving the agricultural economy of the State. Let us not lose sight of this opportunity now while we are making the changes that are necessary to keep us in step with the times.

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THE EFFECT OF ECONOMIC AND SOCIAL CHANGES ON RESEARCH NEEDS IN THE PLANT SCIENCES

C. E. SCARSBROOK

When this topic was assigned to me I was, to say the least, stunned. As I examined the subject I could think of no area in which I was competent to make as much as a two-sentence talk. This has not been an unusual situation for me in the past, so I proceeded to take advantage of one of our most helpful and gratifying traditions, which is, when a fellow staff member needs your help, you help him. And I might digress here to ask, "Have you ever considered how unusual it is to be on a staff where you would have difficulty finding a single staff member who would be unwilling to assist you in finding a solution to any problem on which he could give competent help?" It is certainly not traditional everywhere. Unfortunately, I could find no one who felt competent on my subject. They all looked as blank as I did when I first heard the title. But after the pained expressions died away, they proceeded to come up with some ideas. However, since they may not recognize them with my translation, they won't be expected to have to defend anything in this report.

When we ask how does the economic and social conditions of society affect our research, a quote from the erudite British biochemist Joseph Needham is pertinent. He said, "A scientist's work is inevitably conditioned by the society in which he lives, the nature and stage of development of the society impose limitations upon his choice of the subject of his research, and determine the facilities at his disposal. The knowledge available and a philosophy of the period which he accepts, consciously or unconsciously, influences to a high degree his approach to his problems, his techniques and his conclusions."

We live in an age that has tremendous respect for science and learning. Regardless of how low our educational levels may be, the average American still knows far more about the world around him than any previous generation. This affects what is expected of each one of us. Although the public seldom states it in words, I am convinced that they know that the number one job of each of us assembled here is to be a scholar. The fact that we have plots to manage, labor to supervise, classes to teach, committee meetings to attend, and laboratory determinations that must be made, as important as they all are, does not alter the central fact that our principal duty is to be a scholar.

Since there are several definitions of a scholar, I would like to define a scholar as one who is engaged in acquiring detailed knowledge in one or more fields of study along with skill in investigation and powers of critical analysis in interpretation of such knowledge.

After our formal university education is completed, we, without much effort, learn by associating with our fellow workers. This is beneficial but I don't think any of us can take much credit for this kind of learning. I am convinced that for all of us who are more than 3 or 4 years out of graduate school or other formal training, a conscious organized effort must be made if we are to have the knowledge sufficient to be worthy of the name scholar. Perhaps we are remiss in setting the right climate for scientific scholarship as no one ever questions the usefulness of an individual when he is spraying field plots for weed control or applying fertilizers. Yet how often have you been reading a scientific journal and have it said to you, "Oh, I see you are not working." It is said in jest but perhaps it is not meant to be all jest.

While genuine scholarship does not ensure creditable research since many other factors such as imagination, diligence, and curiosity are important scientific characteristics, it is certain that poor research always follows poor scholarship. (Unless, of course, we get real lucky, which has happened, but I don't think we had better count on that.)

Never before in history has the public had greater respect for scientific research than at present. They believe that given enough funds, time and talent that science can solve any problem. That the public fails to recognize the limits of science is not our problem here today. Our job is to utilize this respect for research for the advancement of agriculture which is the same as saying for the advancement of all people. Happily, this respect for research is not limited to what we have chosen to call practical research as compared with basic research. Since this is true, it is high time that we cease to use the terminology "practical and pure research." The usefulness of these terms is outmoded, as there remains no important group of people that have to be sold on the importance of theoretical research. The separation into kinds of research has always been artificial, except insofar as the objective is concerned, and neither is superior to the other as a form of human activity. Surely it would be better to concentrate on measuring what happens between the time the treatments are applied and the ultimate yield or other end effect is determined. Seeking to understand should be our goal, regardless of whether we have a known use for the expected results.

As has been pointed out, there have been shifts away from rural living as well as away from farming as an occupation. Does this mean that we should direct more research at the specific needs of our non-farm population? I believe that a change in the direction of our research in the plant sciences is not indicated. Since our goal should be to understand, applications of the research results could apply to any group of people. For example, a better understanding of the mechanism of transfer of mineral elements into and within the plant may well be translated into greater efficiency of production of a rye crop used for grazing. But the information may be equally applicable to the production of a handsome zoysia grass lawn in the city or to African violets in a penthouse window. Then too, much of our work is concerned with the production of high quality food products. Consider how much of our research effort is associated with quality problems such as pathology research to control concealed damage in peanuts, entomology research to ensure that the sweet corn and other vegetables in the local market are free of worms, plant nutrition research which provides the basis for highly palatable, nutritious foods, water research which shows the limits of moisture where tomatoes can be produced with both the desired firmness and flavor. Surely these are just a few examples of research that is of benefit to all people regardless of occupation or place of residence.

Since the economic and social conditions of the times does affect our research, what kind of research should we have in the plant sciences? Certainly we will move forward on a broad front with better varieties, better disease and insect control, more efficient utilization of fertilizers and the like. This is important and probably most of our work will fall in this category. However, it seems probable that our greatest opportunity lies in another direction. In the plant sciences, as in other sciences, we have vast areas where our lack of knowledge is probably holding back many important advances. A break-through in one or more of these important areas would bring large dividends to all of us.

If this seems to be speaking in terms that are too general, let us look at some of these specific areas. Many plants utilize from 300 to 1000 pounds of water for each pound of dry matter produced. Of the water taken into the plants less than 1% is used in the photosynthetic process. Considering all the known or suspected functions of the plant, over 90% of the water transpired by plants serves no useful function. Suppose that better understanding of the water relations of plants should, as often has happened in science, lead to means of control of the process. Drouth, which is the major environmental risk of the farmer, would disappear as every year there is ample moisture for the essential functions of the plant. The big break-through here would eliminate the need for irrigation in this region.

Evaporation is another big area of water loss for plants where our knowledge is extremely meager. Perhaps 40% of soil water is lost through evaporation and the only means we have of control is by mechanical means, such as straw or plastic mulches. Perhaps no control can be devised, but certainly there will be none until we understand the forces which hold water in the soil. Control starts with an understanding of these forces. Once again, control could lead to elimination of much of the drouth threat.

Another significant problem is: what are the limiting factors in grain production by the corn plant? With a potential of over 300 bushels per acre of corn we can produce less than half this in Alabama with all the knowledge that we possess. Surely this problem could be solved.

Some other problems at random are (1) Why does one plant produce so much more protein than another? (2) Why will plants accumulate a large excess of elements such as potassium but only a small excess of phosphorus?

If these seem far fetched, consider how many of us outside the plant breeding field would have believed 30 years ago that crossing some puny, unthrifty, largely unproductive plants could have produced corn with superior yielding characteristics; or 20 years ago would have believed that a field could be sprayed with a chemical that would kill most weeds yet the desired plant would germinate and grow without being harmed; or 10 years ago would have believed that bacteria could be sprayed on plants that would kill insects but be perfectly harmless to humans or animals. These advances were caused by imaginative people who believed in their ideas.

Major break-throughs have occurred in this Experiment Station in the past. Look at the prestige, the publicity, and, most important of all, the other research that has been stimulated by a successful vaccine for coccodiocis, fertilization of water for fish production and development of root knot nematode resistant cotton.

I am certain that the public will support future break-through research even though they may not understand the significance of the project. Everyone is aware of the shortage of funds. But even with funds in short supply, I believe that if an individual or a research team with a well thought out program will seek support from without as well as within the Institution that support can be obtained.

In summary, the public expects us to be scholars. The principal result of scholarship and imagination should be the production of ideas. The research that follows suitable ideas can and will be supported by the present economic and social order.

7/27/61

THE INFLUENCE OF ECONOMIC AND SOCIAL CHANGES ON RESEARCH NEEDS IN ANIMAL SCIENCES

by

Lavern Brown

Opening Remarks

This topic assigned to me is so broad in scope that an attempt to cover it would mean speaking in very general terms. I believe it would be advantageous to confine my remarks largely to one branch of animal science and assume they have general application, rather than make such general remarks that it would be difficult to assign them to specific enterprises. Most of what I will say will relate to beef cattle research. Mr. Lanham has outlined the social and economic changes in Alabama agriculture in recent years. He has very ably pointed out the unhealthy economic condition of Alabama agriculture. The farmers' share of the consumer dollar has decreased until his survival depends on volume production with low per unit profit: i.e., in 1952, choice 900 - 1100 pound steers sold for $34.00 - $35.00 per cwt., and the beef from these animals retailed at $.86 per pound. Today, choice steers of the same weight sell for $23.00 per cwt., and the beef retails at $.80 per pound. This is a decline of 30 per cent in farm price, while the retail price declined about 9 per cent. We have had a 100 per cent increase in land value in the last 15 years from $45.00 - $90.00 per acre. There is no reason not to expect this trend to continue.

I am sure that we all recognize the competitive position of poultry products, pork, beef and other high protein non-animal products. Developments in efficiency of producing broilers and hogs have been phenomenal. We are now talking about producing a pound of broiler with 1.5 pounds of feed and a pound of pork with 3 pounds of feed. Developments that effect efficiency in beef cattle production have been less significant. Dr. Warwick[1] of U.S.D.A. made this statement recently:

> "After reviewing data on performance of beef cattle on standard rations, there is no positive evidence in improvement of either gaining ability or efficiency of gain since 1920, and apparent improvements as compared to the period prior to 1920 are of doubtful significance in view of the heavier initial weights and longer feeding periods in the earlier years. Thus, neither economic data nor experiment station results provide clear cut evidence of improved efficiency of the industry as a whole."

This does not necessarily mean that the cattle production picture has been static. It has changed greatly. Beef cattle today have the ability to fatten lighter and at younger ages than those of two or three decades ago. This is a desirable development within reasonable limits. Rations have changed greatly, but it still requires approximately the same number of feed units (feed unit is equivalent to one pound of corn) to produce 100 pounds of gain as it has for the last 30 years.

The competitive position of the beef cattle industry, the tremendous increase in land prices, in cost of machinery and skilled operators make specialization the best route in most cases. The economic position of the beef cattle industry points up the need for an accelerated research program geared to stay abreast, or ahead of these changes.

The census shows approximately a 60 per cent increase in beef cattle in Alabama in the last ten years. This has been done without any increase in pasture acreage during that same period. During the last decade, total acreage of hay decreased 36.2 per cent and corn 24.5 per cent. While these increased numbers of cattle can be accounted for in some measure by feeding in confinement of cattle on imported feed and to reduction in numbers of horses and mules, most of it can be attributed to increased yields of pastures and feed crops, and to the increased use of technology in managing livestock.

These figures point up the production potential of our area. The south has certain natural advantages for production of beef cattle which our research program should exploit to the fullest. A U.S.D.A. official[2] stated recently at the forage conference at Beltsville, that cattle in this country receive 80 per cent of their nutrients from forage and that beef cattle receive 90 per cent. Our long growing season gives us a competitive advantage in the production of forage and our mild winters necessitate only a minimum investment in shelter. What are some of the problems of using forage in the production of beef?

Number one among these is probably the inefficient use of food nutrients produced by present grazing systems. This problem is more acute in utilization of summer pastures. We need to establish how much this poor performance is influenced by temperature and how much by change in plant composition. If temperature is the big factor, we need to approach this problem co-operatively with agricultural engineers. If it is due to change in plant composition, we need to identify these changes that affect animal performance and drop the problem back into the hands of the plant breeder.

Considerable interest has been exhibited in green chopping of forage during summer months. This practice using tall growing forages has resulted in poor animal performance. This apparently is the result of eliminating the animals ability to select between leaf and stem. If this is the case, we need to determine what crops are adapted to soiling or green chopping.

Digestion trials indicate that most of our commonly used pasture plants are digestible enough for good performance provided the animal will consume them in quantity to provide sufficient energy for good gain. Thus we have a problem of trying to accelerate the digestive process or speed up bacterial action of the rumen. We need to determine qualitatively and quantitatively the bacterial changes in the rumen when cattle are fed various roughages. There is a need to determine the factors that effect the growth rate and activity of these organisms in the rumen. Several years ago the Ohio Experiment Station reported digestibility of corn cobs markedly influenced by protein level in the presence of starch, but very little influenced in the absence of starch, and suggested that starch was needed for growth of microorganisms in the alimentary tract. The same station reported very different bacterial population in rumen contents of cattle fed different rations. Other workers have concluded that nitrogen is essential as a nutrient for the growth of rumen microorganisms responsible for roughage digestion. Other work using the artificial rumen technique and rumen fistulas has related other factors to the utilization of roughage by rumenants. There are many mysteries in rumen activity at present and further exploration is needed. Attempts at this station to supplement summer pastures with energy, protein, and minerals has given disappointing results and the increased performance hardly reflects the additional nutrients supplied by the supplements.

We need to develop simple tests for determining nutritive value of stored forages so that we may be able to adequately and efficiently supplement them.

Other methods than digestion trials are needed for measuring feed utilization. In low quality rations; i.e., 45 per cent digestible, there is a greater loss of energy than is reflected in digestion percentages when compared to a so called high quality: i.e., 60 per cent digestible, forage.

So called hot and cool rations need investigation. It is assumed that considerable heat is generated by the digestion process of roughages. Hence, animals may be able to use a ration with a high roughage content more efficiently in cool weather than in warm.

The effect of energy content of a ration on caloric content of carcass needs to be explored. This is not reflected in our accepted scale weight measure of performance.

Work which would explore bio-chemical genetics as related to selection practice offers opportunities. Is there a genetic-rumen relationship that would allow us to select a strain of cattle which utilize forage more efficiently? There is sufficient data indicating selection for gain within any nutritional regime will possibly affect performance under others, but maximum progress will be attained if selection is made in the period and nutritional regime under which the offspring will be used in commercial production.

What are the possibilities of changing the physical forms of feed? No development in feed preparation has attracted so much attention in recent years as has pelleting or cubing. Phenomenal increases in gain have been reported, and can hardly be accounted for by increased consumption. The present high cost of fine grinding and pelleting will likely be overcome by developments of new process methods and equipment. The difficulty of handling dry roughage is a major problem in mechanical feed handling. We must necessarily bear this problem in mind in formulating rations for future use. Apparent advantages of pelleting high roughage rations in different physical forms on ruminary action. Workers from the Georgia station reported ruminal parakeratosis in cattle fed all pelleted rations. There is a question whether these reported conditions were the result of feeding pellets, or a result of some material used to facilitate pelleting. It has been reported that cattle fed pelleted rations do not ruminate and this might in turn affect secretion of saliva. Mature cows secrete 10 - 15 gallons per day which neutralizes, or buffers, the acid produced by rumen fermentation.

With the competitive position of protein feeds we need to explore more fully the use of non-protein nitrogenous materials such as urea. Increased knowledge of the part played by amino acids and the interrelationship of minerals, vitamins, and amino acids makes it possible for us to formulate a balanced ration using some of these non-protein materials.

Other problems which need exploring are: the effect of nutritional regimes on longevity of brood cows; the effects of post-weaning growth rates, and feeding systems of replacement heifers on maternal traits. Last, but not least in the nutrition field, we need to study the effect of diet on carcass quality. Good rations resulting in more rapid growth should delay the onset of degeneration of tissue and indirectly influence carcass quality.

My placing of nutrition problems ahead of breeding problems does not mean that I feel they are more pressing. An important objective of beef cattle breeding research is the establishing of genetic inter--relationships of important traits in order that selection indices permitting maximum progress may be constructed. Large bodies of data are required for accurate estimates and there are very few sets of records complete enough for such analysis. The use of incomplete data in attempting estimates is dangerous. For example: Suppose we take one period of growth of offspring of brood cows in measuring brood cow performance. Koch and Clark,[3] using data from the U.S. Range Livestock Experiment Station, Miles City, Montana, observed a negative relationship between maternal traits and post-weaning gaining abilitu. Using only post-weaning performance as a criterion for selection, one would then unconsciously select against an important characteristic.

Breeding experiments need to be refined. Heritability estimates are being revised downward as we have more and more data for analysis. The increased emphasis on carcass quality and the meat type steer makes it imperative that we explore all possibilities of determining superior breeding stock. The use of the sonoscope and radioactive potassium offer some promise for progress in this field.

Data that we presently have indicates that we have no technique for measuring on raw meat the degree of tenderness that may be expected after cooking. We need to go further back than this in studying this problem. Apparently tenderness of meat is a highly heritable characteristic. U.S.D.A. is now studying the use of biopsy in taking samples from live animals in an attempt to relate this sample to the carcass quality after slaughter. If this method fails, then new techniques must be developed.

The concern of the cattle industry over the frequency of dwarfism poses it as an enormous economic problem. If, as was thought a few years ago, the condition is inherited as a simple recessive it would be expected that elimination of the dwarfs themselves would effect enough selection pressure against the gene to keep these frequencies to a rarity. Recent studies indicate, however, that the gene is not completely recessive and the heterozygous, or carrier animals may exhibit certain characteristics to favor them in selection. The method of selecting against carriers by examining pedigrees is too inaccurate to provide a permanent solution. It is highly important that we be able to identify carriers by some physical or chemical method. Recent work at Missouri, and North Dakota, indicate that dwarf animals exhibit abnormalities in carbohydrate metabolism which may be related to pituitary or adrenal insufficiencies, or both. It is a problem worthy of our attention.

The possibilities of improving breeding stock by the use of proven parents is intriguing. Think of the possibilities of improvement if the techniques of induced estrous with harmones could be perfected. This, coupled with artificial insemination, would make it possible for us to produce as many as 2500 - 3000 calves from one sire in a single year in controlled age groups. Couple this with the possibilities of removing fertilized ova from a superior cow and implanting it into a common cow for development and getting 6 - 8 calves per year from the outstanding cow. Thus we might be able to take a sire and dam with superior ability to perform, with predetermined carcass quality and tenderness and produce from them an offspring to a desired size and finish on an economical ration almost entirely made up of roughages, at the age of 12 - 14 months.

My confining most of my remarks to beef cattle should not be interpreted to mean that there are no problems in other fields. Certainly economic developments in the poultry field have posed new problems. We now have a concentration of poultry in the hands of a few companies. These commercial companies are well equipped and have their own laboratories. Consequently, they will do most of the breeding and nutrition research in the future. University Experiment Stations will be more concerned with housing and environmental problems such as controlled humidity and temperature.

Diseases and parasite problems always become more acute with a concentration of animals. Most pressing in this field at present is C.R.D. (Chronic Respiratory Diseases) which are causing condemnation of thousands of broilers annually.

The Poultry Products Technology Field is virtually unexplored and offers opportunities for the university scientist.

Problems in the swine field like those in poultry are in some measure due to present methods of production which involve concentration of large numbers of animals on a small area. Probably the number one problem is scours in baby pigs. We need to determine the causative agent and develop effective control measures.

S Space requirements under different environmental conditions are unknown. There is a possibility of developing a practical artificial environment using water or other means which we have under natural conditions.

The area of temperature fluctuations needs exploring. Most work on this problem has been done in highly controlled temperature chambers which keep the temperature constant. Work with dairy cows indicates that average temperature is not the important factor, but whether the temperature fluctuated enough (dropped low enough at night during hot weather) for a sufficient period to allow recovery from the stress in the last few hours.

We need to study the possibilities of limited feeding on efficiency and even on carcass quality of swine. Liquid or slop feeding may have some merit.

Basic research is needed in bio-chemistry, physiology, reproductive physiology and related phenomena. Surely all of us recognize the need for enthusiastic dedicated research men with imagination and creativity and with sound philosophy. Research will become more basic and specialized but let's keep in mind that we need more than biochemists, physiologists, geneticists and statisticians. We must have a few darn good animal husbandmen to apply the latest established principles of the basic researcher to practical commercial animal production.

It is a certainty that whether the animal industry in Alabama and the southeast progresses from the bush league to the big league will depend largely on information provided by institutions such as this. Will we be able to meet the challenge?

[1]Warwick, E. J., J. Animal Science, 17:938, 1958

[2]Warwick, E. J., Forage Conference, Beltsville, Maryland, June 1961

[3]Koch, R. M. and R. T. Clark, J. Animal Science, 14:979, 1955

Influence of Economic & Social Changes on Research Needs In Agricultural Engineering

F. A. Kummer

From the viewpoint of the engineer, farming today is a cold blooded business in which only the informed and the efficient will survive and that it is more important to properly plan and manage all operations, equipment and enterprises than to save a few bucks on the purchase of farm equipment.

Economic and social changes have forced our farmers into mechanization. They are going to continue to mechanize. It is our job to provide the information which will make mechanization profitable.

There are signs that in some areas of the country the size of farms may be approaching an optimum and that we may see a leveling-off in farm size. Studies in the Midwest indicate no rapid increases in the number of farms of 1,000 acres or more. Actually, these farms have higher labor and machinery costs per $100 of crops produced than the 300 acre farms. It would appear that in those areas adjustments in size are taking place to accomplish the economies that may be gained from adequate but not excessive size.

Apparently, the situation in Alabama is still quite different and it will probably be a long time before we experience a leveling-off or reversal of the present trend toward larger farm units. We can, therefore, expect further increases in mechanization and automation of farm operations of a magnitude of double or triple the present numbers.

In 1960, Alabama had approximately 750 mechanical cottonpickers. This number is expected to increase by 400-500 units this year even with an average cotton crop. 1961 could bring us to about 20-25% of our cotton crop being harvested mechanically. If 1,200 pickers average 150 acres each, that would amount to 180,000 acres or approximately 20% of total. Certainly, we will have the machines with the capacity to accomplish this and more.

We have reliable reports from owners of 2-row cottonpickers that picked up to 375 bales per machine last season.

This trend, assuming that government policies and regulations remain about the same, will probably continue until we reach 50% of mechanically harvested crop or better than 2,000 mechanical cottonpickers. After that, further increases may depend upon how fast cotton production units will increase in size to 50 acres and more and how well mechanized procedure and custom picking will be accepted by the remaining farmers in this state.

A vital need in this development is the further improvement of cottonpicker performance, through varietal adaptations, weed control, spacing, and topping, defoliation and others. Machine improvements can be accomplished through close cooperation with the industry and by furnishing the design criteria to the industry. However, other disciplines in agriculture must take the lead in plant adaptation for mechanized production, defoliation and harvesting.

The same growth trend percentagewise and many of the same problems may be expected in grain harvesting. In the South, cornpickers have increased nearly 50% in the past five years and approximately 20% of all cornpickers in the country are now operating in the southern states. For many farmers, even this mechanized process will prove too slow and they will turn more and more to field shelling equipment to make the product more suitable for processing and automatic handling. With field shelling corn harvesters gaining wider acceptance, the problems with high moisture grain will multiply. Almost certainly, we will need to give more consideration to adequate drying facilities, storage bins and buildings. These facilities must be properly designed to eliminate hand labor and permit complete automation in materials handling.

As farms increase in size, knowledge which may lead to greater efficiency at the lowest cost becomes increasingly important. Limited use of linear programming techniques has demonstrated that it is possible to determine the optimum number and size of machines that should be used for a specific job or enterprise or the maximum number of acres that can be handled by a machine. Research in the further application of this technique to farm planning appears to have real potential and should be pursued vigorously.

The trend toward larger and larger tractors and machinery will require that we concern ourselves more and more with the problems of maximum use of and minimum investment in machines for specific farm units and farming enterprises.

For example, we should be able to establish accurately and conclusively when it is profitable to substitute 2-row or 6-row equipment for 2-row equipment under specific conditions. Obviously, machine size is not the only factor to be considered since often machine use is also governed by the timeliness of the operation.

Large capacity planting outfits such as 4-row and 6-row planters, have created new problems. They require up to twice as much equipment for the primary operations to get the land ready for planting. Unless the tillage machinery is large enough to match the planters, the time that can be saved in one operation is lost by the other. Here again, linear programming may be a valuable tool in determining the proper balance.

The larger and heavier machines create problems of soil compaction in some of our soils. These will become progressively more serious. It may be necessary to develop methods and equipment which will tend to reduce the number of trips over the field. Also, we may need to consider the possibilities of limiting the tillage operation only to the area where the plant grows rather than the whole field. Experiments with strip tillage are presently underway at North Auburn in cooperation with the National Tillage Machinery Laboratory.

Another important opportunity for engineering research is ways and means to get the most out of tractors and machines. Many tractors are wasting fuel and money because they are either too powerful for the job they perform or not large enough.

To my knowledge, little -- if anything -- has been accomplished in the South in the area of controlled atmosphere for the storage of fruits and vegetables. In the State of Michigan alone, over 600,000 bushels of apples were stored under controlled conditions of temperature and humidity during 1960. This resulted in high quality fruit being available for a longer period thereby justifying a higher net return to the producer. Our forest products offer many opportunities for increased utilization. To be competitive with other raw products, however, will require the application of engineering principles and methods to reduce unit costs. It is gratifying to note that the U. S. Forest Service is cognizant of this need and contemplates the establishment of a Forestry Engineering Research Laboratory in the Southeast and probably at Auburn.

To be efficient and to be competitive, we should also devote more research effort to the usefulness and the preservation of our most important resource, the land. Modern machinery can operate satisfactorily and efficiently only if land conditions are favorable. For this reason, we should place more emphasis on land forming, drainage, tillage and terracing, keeping in mind that mechanization without conservation has no better future than conservation without mechanization unless we are ready to put all of our land into trees.

The question of machinery custom work seems to arise regularly but the trend in the state is not clear. According to surveys made by U.S.D.A. in 1960, about 90% of the machines on farms are owned by single individuals. The remaining 10% are owned jointly by two or more farmers. Joint ownership is associated with certain types of machines, such as pick-up balers, forage harvesters, cornpickers and combines. Nationally, custom work has accounted for about 20% of the acreage covered in grain combining, hay baling and corn picking.

Another practice, still fairly new but gaining in importance is the practice of leasing equipment for certain specialized jobs. This practice may expand as individual financing of high capacity machines with limited versatility becomes more and more difficult. Experiments of this type are being considered by the automibile industry where individuals (primarily professional people) would lease their automobiles at an annual rental charge which includes maintenance, service and annual replacement with new models. The advantages of such arrangements for professional people are evident to say nothing about the simplification of tax accounting.

As engineers, we are primarily interested in effecting economies through increased labor productivity. The goals and limitations in the areas of farm crop mechanization are fairly well defined, and real progress has been made toward the accomplishment of the ultimate goal of completely mechanized production with some crops, such as corn, soybeans, small grains, and even peanuts and cotton.

Until animal production became a major source of farm income, the application of engineering to animal production lagged far behind that of crop production. Yet, livestock production is actually better suited to engineering applications than crop production. This is because, in general, the materials and products to be handled are more uniform and, therefore, better adapted to mechanization or some aspect of automation. Also, many operations are repeated daily, sometimes several times a day ---- the year around as contrasted by the short seasonal character of most crop production operations.

In further contrast to crop production, animal production can usually be confined to relatively small areas. This makes it especially suited for automated mechanization.

Future possibilities of engineering in livestock production are enhanced daily by the development of new materials and methods of construction, new forms of energy, new chemicals, new drugs and new devices for automatic control. While much has been done on the relation of physical environment to animal response, this phase of livestock production research is hardly beyond the exploratory phase and needs to be strengthened.

Let's examine some figures by R. H. Mason, Program Director, Long Range Planning Service, Stanford Research Institute as reported in the June issue of I & T.

Over the period 1945-1958, total production of agricultural commodities per man-hour increased 124% or 6.4% compounded annually.

The output for all crops per man-hour of labor increased 7% annually while all livestock products increased only 3.6%.

The major factor in the slow gain in labor productivity was the meat animal industry which showed an increase of only 1% per year, compounded.

The main contributor to the labor productivity of 3.6% for all livestock products was poultry which had a compound annual rate of 6.3%.

A look at the labor distribution among the various enterprises gives further emphasis to the labor problem in livestock production. The distribution (nationally) of direct labor in agriculture is:

Feed Production & Livestock Care	------ 59%
Non-Feed Crop Production	------ 26%
Farmstead Maintenance	------ 15%

Of the 59% going into feed production and livestock feeding, over 3/4 is used in livestock feeding and only 1/4 goes into the production of feeds. The principal materials handled are water, feed, bedding, litter, manure, eggs, milk and meat. All of these can and some are being handled mechanically. It is hard to realize that in the northern states the materials being handled for dairy cattle has been estimated to be as high as 20 tons per cow per year.

The current breakdown in livestock production labor is:

Milk Production	------ 47%
Meat Animals	------ 34%
Poultry	------ 17%
Other	------ 2%

Improvements in labor productivity, therefore, should come from dairy and meat production. If the prevailing labor productivity in meat animal production of 1% per year continues at this low rate in comparison with other farm enterprises, more labor would be required in 1975 for livestock production than actually would be needed for all other agricultural products. To achieve the livestock production projected for 1975, labor productivity in the meat animal category must be raised from its current increase rate of 1% per year to at least 4.8%. This can only be done by the substitution of capital for labor and by the further development of mechanization, automation, processing and building construction.

Mr. Mason estimates that during the next 15 years enough labor-saving equipment will be used in animal production to replace 900,000 full-time laborers. He further estimates that 41% of the equipment will go into meat animal production, 29% into dairy production and 24% into poultry and 6% into other. Farmers can make this change only to the extent that effective and reliable labor-saving equipment can be developed and manufactured.

Automation is definitely lagging behind mechanization in most farming enterprises in Alabama. Poultry feeding and pipeline milking are about the only two items of automation that are reasonably well accepted. Effective planning o livestock shelters and feed lots will pave the way for increased use of automati and the reduction in labor.

The idea of feed pelleting and hay wafering aroused nation-wide interest a few years ago. Now this practice seems to have been greatly deemphasized. A recent visitor from the New Holland Machine Co., a manufacturer who was greatly interested in this subject initially, tells us that his company has discontinued all development work dealing with pelleting and wafering. His reason was that their surveys, based on Experiment Stations findings, seem to indicate that pelleting cannot be justified economically on the basis of increased feed value.

The problems which they encountered with wafered hay were:

1 - Wafers are more wasteful

2 - There are no good binders available to hold the wafers together

3 - Wafers will bridge making automatic loading and unloading of storage bins, wagons and feedlot conveyors difficult.

What the next development will be is anybody's guess. Nevertheless, we should be vitally concerned with the problems just stated and through a methodical program of research find ways and means to overcome them. If a product has merit from a feed standpoint, and offers economic advantages to the farmer, we should bend every effort to provide him with methods and means for producing and handling it.

It is my feeling that, from an engineering standpoint, the opportunities are many in the areas of livestock production and management.

INFLUENCE OF ECONOMIC AND SOCIAL CHANGES ON RESEARCH NEEDS IN FAMILY LIFE

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It is most appropriate, in my opinion, to conclude a series of papers on influence of economic and social changes on research needs with those related to family life. Plant and animal sciences and agricultural engineering are definitely influenced by economic and social changes but they also have great impact on Family life. To a degree they determine the direction, emphasis and extent that Home Economics research is needed. In all four areas it is quite possible to relate, correlate and/or coordinate many research projects in Agriculture and Home Economics. A great deal of worthwhile cooperative research has been done in Nutrition, Housing, and Textiles but the opportunities are also many and rich in Family Economics, Management, Food Science and Rural Sociology.

May I share with you this morning some of the thinking of the home economics staff members regarding the total Experiment Station research programs conducted in the following subject matter areas: Human Nutrition; Food Science; Textiles and Clothing; Family Housing; Equipment and Household Processes; Consumption and/or Household Economics; Rural Family Living; Institution Management; and Home Economics Education.

With economic and social changes new problems continue to arise concerning food consumption and nutrition of our population; there is usually some change in food habits, dietary patterns, food purchases and methods of preparing foods. These changes have a definite effect on the nutritional status of our families. In the past, changes in food patterns have, usually been considered beneficial changes, but several problems concerning our diets still need attention and further research before definite conclusions may be drawn about our diets and our nutritional status. Today, our state of health is high but not as high as it might be. In spite of the great quantity of food available, more money for purchasing food, new convenience foods, a ready supply of food, and time for mid-day and rest breaks, we still need to improve our health and efficiency.

Nutrition research is based on how food nutrients are metabolized and utilized within the body. In the past 10 years, scientists and nutritionists have studied the diet and food habits of over 15,000 people and these studies indicate that many Americans still have a low nutritional standard. Among our problems are the regulation of the intake of food energy (calories) and poor practices in this area have led to the problem of obesity. Other studies are concerned with the relation of nutrition to normal physiological functions in growth, reproduction and aging of the human body. With an increase in the proportion of persons over sixty-five years of age, the nutritional needs of our elder citizens should receive increased attention.

Today, fewer hours are spent in preparing food in the home and many new food products are available on the market. Food processing has become a large industry and is essential if a large population is to be fed. Methods of food processing present many new problems to the food technologist and the nutritionist, since in most cases food processing causes a reduction of the nutritional value of a food; with new techniques for food analyses we are able to identify adverse effects which formerly were not evident. More research must be carried out to evaluate the effects of processing upon the nutritional values of foods.

A greater variety of foods are being consumed than ever before; this leads to further study on the interrelationship of nutrients and factors influencing their utilization and absorption.

With new methods of preparing foods in the home, more studies need to be made to test the effect of various cooking methods on the retention and utilization of vitamins, minerals, and the other nutrients.

More homemakers are buying home freezers and frozen foods today than ever before. The effect of freezing on changes in quality and nutritional values must be studied.

With the purchasing of new time and energy-saving devices, it is evident that the energy expenditures of the homemaker and other special groups must be re-evaluated.

Correlations have been reported between the dietary patterns and food consumption of certain groups of people and the incidence of some of our public health problems such as obesity and atherosclerosis.

In recent years, there has been considerable interest in the factors related to the development of one of thepprime public health problems, atherosclerosis. Evidence has been presented which suggest that diet may be implicated in the genesis of atherosclerosis. In the Spring of 1961, we began a project entitled "The Effect of Controlled Diets on the Level of Plasma Lipids in Human Subjects". It is hoped that these studies on humans will be useful in planning and recommending better dietary patterns for the general public and in therapeutic prodedures in the dietary treatment of atherosclerosis.

Food marketing research has put many familiar food products within the reach of more consumers and at the same time, has provided many new and improved food items. Findings have, also, recorded consumers' preferences for certain foods such as lean pork chops, pre-cooked and convenience foods and for new forms of packaging.

Food marketing research completed in the area of meats in the Foods Department at Auburn University includes "Meats and Eggs Preferred by Alabama Consumers," Bulletin No. 321 and "Meat Choices for Family Meats in Selected Cities, Alabama-Georgia," Regional Bulletin No. 77. In these studies, an attempt was made to determine factors involved in decision making; sources and types of information used by consumers in making decisions; and the relationship of the decision making process to purchases and use of selected meats. Data was related to certain family characteristics. These studies were designed to provide those engaged in production, marketing, consumer education and nutrition with specific information regarding consumer selection of specified meats and factors affecting this selection.

The revised regional research study entitled "Consumer Responses to Food Marketing Programs," is designed to measure effectiveness of marketing programs. With controlled experiments, the consumer responses to in-store promotional and merchandising programs for selected meats or meat products will be studied. The effectiveness of local, regional, and national advertising upon consumer buying will also possibly be studied under the revised regional project.

It is recognized that in housing research, the original function of the house was largely to meet the needs of the family for shelter, and must now meet a much more complex set of needs. If we consider the house to include the major equipment and facilities that families require for their functioning, even the shelter that the house provides is expected to meet increasingly higher standards. People expect to be protected from the elements in a highly refined manner according to their ability and willingness to finance such protection. Instead of protection from cold, rain, and the most severe heat, there is now a small but increasing demand for an even temperature, regulated atmospheric moisture, and even protection from dusts of various kinds.

Research activities continue to focus upon design and space requirements for the modern home. Families own greater numbers of items and they want more functional storage facilities for these items. The cost of housing has at the same time made it necessary to reduce house site so that careful planning is necessary to make storage spaces compact and accessible.

Difficulties in obtaining personal privacy increase directly with the density of population. Caught in the squeeze of increasing cost per square foot of housing and increasing family size, planning for privacy becomes a major problem. Facilities and equipment associated with cleanliness have raised the standard for cleanliness.

Some of the early research in housing was to develop criteria for judging the space adequacy of the house in terms of work done and family living needs. Valid data were established in determining housing standards and requirements for optimum living.

A new area creating interest in housing research includes studies of the climatic and physical environment and their control. Heat and humidity control within the home presents many problems to the homemaker. She is concerned with heat, light and moisture conditions as related to her daily household task. The purpose of research is to develop criteria for judging these needs.

The changing tax situation makes bookkeepers of us all, but the farmer whose operations lift him beyond the subsistence level begins to need an office or a reasonable facsimile thereof.

The changing social emphasis, from respect for elders to child-centeredness in the family, along with economic necessity for smaller houses and the increasing age span, points up the problem of how to house the senior citizens. Increasing use of mechanical aids for the homemaker have made these elderly relatives less needed in rearing the family. The existing private, semi-private and public form of institutions, homes, and housing developments are meeting some of these needs at varying levels of satisfaction to those concerned.

The house has been and will probably continue to be a status symbol. The aspects of housing that serve as symbols of status are of great importance. There may be a possibility of influencing the choice of people in this respect. For instance, if truly functional values can be made to take the place of useless furbelows, then a great service to families might result.

Who creates these symbols: the planner, the builder, the seller, the buyer, or the innocent bystander? When this is known the point of attack on the problem will become evident.

The foregoing implies that the house, the physical and social center of family living, has a very great influence on the well-being of members, and that this influence reaches out beyond the physiological into the economic, social and psychological.

Research in the area of household economics has been stimulated by public interest in the family income. This is partly due to more qualified research workers in family economics and partly by the fact that more Marketing funds have been made available to support research studies. The home economist and researchers in closely related subject matter fields are contributing to the knowledge and understanding of consumer preferences in family buying practices. The home economist has much to contribute in this area of research. First, she is interested in the family exchequer and second, she understands and respects the homemaker for her contribution to the well being of the family.

Home Economists are also concerned and realize the need for more research and education on farm family financial security, types and kinds of part-time as well as full-time employment for some members of the family. There is need for making provisions for income in case of disability, consumer credit, better health conditions as well as greater regard for health.

Home Economists have, through the years, been interested in our aging population; better housing for them; building a reserve or emergency fund; building a retirement plan or making provisions for the future; rehabilitation and/or adjustment to another type of living; and social insurance. There is a need to analyze relationships between family financial security and selected economic management practices.

Interest in consumer satisfactions has always been the concern of home economists. Clothing has long been accepted as a status factor in family life and with improved techniques in social science research, public demand can lead to vast investigations in this area. The economic and social problems can also produce rather wild fluctuations in the fashion world. How much of these changes may be caused by deep seated human needs--what is the impact on the economy of a society? These are problems for the research worker in social science. What instruments will they develop to determine needs, satisfactions and results?

In the field of textiles, there is a major effort directed toward two basic problems. One of these is concerned with relationship of the properties of cotton fibers, such as elongation or fineness, to the in-use performance of the fabrics. The other is a study of the effects of atmospheric conditions on selected cotton fabrics.

Cotton today is a new miracle fiber which does not resemble the cottons the housewife used twenty years ago. Cotton fibers have been changing but all of the qualities are not known; neither has all of the possibilities of change been discovered. Many new finishes are being discovered each year for cellulose fibers. Many new finishes are on the market and many more are yet to be mass produced.

There are also investigations concerned with household textiles, including curtains, rugs, and blankets which relate service qualities to textile properties.

With our changing economy, needs of textiles for the family and the home have altered. Casual living and need for economy of time has made the housewife conscious of maximum efficiency household textiles. Textile research progress has made life more comfortable for the family while on the other hand, the consumer must be better informed to obtain the maximum efficiency of the new fabrics that clothe the family.

A great part of the Experiment Station Home Economics research has an inter-disciplinary approach; especially that which is concerned with improved rural family living. Today, most current projects are directed toward the level of living of families located in underprivileged rural areas or concerned with adjustments of families who are relocating or changing occupational patterns.

The influence of present day economic and social impact on the American family has greatly changed our way of life and thereby changed the need for research. Today we live in an entirely different world from that which confronted our grandparents; our standards of living have changed; our requirements have increased; and our national economic system has suffered inflation. These factors greatly influence our educational program which includes research as well as instruction.

A Discussion of Linear Programming

Theo H. Ellis

Background

The use of linear approximations in dealing with important problems in economics and in the natural sciences is fairly well know. In economics, the tableau economique of Quesnay, the general equilibrium systems of Walras and Cassel, and the input-output analyses of Leontief are major examples. In mathematics, the works of Weyl (9) and Von Neumann, (9, 12, 13) as well as other mathematicians, might be singled out in the development of the analytical background of linear programming. G. B. Dantzig's (8) development of the "simplex method" of solution has standardized the computational algorithm and relegated it to the realm of algebaric addition, subtraction, multiplication, and division, although the mathematics of linear programming is essentially matrix algebra.

The diet problem is a monument in the history of linear programming. It involved formulating a human diet that provided the minimum nutritive requirements at the lowest possible cost under a given set of food prices and food nutritional analyses. In 1941, Jerome Cornfield formulated the problem in an unpublished memorandum. In 1945, George J. Stigler solved the problem but did not use linear programming as such in the solution. 1/ In 1947, Dantzig and Laderman solved the problem using linear programming but did not publish their results.

From these rather feeble beginnings, the technique, largely through the efforts of Dantzig and Charnes (3), was used during World War II to solve major logistic problems and to formulate lowest cost aviation gasoline

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1/ The diet formulated was not too palatable being composed largely of beans, flour and cabbage. See Journal of Farm Economics, Vol. XXVII, May 1945, p. 303.

mixes that met specified octane ratings. Industry soon accepted the technique in solving distribution problems by using the transportation model (8) and in the solution of minimum cost mix problems for feed, fertilizer, cigarettes, and ice cream, among other things. In a methodological publication made in 1951, Dorfman applied the technique in the optimum allocation of resources for an automobile manufacturing firm (4).

Probably the first application of linear programming to the economics of agriculture was a methodological article 2/ published in 1951 by Hildreth and Reiter in the Cowles Commission Monograph Number 13 (8). Also in 1951, Waugh developed a lowest cost dairy feed 3/ and in 1953 King applied activity analysis in developing an optimum combination of farm enterprises 4/. The contributions of Heady in his numerous articles and in his book coauthored with Candler (7) cannot be ignored. These, plus many other articles and books, have developed and stardardized the linear programming technique until today it is in wide use as an analytical "tool" by non-mathematical Agricultural Economists, as well as by others.

The Linear Programming Technique

What is linear programming, mathematical programming, or activity analysis? Each of these terms, as well as others, has been used to designate the technique being discussed, although the term "linear programming" is the most widely accepted at the present time.

Linear programming is a mathematical technique that is concerned with the problem of planning a complex of interdependent activities in the best possible (optimal) fashion (3). Thus, Charnes, Cooper, and Henderson have defined linear programming. A more mathematical definition has been presented by

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2/ Hildreth, Clifford and Reiter, Stanley, "On the Choice of a Crop Rotation Plan."

3/ Waugh, F. V., "The Minimum-Cost Dairy Feed," Journal of Farm Economics, Vol. XXXIII, August, 1951.

4/ King, Richard A., "Some Applications of Activity Analysis in Agricultural Economics," Journal of Farm Economics, Vol. XXXV, Dec. 1953.

Dorfman, Samuelson and Solow (5). Linear programming is the analysis of problems in which a linear function of a number of variables is to be maximized or minimized when these variables are subject to a number of restraints in the form of linear inequalities.

The Process

The linear programming technique centers around the productive process or activity. 5/ A process is the combination of a specific set of inputs that will yield a specific quantity of output. If the ratio of productive factors and the ratio of each of the factors and the product are equal for two or more specific sets of inputs and outputs, the processes are identical and must be considered as a single process in programming analysis. However, if this equality of ratios is not evident, distinct processes exist and they must be considered as such in the analysis. For example, two different processes for the production of cotton will exist where two levels of fertilization and correspondingly, two levels of output are considered. A process is not necessarily an enterprise since an enterprise pertains to the production of a particular commodity and may be carried on in a number of different ways with each way being a distinct process.

Assumptions of the Technique

Certain assumptions are inherent in the linear programming technique. They must be recognized for the programming results to be considered in their proper perspective.

Linearity: The ratio of the quantity of one resource to another and of each resource to the quantity of product is constant and independent of the level at which a process is considered. In other words, constant input-output ratios and constant returns are assumed. The model of this relationship yields a straight line when considered geometrically, hence the term "linear programming."

5/ Productive process and activity are synonymous terms in this paper.

An individual process does not allow the concept of diminishing returns, since its input-output relationships are linear. However, the concept can be included by establishing several processes with varying levels of inputs for an individual enterprise. This gives a discrete rather than a theoretically continuous relationship since all the minute levels of inputs are not considered. The discrete relationship is probably the more practical one because producers generally are not interested in output responses to extremely small increments of inputs. urthermore, because of risk, uncertainty, and the variability of the data from which most input-output coefficients are developed, it is doubtful if extremely precise input-output ratios are practical.

Finiteness: The mathematics of linear programming requires that the number of processes considered in a problem be finite. In production the number of variations in the productive processes for an enterprise are more or less unlimited. The number of enterprises, and the size and type of productive factors are almost infinite permitting the formulation of an almost unlimited number of processes. Regardless of this unlimited number of possible productive processes, the number given consideration in a particular linear programming problem must be finite.

Divisibility: The technique assumes that the resources used in production and the products produced are divisible at infinitely small levels. Theoretically, inputs may be applied at minute levels, and products produced in small fractions of a unit. Again, the practical aspects of production lead to discreteness rather than continuity as far as the input-output relationships are concerned.

Additivity: The resources required and the products produced by a programmed optimum combination are additive. The sum of the amount of each resource used by each process in a maximization optimum combination must be equal to or less than the total amount available. 6/

Single Valued Expectations: The input-output coefficients and prices for each process are considered as single-valued. That is, the quantity of each resource required for each process and the prices of the resources and products are assumed to be known with certainty. It is also assumed that when given a particular combination of inputs to be used in a process, the output can be predicted with certainty.

Hypothetical Example

A simple hypothetical example involving two processes with four limiting resources can be used to explain the programming technique. The example is limited to two processes to facilitate illustration by means of a geometrical model in two dimensions. The limiting resources available, amounts required per acre, yields per acre, and prices per bushel for the two corn and oats enterprises are given in Table 1.

Table 1. Resources Available, Amounts Required, Prices and Yields for Corn and Oats Enterprises.

Resources	Amount Available (units)	Process Requirements Per Acre	
		Corn	Oats
Capital	18	3	2
May labor	12	1.5	2
June labor	18	2	2
August labor	20	4	0
Price per bushel		$1	$2
Yield per acre		35 bushels	15 bushels

In the case of the capital resource, the optimum combination of corn and oats must be such that three units of capital multiplied by the size of the corn

6/ This is an example of the inequalities mentioned in the Dorfman, Samuelson, and Solow definition previously given.

enterprise plus two units of capital multiplied by the size of the oat enterprise must not be more than the amount of capital available. The same is true for each of the other resources.

Assuming that the 18 units of capital are used to produce oats, and no other resources are limiting, 9 acres of oats will be produced. If the 18 units of capital are used to produce corn, and no other resourdes are limiting, 6 acres of corn will be produced. This is shown, Figure 1, by the capital iso-resource line crossing the oats axis at 9 acres and the corn axis at 6 acres. Similar calculations are made for the other resources and the iso-resource lines for each of them drawn on Figure 1.

The mathematics of linear programming requires that any feasible solution must be a point either on the boundary of, or within, the area outlined by ABCDO. It also requires that the combination of enterprises at this point must not require more of any resource than is available. The optimum feasible solution will be the most distant extreme point with the extreme points defined as the corners of the area ABCDO. Testing of the extreme points to determine the optimum combination of enterprises is given in Table 2.

Table 2. Determining the Optimum Combination of Corn and Oats to Produce

Extreme Point	Enterprise combinations		Total production		Returns		
	Corn	Oats	Corn	Oats	Corn	Oats	Total
	Ac.	Ac.	Bu.	Bu.	Dol.	Dol.	Dol.
O	0	0	0	0	0	0	0
A	5	0	175	0	175	0	175
B	5	1.7	175	25.5	175	51	226
C	4	3	140	45	140	90	230
D	0	6	0	90	0	180	180

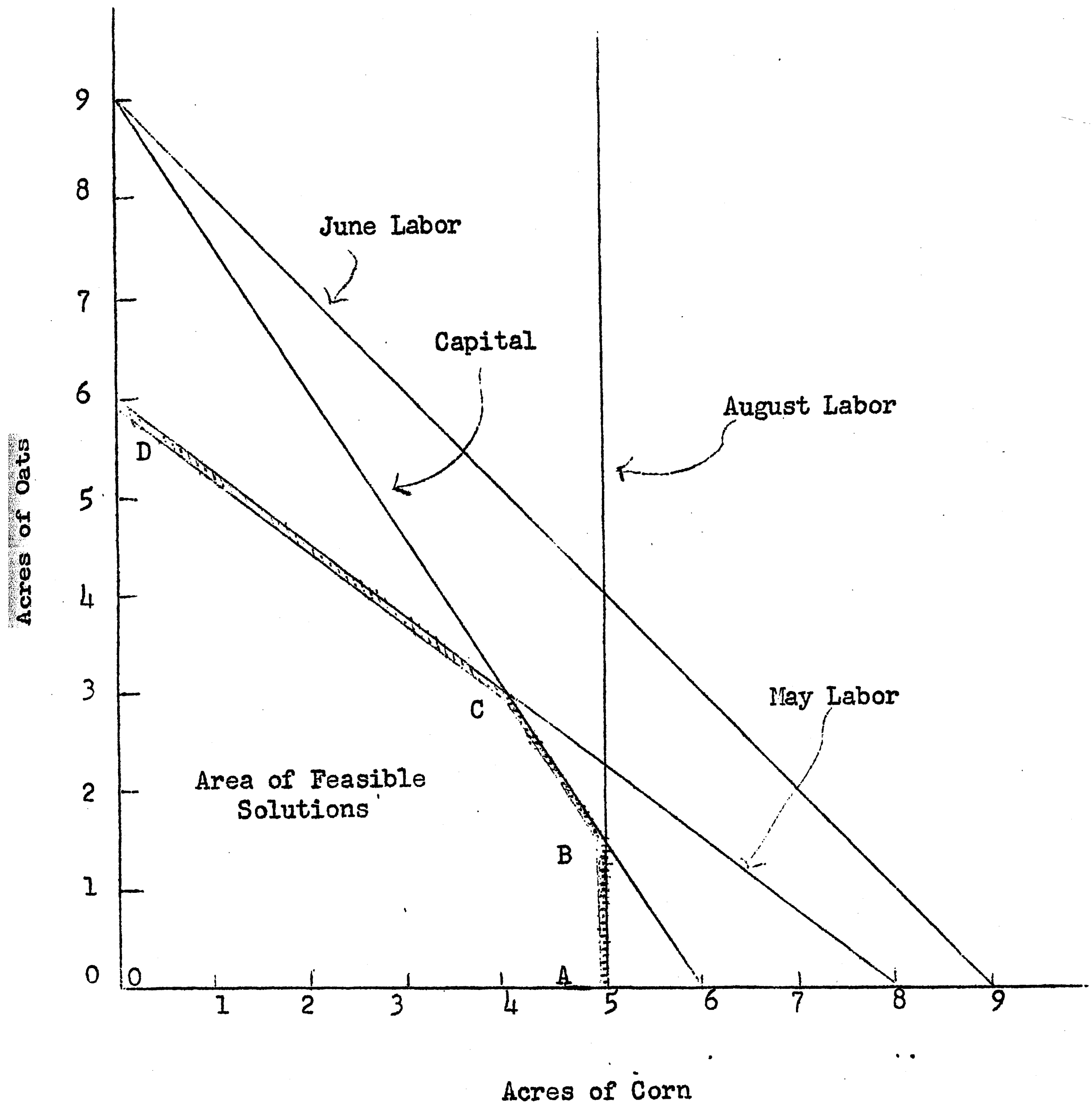

Figure 1. - Geometrical presentation of the determination of the optimum combination of corn and oats to produce.

SOURCE: Ellis, T. H. "Optimum Farm Programs in Columbia and Suwannee Counties, Florida," unpublished Ph.D. thesis, University of Florida, Gainesville, Florida, 1957.

Point O is a feasible solution, but since no production is carried on at this point, it can be rejected as an optimum solution. Examination of the total returns column in Table 2 shows point C to yield the greatest total returns and therefore, is the point of optimum combination of enterprises with 4 acres of corn and 3 acres of oats yielding $230 returns.

Although only two processes are considered in this example, the technique can be expanded to include any number of processes within reasonable limits. The usual problem will necessitate the use of some method of solution other than geometry, since each process adds another dimension to the geometric model. Several methods of solving problems with a large number of processes are available. The previously mentioned simplex method is probably the simplest and most widely used at the present time (3).

Examples of the Use of Linear Programming for Maximization and Minimization Problems

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Prepared for the
ANNUAL STAFF CONFERENCE
School of Agriculture and Agricultural Experiment Station
Duncan Hall Studio
July 5-7, 1961

SOURCES

The tables dealing with profit maximization were taken from a program presented at the April 28, 1960 meeting of the Alabama USDA council by Theo H. Ellis and Earl J. Partenheimer of the Agricultural Economics Department, and O. B. Copeland of The Progressive Farmer. The tables dealing with the least cost feed mix are taken from: Theo H. Ellis, "Linear Programming: Price Mapping to Reduce Feed Mix Computation Costs," Agricultural Economics Department Mimeo., March, 1959

Examples of the Use of Linear Programming
for Maximization and Minimization Problems

The previous two speakers have told us what linear programming is and gave us a graphical example of its use. We shall take up two more examples — one a maximization problem and the other a minimization problem.

For any linear programming problem we must have five types of information.

1. A list of restrictions.
2. The amount available of each of these restricting quantities.
3. A list of activities to be considered.
4. The amount of each restriction used per unit of each activity.
5. A quantity associated with each activity that is to be maximized or minimized.

Maximization Problem

Our first problem involves maximizing the returns for a hypothetical Alabama farm. In this problem the restrictions are the amounts of fixed resources available. They include 12 split-month labor restrictions; row crop land, pasture land, investment capital, and cotton allotment. These are shown in the first column of Table 1. The P_0 column shows the amount of each limiting resource that is available.

The activities — enterprises in this problem — to be considered are shown at the top of columns P_{19} through P_{27} of Table 1. The figures in the body of the table show the amounts of each restricting resource that is required per unit of the enterprise. A word of explanation is needed regarding the absence of capital requirements for row crops. Any likely combination of enterprises in this example will require a tractor, row crop equipment, and certain other items of equipment. Therefore, investment in these items

Table 1. Programming Matrix for a Farm with 210 Acres of Open Land.

		P_0 Resources available	P_{19} Cotton	P_{20} Corn	P_{21} Soybeans	P_{22} Grain sorghum	P_{23} Alfalfa hay	P_{24} Layers	P_{25} Beef cow and calf herd	P_{26} Steer feeding	P_{27} Hogs
Resident labor: (man hrs.)											
Jan. 16-Feb. 15	P_1	426	0.3	0.3	0.4			163.1	46.2	22.0	61.6
Feb. 16-Mar. 15	P_2	388	0.5	0.4	0.3			146.1	100.1	26.0	51.6
Mar. 16-Apr. 15	P_3	478	1.3	0.9	0.5			155.1	22.5	30.3	60.1
Apr. 16-May 15	P_4	462	2.6	2.3	1.3	2.0	2.4	192.0	83.2	41.6	73.5
May 16-June 15	P_5	532	2.0	1.2	1.5	2.9	1.5	187.5	24.8	20.8	62.9
June 16-July 15	P_6	498	1.2		0.6	1.0	1.5	181.4	17.7	12.6	49.9
July 16-Aug. 15	P_7	532	2.2			0.1		187.5	28.5	52.8	59.9
Aug. 16-Sept. 15	P_8	532	0.2			0.5	1.5	187.5	26.8	23.4	70.7
Sept. 16-Oct. 15	P_9	514	2.2	1.6	1.1	1.0		217.0	15.7	27.7	64.9
Oct. 16-Nov. 15	P_{10}	478	0.1	1.6	0.9	0.5		155.1	26.3	47.5	62.3
Nov. 16-Dec. 15	P_{11}	398	0.6	0.6				156.6	41.2	21.4	49.7
Dec. 16-Jan. 15	P_{12}	398	0.4	0.5	0.2			163.1	48.0	24.6	57.8
Row cropland (Ac.)	P_{13}	180	1	1	1	1	1			13.2	26.9
Pasture land (Ac.)	P_{14}	30							68.0	16.0	4.0
Investment capital (dol.)	P_{15}	16,090						12,852	9,337	1,700	1,544
Cotton allotment (Ac.)	P_{16}	41	1								
Net returns	C_j		72.79	40.41	22.56	20.69	33.32	4,229.40	1,019.53	467.97	1,700.48

NOTE

These figures are for illustrative purposes only and do not constitute recommendations or research results.

was subtracted from the amount of investment money available to obtain the $16,090 capital restriction. This avoided having to distribute the investment in these items on a per acre basis. On this size of farm other specialized items of equipment were custom hired.

The last figure in each column of Table 1 shows the net returns per unit of the enterprise. This figure represents returns to management and the restricting resources used by the enterprise. It is computed by subtracting the cost of all non-limiting resources from the gross returns per unit of the enterprise. Our problem is now to choose the combination of units of enterprises in such a way that the sum of these net returns will be a maximum, subject to the restrictions in the P_0 column. The linear programming procedure itself imposes other restrictions which were discussed by Dr. Ellis.

The solution is shwon in Table 2. It contains 41.0 acres of cotton and 4.8427 units of hogs. Ther are 8 sows in a unit of hogs. Therefore, the solution is 41.0 acres of cotton, 39 sows, and the crops necessary to feed the hogs. The net returns to the limiting resources and management are $11,209.60.

The first column of Table 3 shows the amounts of resources that are unused. The second column shows how much an additional unit of the resource would add to the net returns.

One point needs emphasis before we go to the next example. Punching input data and running it through a computor is clerical work. The researcher's job is developing the data to be used in the problem and setting up a program that will give the type of solution he wants (in most cases the program is already available). Too much emphasis can not be placed on correctly (1) indentifying and measuring the amounts of the fixed resources, ble 2. Optimum Combination of Enterprises for a Farm With 210 Acres of Open Land.

nterprise:		
Hogs (4.8427 units X 8 sows = 38.7 sows)		39 sows
Corn	(cropland)	110.9 acres
Alfalfa	(cropland)	19.4 acres
Oats and Crimson clover pasture		19.4 acres
Cotton		41.0 acres
t returns		$11,209.60

able 3. Resource Use of Optimum Combination of Enterprises for a Farm With 210 Acres of Open Land.

esource:	Unit	Amount unused	Value of additional unit
Labor:			
Jan. 16-Feb. 15	hr.	115.47	0
Feb. 16-Mar. 15	hr.	117.79	0
Mar. 16-Apr. 15	hr.	134.27	0
Apr. 16-May 15	hr.	0	$23.136
May 16-June 15	hr.	145.65	0
June 16-July 15	hr.	207.73	0
July 16-Aug. 15	hr.	152.20	0
Aug. 16-Sept. 15	hr.	181.90	0
Sept. 16-Oct. 15	hr.	110.14	0
Oct. 16-Nov. 15	hr.	172.50	0
Nov. 16-Dec. 15	hr.	133.17	0
Dec. 16-Jan. 15	hr.	102.35	0
Row cropland	acre	8.86	0
Pasture land	acre	10.638	0
Investment capital	dol.	8,642.00	0
Cotton allotment	acre	0	$12.70

(2) indentifying alternative enterprises and finding the amounts of each restricting resource used by a unit of each enterprise, and (3) accurately computing the net returns per unit of each enterprise. If input data is inaccurate the results of linear programming must be inaccurate.

Minimization Problem

Our second example involves finding a minimum cost turkey starter ration. Linear programming is ideally suited to this type of problem, as compared to the previous problem, the restrictions (nutrient requirements of mash) are better known; the nutrient composition of the ingredients are subject to less variation than the input coefficients of farm enterprises; and we are not bothered by scale difficulties.

The first task in setting up the problem is to determine the restrictions. These are listed in Table 4. Notice that there are both "maximum" and "minimum" restrictions rather than only "maximum" restrictions as in the previous problem. Note, also, that alfalfa leaf meal and dried milk both must come into the ration at exactly 2 per cent. Therefore, there is no need to include them in the programming matrix. In Table 5 we have subtracted the nutrients supplied by the 20 pounds of alfalfa leaf meal and the 20 pounds of dried milk from the total requirements per thousand pounds of feed. This gives the programming restrictions which were used.

Vitamin supplements are relatively cheap. It was determined that the savings made possible by including vitamin restrictions were less than the costs of the extra computer time involved. Therefore, the following procedure was used:

1. The weight restriction was reduced 0.5 pound to allow for the weight of vitamin additives.

Table 4. Nutrient Requirements Established for Turkey Starter Mash

Restriction	Unit	Minimum	Maximum
Crude Protein	Percent	28	None
Energy	Met. Cal. per Lb. 1/	1,150	None
Calcium	Percent	1.9	2.1
Available Phosphorous	Percent	.65	.7
Salt	Percent NaCl Equiv.	None	.6
Vitamins:			
A	USP units per Lb.	4,000	None
Riboflavin	Mg. per Lb.	3	None
Pantothenic Acid	Mg. per Lb.	8	None
Choline	Mg. per Lb.	800	None
Niacin	Mg. per Lb.	30	None
Alfalfa Leaf Meal 2/	Percent	2	2
Dried Milk 2/	Percent	2	2
Animal Protein	Percent	7	None
Weight	Pounds	1,000	1,000

1/ Metabolizable calories per pound of mixed feed.

2/ For nutritional reasons the feed mix contains 2.0 percent alfalfa leaf meal and 2.0 percent dried milk. Consequently, these feedstuffs are not included in the programming computations but are added to the other feedstuffs after they are computed.

Table 5. Procedure Used in Establishing Programming Restrictions for Turkey Starter Mash

Item	Unit	Relationship	Amount: Required Per 1,000 Lbs. of Feed	Amount: Supplied by Alfalfa Leaf Meal and Dried Milk	Programming Restriction 1/
Crude Protein	Lb.	Min.	280.0	9.4	270.6
Energy	Met. cal.	Min.	1,150,000.0	31,560.0	1,118,440.0
Calcium	Lb.	Min.	19.0	.538	18.462
Calcium	Lb.	Max.	21.0	.538	20.462
Available Phosphorous	Lb.	Min.	6.5	.208	6.292
Available Phosphorous	Lb.	Max.	7.0	.208	6.792
Salt (NaCl equiv.)	Lb.	Max.	6.0	.36	5.64
Vitamins:					
A	USP Units	Min.	4,000,000.0	1,200,000.0	2/
Riboflavin	Mg.	Min.	3,000.0	320.0	2/
Pantothenic Acid	Mg.	Min.	8,000.0	570.0	2/
Choline	Mg.	Min.	800,000.0	17,800.0	2/
Niacin	Mg.	Min.	30,000.0	390.0	2/
Alfalfa Leaf Meal	Lb.	Min.	20.0	20.0	2/
Dried Milk	Lb.	Min.	20.0	20.0	2/
Animal Protein	Lb.	Max.	70.1	0	70.1
Animal Protein	Lb.	Min.	69.9	0	69.9
Weight	Lb.	Equal	1,000.0	40.0	3/ 959.5

1/ Amount required per 1,000 pounds minus the quantity supplied by the alfalfa leaf meal and dried milk.
2/ Not used as a programming restriction.
3/ 960.0 pounds less 0.5 pound allowed for vitamin additives.

2. Programming was done without vitamin restrictions.
3. The vitamin content of the resulting mix was determined.
4. Enough vitamin supplements were added to meet the nutritive requirements.

The feed ingredients form the activities in this problem. The ingredients and nutrient contents (amounts of each restriction per unit) are shown in Table 6. The price of each ingredient is shown in the first column of this same table. These prices correspond to the net revenue per unit of each enterprise in our maximization problem.

The optimum feed mix on a ton basis is shown in Table 7.

Summary

I have gone through examples of two types of problems where linear programming can be used. Many of the minimization and maximization problems which you encounter in research can be stated in such a way that they will fit the assumptions of linear programming. Linear programming allows one to consider more restrictions and alternatives and it saves time. If your input data is accurate, it will give you the maximum or minimum rather than a quantity which you hope is somewhere near the maximum or minimum. I believe that many of you will find instances where linear programming can be profitably used as a tool in your work.

Table 6 - Price and Nutrient Analysis of Feedstuffs Available for Formulating Turkey Starter Mash

Feedstuff	Price per 100 Lbs.	Crude protein	Energy per Lb. 1/	Calcium	Available Phosphorous	NaCl equivalent	Vitamins: A, per Lb.	Riboflavin per Lb.	Pantothenic acid per Lb.	Choline per Lb.	Niacin per Lb.
	Dol.	Pct.	Met. Cal.	Pct.	Pct.	Pct.	U.S.P. units	Mg.	Mg.	Mg.	Mg.
Corn	2.25	8.5	1500	0.02	0.08	0.08	1800.0	0.50	2.6	200	9.5
Millet	2.00	11.0	1362	.01	.10	---	---	---	---	---	10.0
Oats	2.15	12.0	1133	.10	.11	.13	250.0	.50	5.7	420	7.2
Barley	2.00	12.7	1255	.07	.11	.17	320.0	.65	3.5	500	23.0
Soybean Meal	3.60	44.0	1100	.25	.18	.06	140.0	1.30	6.8	1250	16.7
Meat Meal 2/	4.75	50.0	1150	9.85	4.70	3.50	---	2.40	2.0	1000	23.0
Fishmeal 2/	8.75	60.0	1230	5.75	3.20	1.50	---	3.10	4.0	1230	30.0
Dried Fish Solubles 2/	10.50	54.0	1100	1.50	.50	---	---	7.00	20.0	2200	135.0
Wheat Middlings	2.00	17.0	1043	.08	.28	.05	225.0	1.00	8.0	500	45.0
Alfalfa Leaf Meal	2.65	17.0	348	1.40	.06	.50	60000.0	6.50	13.0	400	14.0
Dried Milk	9.00	30.0	1230	1.29	.98	1.30	---	9.50	15.5	490	5.5
Calcium Carbonate	1.00	---	---	39.00	---	---	---	---	---	---	---
Dicalcium Phosphate	5.00	---	---	28.00	18.00	---	---	---	---	---	---
Steamed Bonemeal	4.75	13.0	---	29.00	13.50	---	---	---	---	---	---
Salt	1.65	---	---	---	---	100.0	---	---	---	---	---

1/ Metabolizable calories per pound.

2/ The following combinations of animal products or animal products used alone give about equal growth and feed efficiency response:
1. 2% dried fish solubles and 5% meat meal;
2. 2% dried fish solubles and 5% fishmeal;
3. 10% fishmeal alone.

Table 7. Optimum Turkey Starter Feed Mix and Cost Per Ton

Feedstuff	Price Per Cwt.	Amount Per Ton	Percentage of Total Mix	Cost Per Ton
Programmed Feedstuffs	Dollars	Pounds	Percent	Dollars
Millet	2.00	777.0	38.8	15.54
Soybean meal	3.60	836.3	41.8	30.11
Meat meal 1/	4.75	99.9	5.0	4.75
Dried Fish Solubles 1/	10.50	39.9	2.0	4.19
Wheat middlings	2.00	95.6	4.8	1.91
Calcium Carbonate	1.00	41.7	2.1	.42
Dicalcium Phosphate	5.00	28.6	1.4	1.43
Total	---	1,919.0	95.9	58.35
Added Feedstuffs				
Alfalfa Leaf Meal	2.65	40.0	2.0	1.06
Dried Milk	9.00	40.0	2.0	3.60
Vitamin Additives	---	1.9	.1	2.06
Total	---	81.9	4.1	6.72
GRAND TOTAL	---	2,000.9	100.0	65.07

1/ Although dried fish solubles and meat meal were programmed as a composite feedstuff, they are separated for presentation at this point.

Linear Programming As A Tool For Determining Farm Machinery Needs and Uses

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and
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Annual Staff Meeting School of Agriculture and Agricultural Experiment Station. Auburn, Ala.
July 5-7, 1961

Linear Programming As A Tool for Determining Farm Machinery Needs and Uses

The role of farm machinery is becoming more and more important in the production of agricultural crops. Economic pressures demand that the farmer use his farm machinery as efficiently as possible and that he match his machinery needs and productive acres as accurately as possible.

Linear programming offers another opportunity to determine the hours of machinery use needed to handle a certain job or to determine the maximum acres that a machine should handle under certain conditions and production practices.

The Linear Programming Technique

Linear programming is a mathematical method of solving linear problems made up of a series of complex interrelated items or activities. Mathematically it may be expressed as a technique to maximize or minimize a linear relationship subject to a set of limitations or restrictions. The activities in a problem are a combination of output and input factors in various ratios. An activity may be expressed as a constant or coefficient which indicates the relationship between the input and output. If the activity of production is the plowing of a field and if the unit of measure is an acre, then the tractor "coefficient" for plowing might be 1.7 hours per acre.

Linear programming as used here is not a procedure for getting or estimating the coefficients or constants. The programming procedure merely uses those constants which have been obtained from research or by some other means. Linear programming is generally thought of as applying

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Acknowledgement: The author wishes to express appreciation to Mr. J. O. Helms, Farm Superintendent, Agricultural Engineering Farm Unit, Agricultural Engineering Department, Auburn University, Auburn, Alabama for assistance in this project.

to straight line functions, however, according to Swanson, et al (4)* the procedure can be applied to a curvilinear function without being unduly restrictive.

Linear programming techniques take several forms. The simplex method developed by Dantzig (2) is widely used. An excellent description of this method is given by Charnes et al (1). An example of the application to a problem in agriculture is given by Heady (3). Programming can be done by using graphic applications or by using mathematical solutions.

Graphic Applications

Since linear programming techniques lend themselves to solving linear problems, it would appear that this technique could be used for solving some of the farm machinery use problems. Many of these problems are of a linear nature. If the necessary information for capacity, time available, total units to handle, and other coefficients are available, the programming technique can be applied. The following simple problem in machinery use will serve to illustrate the graphic application of the linear programming technique.

A. The Problem - to determine the minimum hours of use and minimum cost for baling 7000 bales of hay under the following conditions:

B. Farm Conditions

1. 7000 bales to bale
2. 100 machine hours of time to do the job.
3. Has available two balers - B_1 and B_2.
4. B_1 capacity = 60 bales/hour; B_2 capacity = 80 bales/hour.
5. B_1 cost 5 cents/bale; B_2 cost 8 cents/bale.

* Numbers in parenthesis refer to the appended references.

The solution sought is to determine the number of bales handled with each machine, the hours each baler will be used, and the least possible cost that will bale all of the bales. The restrictions of the problem and the basic relationship of the coefficients can be expressed in equation form as follows:

1. B_1 (bales) + B_2 (bales)= 7000 bales

2. B_1 (hours) + B_2 (hours)= 100 hours or less

3. B_1 (cost) + B_2 (cost) = minimum

The limitations of these equations are presented graphically in Figure 1. The interpretation of the graph is as follows:

1. Line AC represents total possible bales. Any point along this line represents a total of 7000 bales and indicates the relative number to be baled by each baler.

2. Line DE represents the limits of time available to each baler indicated in total bales each could bale in the total time available. B_2 could bale 8000 bales in 100 hours while B_1 could bale only 6000 bales using the total 100 hours.

3. The limits of time (line DE) and bales (line AC) cross at point H. Within the area bounded by CODH lie the possible combinations of baling. Any combination lying along line CH will bale all 7000 bales. Any combination along line HD will bale less than 7000 bales and therefore is not acceptable.

4. Line FG is the cost line showing the cost ratio of B_1 to B_2. The slope of this line is 5/8. That is, 8 bales from B_1 cost the same as 5 bales from baler B_2. From the graph it should be evident that as line GF is moved away from the origin the cost of baling will increase. As this line approaches the origin the cost will decrease.

The maximum cost would be with line GF drawn through Point C. This would indicate a total cost of $560. If line GF is drawn through point H (closest to the origin that will bale all 7000 bales) the cost will be a minimum. At the limiting point H, B_1 bales 3000 bales and B_2 bales 4000 bales for a total of 7000 bales. Each baler is used a total of 50 hours. The cost for B_1 baler is $150 and for B_2 baler is $320 for a total of $470. If only B_2 baler is used the cost would be $560 and would require 87.5 hours.

Numerical Application

Linear programming techniques can be used to determine the minimum machinery needs for certain farming enterprises. It can also be used in planning farm machinery use schedules and in determining the number of acres or size of an enterprise than can be handled by certain specific items of farm machinery under certain operating conditions.

In order to use the programming idea to solve a machinery problem, certain basic information about the problem or relative to it must be known. Basic information needed would include material on machine capacities, field and operating conditions, labor available, reliability of machines, weather conditions and sequence and timing of certain operations. Linear programming solutions can be no more reliable than the basic information put into the problem.

Linear programming can be used to obtain a picture of the maximum acres of a particular farming enterprise that can be handled by specific machinery under a specific set of conditions. The specific conditions would be those that exist on the actual farm or are common to the area for which the solution is sought. The specific machinery would be any single machine or group of machines being used or being considered for use.

In order to determined the maximum acres handled by a machine one might reason in this way. Since acres are to be maximized, they are not limited. The machinery is assumed to be on hand or can be obtained. The other important item is time. Time to do the jobs that must be done. Time is limited to some hours per day, week or year. If the machinery time needed for each acre of the crop is known, and if the total machine time available is known, then the maximum acres handled by that machine can be determined.

In applying the programming technique to an actual example one might start by determining the acres of corn and cotton that can be handled with specific machinery on the farm. The example is a farm typical of the Piedmont area of Alabama using the recommended production practices for corn and cotton.

Time for productive field work for each month is determined by taking into consideration weather conditions, Sundays and holidays and length of working day. The hours available for field work vary each month and are shown in Table 1.

Machinery capacity is an important part of the programming application. Capacity is expressed as hours per acre and usually is considered to be the actual operating time needed to complete a job or cover a specific area. In linear programming uses, the capacity must include the productive and non-productive time needed to complete the job. Included would be time for daily service, adjustment and repairs, mounting and dismounting machinery on the tractor, turning at the ends of rows and etc. The capacity of the machine is expressed in hours per acre and is referred to as the machinery coefficient. A monthly coefficient is determined by multiplying the machinery coefficient by the number of times the machine will be used

Table 1
Monthly Time Available for Field Use of Farm Machinery*
Piedmont Area of Alabama

Month	Hours	Month	Hours
January	112	July	91
February	98	August	126
March	98	September	112
April	98	October	153
May	119	November	105
June	112	December	98

*Using 7 hours per day and no field work on holidays, Saturdays and Sundays. Excludes days of bad weather and those too wet for field work.

per acre during the month. For example, the machinery coefficient for a disc harrow might be .55 hours per acre. If the harrow is used to cut the land twice prior to planting in April, then the monthly coefficient for the harrow for the month would be .55 x 2 or 1.1 hours per acre.

The field operations for producing corn and cotton can be divided into groups which can also be classified by months. From this classification monthly machinery coefficients for each machine or operation can be determined. The monthly machinery coefficient for a particular machine might apply to part of the month or to the entire month. Naturally, the monthly machinery coefficient will vary from month to month.

The number of acres that a machine can handle during any month or part of a month is determined by dividing the monthly machinery coefficient into the hours available in that month for the job being studied. Applying the procedure as discussed resulted in the material shown in Table 2.

This table is a summary of the maximized corn and cotton production. The hours of machinery use for each month and for each operation are shown as well as the hours available each month when the tractor is not used.

Summary

1. Programming can be used to determine, within reasonable limits, the maximum acres a machine should handle under a given set of production practices and conditions.

2. Programming should be useful in obtaining greater efficiency of production by comparing the acres actually being handled to those possible to handle. If the acres handled per machine are low, then the operation can be analyzed to determine where and why the operation is faulty.

3. The programming technique is useful in determining machinery needs and uses.

4. Linear programming applications to machinery use and need problems depend upon the use of certain machinery coefficients and thus are no more accurate than the coefficients used.

5. By using graphic applications of linear programming, machinery need and use problems can be solved faster and easier than by other methods.

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Table 2
Maximized Corn and Cotton Production
Using One 2-row - 2 plow Tractor and Equipment
56 acres Cotton and 34 acres Corn

Month	Work Done	Total Hours Available	Acres of Cotton	Hours for Cotton	Acres of Corn	Hours for Corn	Hours Not Used
January	Plowing	112			34	56	56
February	Plowing	98	56	95			3
March	Harrowing 1/	70	56	62			8
	Harrowing 2/	28			34	19	7
April	Smoothing and Planting	98	40	80 3/			18
May	Smoothing and Planting	32	16 4/	32			0
	Smoothing and Planting	37			34	37	0
	Cultivating	50	56	50			0
June	Cultivating	112	56	79 5/	34	29 6/	4
July	Cultivating	31	56	27			4
	Insect Control	60	56	40			20
August	Insect Control	126	56	61			65
September	Defoliation	112	56	19			93
October	Picking Corn	153			34	45	108
November	Stalk Cutting	105	56	19	34	12	74
December		98					98
Total Hours		1322	56	564	34	198	560

1/ Harrowed 2 times
2/ Harrowed 1 time
3/ Using last 4/5 of the month to plant cotton
4/ Planting 16 acres during early part of May to give a total of 56 acres of cotton
5/ Cultivated 3 times
6/ Cultivated 2 times

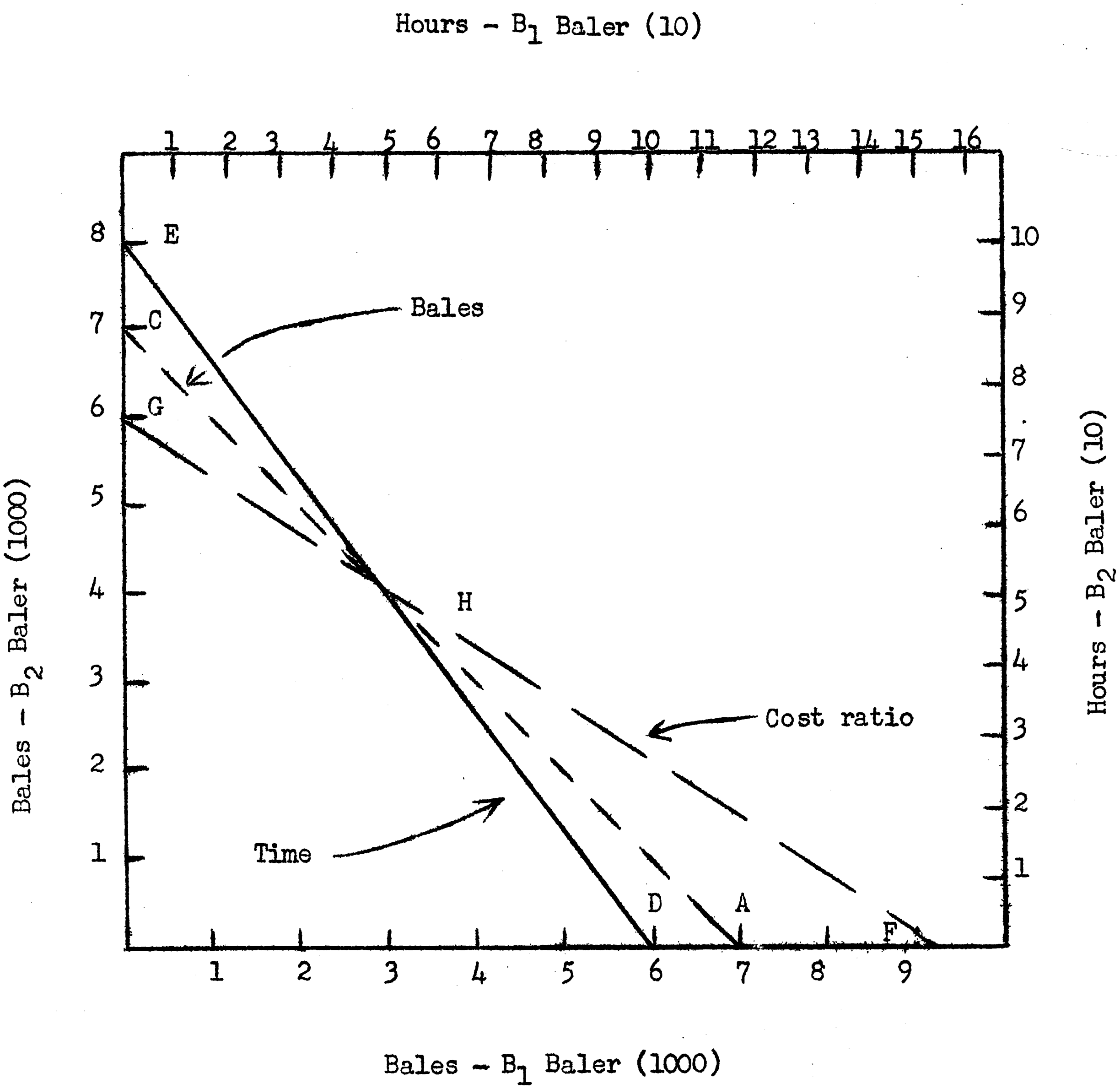

Figure 1. An application of Linear Programming to a hay baling problem. Time, bales, and cost ratio lines are used to obtain a solution.

Status of Research Data Analysis

by

Albert E. Drake

I Present

A. Four Primary Functions of Personnel

1. Keep experiment station records

   (a) Available for reference

2. Teach courses in biological statistics

   (a) One senior-graduate level course (32 enrolled)

   (b) Two graduate level courses (13 and 7 enrolled)

3. Provide a statistical consulting service for research workers and graduate students

   (a) The procedure, analysis, and limitations of the potential results are discussed in detail and a statistically sound plan is proposed for adoption.

   (b) Where no statistical services were obtained prior to the undertaking of the project, the statistician advises the researcher, who seeks his assistance, on the appropriate statistical analysis which can be carried out on his data and on the limitations of the proposed analysis.

   (c) Limitations of the facilities, time, and personnel are related to the desired precision in order that a proper course of action can be implemented.

   (d) This service provides the researcher with the opportunity of sound statistical planning without detracting time from his primary area of interest.

4. Process experimental or survey type data in accordance with the directions of the researcher.

   (a) IBM equipment is used extensively in these computations--particularly the electronic computer.

   (b) Most problems can be processed with canned programs.

(c) Original programs are oftentimes written to facilitate the data processing.

(1) Can currently justify writing only those programs which can be used repeatedly.

(d) Charges to the individual projects are at the hourly rate of $1.25. No overhead charges are made.

(e) Recent survey indicated over 44% of faculty are already using Research Data Analysis for computational work on the computer.

(1) Substantially higher percentage of faculty and graduate students are using the consulting service, however, no figures are available.

B. Data Processing

1. With but few exceptions the researcher no longer need be concerned with volume of data or complexity or length of computations which needs to be processed.

(a) Check with personnel in Research Data Analysis before running experiment or survey to formulate appropriate plan.

(b) Table construction from questionnaire type data, which formally took months, can be done in hours and more information obtained.

(c) Experimental data of five factors and 972 observations can be processed in about twenty minutes.

(d) Thirty multiple correlations of five variables, more or less, will take about 30-40 minutes.

(e) Disproportionate subclass numbers in some experiments have not, as yet, been processed on our machine.

II Future

A. Continue Same Service as Previously.

1. Efficiency increases allows us to do more work with given personnel.

2. Mark sensing will continue to be available as previously.

B. Add Computer Programmer

1. More specialized services.

(a) Example: Currently working on project to summarize farm business and operators labor income on the IBM equipment.

(b) Can do much the same for any set of records.

(c) Increase efficiency of current programs by adapting them for our specialized need.

(d) Put more work on computer.

C. Add Another Professional Statistician

1. Increasedundergraduate and graduate course offering.

(a) Shortcomings of many of our recent graduates can be alieviated through an understanding of research work. A knowledge of statistics provides a means for attaining this understanding.

2. Increase demands on current personnel are making it more difficult to give attention to all the facets of Research Data Analysis.

D. New Techniques in Statistics

1. Linear Programming

2. Econometrics

(a) Study of price and quantity movements simultaneously.

3. Multi-variate analysis.

(a) Simultaneous analysis of variance of several types of observations that have been reduced to a common measure--like dollars.

4. Response surface fitting.

(a) Method of ascertaining an optimum or near optimum allocation of factors in the response or yield under a given set of conditions.

E. New Techniques in Data Records and Processing.

1. A random access file of five million words storage.

(a) Centralized computer installation with attached file. Inquiry and response stations acattered about different parts of the country, city, or campus.

(b) Interruption of current operation to look up desired information, make necessary computation, punch information or answers, and restore computer to point of interruption for continued processing.

(c) May store experiment station records which can be called on almost instantly with any desired analysis that is stored in random access file

(d) May store college finances in file which is kept up to date daily or weekly and summary of any portion or whole can be punched upon inquiry.

(e) May be used to prepare payrolls and other periodic reports upon command.

* * * *

Present Status and Future for Use of

Nuclear Energy in Agricultural Research at Auburn University 1/

Donald E. Davis

The most significant development in nuclear science at Auburn University is the proposed construction of a Nuclear Science Center. The proposed center would include a reactor, cobalt 60 gamma source, hot cell, and associated laboratories, classrooms, and offices. The present time table calls for completion of plans in November 1961, starting construction early in 1962 and occupancy in June 1963. The tentative plans which are presented here were used as a basis for a request for funds submitted to the National Institutes of Health. Most of this presentation will be devoted to a discussion of the proposed Nuclear Science Center with only a few general remarks in closing. The presentation of information will be developed around seven key questions.

1. What will the Nuclear Science Center look like?

The proposed building will be on three levels with the bottom level being partially dug back into a hillside and the top level resting on top of the hill. An octagonal reactor room will connect all three floors and will contain the reactor in its swimming pool. The top floor will be devoted to offices and classrooms, the second to a change and decontamination area, and the bottom to the reactor ports, laboratories, and associated facilities. The ground floor will have two long wings and two shorter ones that may be expanded in the future. (A slide was used to present this information.)

2. How big is the proposed building?

The ground floor measures 400 ft. from the tip of one wing to the end of the opposite wing. The gross square footage is 35,900 with 15,700 sq. ft. in health related areas. There is an estimated 8,000 sq. ft. for the School of Agriculture.

3. Where would it be located?

Tentative plans call for the use of a hillside a short distance off of Wire Road and in a small part of the area now used for swine production. (A slide was used to present this information.)

4. How much will it cost?

Approximately 1.1 million dollars have been budgeted for the construction of this facility.

5. What is the source of money to build this center?

The Nuclear Science Center has been given first priority in the use of funds raised for the Auburn University Development Program. This fund now has nearly 0.6 million on hand and over 2.3 million pledged. The National Institutes of Health has been asked to supply a little over one-quarter million dollars. It is hoped that pledges paid between now and the start of construction will be adequate to cover the remaining balance. Bonds will be purchased against the pledges if adequate money is not on hand.

6. What is in the Center for the School of Agriculture and Experiment Station?

First floor - Some office space

Second floor - Use of change and decontamination rooms.

Bottom floor - Biology wing

Four two-man laboratories, 1 plant growth chamber and associated preparation room, 1 radiochemistry and synthesis laboratory, 1 general laboratory for teaching, 4 large animal holding pens, 1 large animal preparation room, 1 autopsy room, 2 small animal rooms and diet preparation room, 2 rooms for equipment and feed storage, 1 dark room.

Bottom floor - Shared facilities.

One hot cell with remote handling equipment, one large dry irradiation room associated with the reactor, one cobalt 60 irradiation room, one radioisotope assay room.

Bottom floor - Service facilities.

One machine shop, one glass blowing shop, one health physics laboratory.

Equipment.

Reasonable amounts of equipment have been supplied only for the machine shop, dark room, health physics laboratory, irradiation rooms, hot cells and the necessary equipment for handling, operation, and maintenance of the reactor. A few other items of equipment have been included but most of the balance of the equipment will have to be supplied by the research personnel using the facility.

7. What good is the Nuclear Science Center?

The Nuclear Science Center will make a notable contribution to the space and equipment available to carry out fundamental studies in agricultural research requiring the use of radioisotopes or ionizing radiation. The Center will provide valuable technical assistance and more efficient radioisotope assay equipment for the sizable nuclear science program already in operation in the Agricultural Experiment Station.

The following new projects have been proposed for initiation as soon as the facility is available.

(1) An *in vivo* study of the metabolism of nutrient cations. Drs. W. Brady Anthony, Paul M. Newberne, J. F. Price, and D. R. Strength.

(2) Determination of plant root behavior in subsoils. Drs. L. E. Ensminger and R. W. Pearson.

(3) Effects of heat, dehydration, and neutron irradiation on peanuts. Drs. Norman D. Davis and Donald E. Davis.

(4) The effect of phosphorus supply on iron metabolism in pine seedlings. Drs. Mason C. Carter and Harold C. Beals. (This project has not been fully formulated.)

(5) Effect of irradiation and/or heating on green Chinese chestnuts. Mr. Hubert Harris and Mr. J. M. Barber.

(6) Mechanisms involved in egg shell formation. Dr. J. R. Howes.

(7) Sterilization and eradication of insects by irradiation. Dr. W. B. Arthur.

The following are the general types of agricultural research made possible by the Nuclear Science Center.

(1) Genetic research in which the gene pool is increased by mutations produced by ionizing radiation.

(2) Insect control in which the ionizing radiation is used to sterilize insects for release or for killing insects in stored foods or feeds.

(3) Food preservation studies in which the ionizing radiation is used to kill microbes or inhibit growth of dormant buds.
(4) Basic metabolism research concerned with metabolic pathways, synthesis, or degradation.
(5) Mineral nutrition studies in both plants and animals where radiolabeled elements are used.
(6) Fertilizer placement and efficiency studies with radiolabeled fertilizers.
(7) Neutron activation analysis making possible highly precise determinations of certain micro elements in biological materials.
(8) In vivo and in vitro investigations of the effects of various kinds of ionizing radiation on living systems.

It thus appears that Auburn's dream of a Nuclear Science Center is now nearing realization. Agriculture will have an important part in this dream.

The Meats Laboratory

James F. Price

During the course of this program we have learned of many shifts in Alabama's agricultural population and economy. We are rightly concerned with the roll that our college teaching, research, and extension programs has had in effecting these changes, and how they should influence our future philosophies and actions.

Likewise there have been major changes in our food marketing system during the past few decades. Many of the revolutionary shifts in this phase of agricultural products marketing have been demanded by inescapable industrialization and automation. However, we can not overlook the important influences that changing society has had in food marketing. The consumer has been offered a wide variety of new products, processes, programs, and packages. Those that were found acceptable have designed our present system of processing and distributing this abundant wealth of agricultural progress.

The importance assigned to the Meats Laboratory work depends upon the scope of activities allowed under our definition of the term "agriculture", as mentioned by Dr. Wilson yesterday. The era of farm slaughter of livestock and home processing of meat products is rapidly fading into oblivion. If we try to justify a program designed to face only the problems of "on the farm" meat processing, it is a lost cause. Only as we embrace the full concern of livestock evaluation and improvement, food marketing, and processing technology do we realize the full impact of contribution that can be made to agricultural teaching and research by studies in meat food products.

Let us examine the ways in which the Meats Laboratory can be applied as a tool in an agricultural research and teaching program. I would like to present my ideas as two concepts of meats work or two schools of thought on the subject. First, let us think of meats work in the concept of livestock improvement.

The shift in Alabama agriculture to more cattle and livestock production along with many of our neighboring states has been emphasized earlier in our program. Increased emphasis on livestock production now demands that Alabama join hands with many of the states in the southern region and the whole nation with definite livestock improvement studies. Many are underway. In such studies it is easy to forget the variation in the quality of the end product being produced, and to evaluate production efficiencies solely on the basis of quantity or pounds produced per day or per feed unit. However, it is essential that our final product be economical in terms of units usable and acceptable as high quality food stuff. To stress this point allow me to delve into the realm of the "to say the least" unrealistic. Let's suppose that the animal physiologist, nutritionist, geneticist, and animal breeder combined their talents to develop cow-like-beast that is capable of producing 1200# live weight in 60 days on only 1500# of Bermudagrass hay. This would be fantastic. But I dare say that we would bolster the agricultural economy very little (or more likely suffer a 100-year set back) if the food product from such an animal had no more nutritive value or taste qualities than unflavored gelatin. This situation will, not likely, arise. No researcher would ignore such an obvious factor. On the other hand, it is no easy task to constantly evaluate, in livestock research, the subtle differences in meat quality that so strongly influence its marketability.

It is also easy to become so involved with production problems and analytical methods that the changing pattern of society is forgotten. We over look the shift in consumer ideals of "quality". The definition of "top quality" is constantly changing, not only as influenced by changes in consumer taste preference but also by the impact of new knowledge in the fields of nutrition and physiology, etc.

Nationwide, we in livestock production research have been a little bit tardy in applying known methods of meat and carcass evaluation as a final criteria in assessing values to studies aimed at improvement of livestock production efficiency. We may also be accused of quickly adopting standard methods and evaluation techniques that were not fully understood. Recently we have come to realize that past methods of evaluating livestock (particularly their carcasses) were not presenting the whole picture.

Nonetheless it seems essential to me that any real improvement in a species of food producing beasts must come about through evaluation of the consummed product. Certainly we need rapid growth potential and efficient feed utilization bred into this beast. But we must not fail to realize that the market position now held by livestock products might well be overtaken by some meat substitute unless we maintain or improve this evasive thing termed quality or acceptability.

It appears that application of the Meats Laboratory to agricultural research finds its stronghold in this concept of livestock improvement. Critical evaluation of proposed advances in livestock breeding, nutrition, and production is going to depend to some degree upon our ability to evaluate just what is being produced in terms of protein, fat, minerals, vitamins, and satisfied palates. (tenderness, juiciness, flavor)

In connection with an agricultural research program meats work should set its goal to:

1. Strive to improve livestock through evaluation of carcass traits such as composition, nutritive value, and palatability.
2. Strive to improve evaluation methods by constantly examining and improving the research methods used in meats evaluation and attempting new methods, that may give greater insight into end product quality while the animal yet lives. Like the analytical chemist, in meat Science and Livestock evaluation we must constantly question if our test methods are actually measuring what we are trying to quantitate.
3. Strive to evaluate consumer ideas or preference and to season these ideas with the scientist's views of nutritional value, and meat quality. Then to fit all these into a more meaningful livestock evaluation program.

A great portion of the undergraduate teaching program in meats also fits into this concept of livestock improvement and marketability. I hope to de-emphasize the skills involved in slaughtering and meat cutting, but to demonstrate and use the required skills only to stress the factors involved in livestock and meat carcass evaluation. How skills affect the quality - values - and marketability of this agricultural product. I feel that the agricultural graduate will seldom, if ever, have need of these specific handy work skills. Our meats teaching program should fit well into the curriculum philosophies expressed yesterday. Meats courses should broaden the base of the students experience and philosophy, and provide specific knowledge in the fields of meat marketing and economics, food science, and meat production. Much of the specific knowledge of the market procedures, meat quality, and food preservation is relevant to the whole of agriculture.

Only if the future leaders in agriculture are aware of the criteria used in livestock evaluation and the philosophies underlying the evaluation methods will we be able to even maintain status quo as far as meat animal improvement is concerned. A questioning mind, with the ability to understand and apply the knowledge history has given the meat evaluation and food marketing field may lead to continued advancement.

Now let us turn to the second concept of meats work and its application in a research and teaching program in our land-grant institution. The second concept, I term the Food Science concept. Studies of the very nature of the red meat product find much common ground with technology of all food products, particularly with studies of dairy, poultry, and fish products. My definition of this "Agricultural business or Agricultural industry" would include all the facets of food and fiber science. I am stubborn enough to believe that personnel with an agriculturally oriented background (our graduates) when provided with the proper technical knowledge are better suited to make decisions on food or fiber marketing and processing problems than those who may be well trained in business or chemistry but lack fundamental knowledge about the source of the raw products.

This means that in research and education the Meats Laboratory work would require assistance from many avenues of learning - from physiologists food or biological chemistry - home economics - ag. economics, nutrition and many others. In order to be assured that livestock products in the form of beef, pork, lamb, cheese, eggs, poultry or processed meats will continue to be accepted in the market place, and on the plate, we must constantly be concerned with their storage, taste, and nutritive properties. New processing and packaging methods are sure to be required. Treatment of live beef animals with injected enzymes or the like may result in all beef having the same in tenderness and taste properties. If this is so, we need to be sure of it, and find out what effects will be felt in the agricultural industry.

The demand for convenience food items could very well do away with current meat display on packaging methods. Diminished uses of animal fats and reported adverse physiological responses to high fat diets has caused us to reevaluate our livestock breeding and feeding programs.

A facility such as the Meats Laboratory will find many uses. Its immediate service will more than likely be to study carcass qualities with the aim of more economical production of the demanded product. However, I believe that the greatest impact of meats work will be felt when considered in the light of the broad scope of agriculture cooperating with and demanding the assistance of the nutritionists, agricultural economists, home economists, food chemists and animal physiologists.

THE HIGH SCHOOL RESEARCH PROGRAM
by
J. T. HOOD

The Summer Program in Life Sciences at Auburn was designed for academically superior high school students. These students are potential Ph. D. material. The purpose of this program was to acquaint high school students with the Science in Agriculture---to show the students that there is a lot more to the field of agriculture than just feeding pigs, chopping cotton and other similar tasks. In this program we attempted to inform the students of the challenges and opportunities in the life and applied sciences.

The program was sponsored jointly by Auburn University and the National Science Foundation. The Foundation paid one-half of the cost of room, board, and travel for the students, and the student in turn paid one-half. The Foundation also contributed toward the direct operational cost of the program. Auburn did not charge the students tuition and made a contribution through supplying faculty not budgeted under the program and by furnishing its facilities.

Participation was limited to boys who had just completed the eleventh grade in high school. This group was chosen because it was desired to have students who had the most training and were the most mature, yet, ones who would have direct contact with the high school next year. These students will be seniors this fall and are thus likely to have the most prestige and the most influence on their classmates. It is hoped that these students will act somewhat like missionaries.

Twenty boys were selected for this program. Eighteen were from Alabama and two from Georgia---Columbus. These students represented 18 schools and 15 counties in Alabama extending from Mobile to Cherokee Counties.

The participants were chosen from about 80 applicants from seven states extending from Florida to Wisconsin. The applicants from Alabama represented 42 schools and 33 counties.

The following information will indicate the caliber of the students who were chosen for the program. A summary of the professional plans of this group showed that 7 were interested in science in general, 4 in medicine, 2 in agricultural science, 2 in engineering, 1 in agribusiness, and 1 in chemistry. Three indicated no preference.

The scholastic records of these students were really outstanding. Eight had a grade point average above 2.9 out of a possible 3.0. To have an average of 2.9, a student must make 9 A's for every B. Seventy-five percent of the participants had an average above 2.75---at least 3 A's for every B.

Twenty of these students had taken algebra in high school; 18, geometry; 19, biology; 14, chemistry; and 9, physics. A foreign language had been taken by 12. Since normally a student takes physics or chemistry in the eleventh grade and the other in the twelth grade, these students were ahead of schedule with respect to these two courses.

Ten of the students came from small high schools (less than 500 pupils), 5 from high schools with an enrollment of 500 to 1000, and 5 from large schools (over 1600 pupils). The large schools represented were Murphy of Mobile; Woodlawn of Birmingham; Baker of Columbus, Georgia; and A. G. Parrish of Selma.

The length of the program this summer was six weeks. It began on June 12 and ended July 21. In the program, two courses were taught---one in plant sciences by Dr. Norman Davis and one in animal sciences by Dr. Ottis. These courses were somewhat similar to the first courses in Botany and Zoology.

Seminars were held from 7 - 9 p.m. Monday, Wednesday, and Friday each week. Some of the topics presented were "Philosophy of Research" by Dr. Scarsbrook, "Agribusiness" by Dr. Yeager, "Tree Growth" by Dr. Carter, "Grasses and Civilization" by Dr. Hoveland, "Radioisotopes in Animal Nutrition" by Dr. Newberne and Dr. Strength, and "Viruses" by Dr. Mora. The seminars have been presented in such a way as to challenge the students with the questions not yet answered in a particular field.

Field Trips were scheduled for Saturdays. These trips included a visit to the computer laboratory with a short course in Statistics by Dr. Drake preceeding the visit to the computers. There was a visit to some of the animal science research facilities which included some of the laboratories in which cancer research is being conducted. Trips also included visits to some of the plant science research facilities and the tillage laboratory.

The students conducted research projects under senior staff members. Each student chose his project from projects submitted by staff members. Students wrote reports on their projects and some made short presentations at a meeting the last day of the program.

The students' high school principals will be contacted and urged to have the students report in assemblies, science classes amd clubs on the program at Auburn. It is hoped that private conversations between these students and classmates may be effective.

Publicity was given this program through newspapers and on television.

The participants were enthusiastic and possessed tremendous curiosity. Certainly some doors were opened for them. As these students have a chance to reflex on this experience, it is expected to have quite an effect on them.

Summary of Remarks by
J. H. Yeager
Department of Agricultural Economics
As A Part of A Panel Discussion-
The Agricultural Curriculum
Annual Staff Conference, July 7, 1961

Who Are We Training?

Probably the best word to describe the academic background of the freshmen students enrolling in agriculture is the word "variable." Some students come from city high schools or certain schools in which they have had good basic training in math, English, and chemistry. Others come from small rural high schools and in many cases have a very poor background in basic subjects.

Our entering freshmen students in the fall of 1960, as an average, were in the 5.4 decile group according to placement tests. However, they no doubt scored lower than freshmen entering the various engineering and certain other curriculums.

Although entering freshmen may have been exposed to training in "so-called" basic subjects, many have not had to organize and present subject material. They have done little serious studying and consequently do not know how to study. Thus, mortality is high their freshman year in college.

For What Are We Training Them?

First, I want to say that in my opinion we are not nor can we afford, with present numbers of students, to train specialists. We are not turning out specialists with a B.S. degree. Students finishing in Agricultural Science and the various majors are getting about the same kinds of jobs as those finishing in Agricultural Administration. This is also true in a large measure for students finishing in Agricultural Engineering and Forestry.

Dean Simmons has reported that a large percentage of our graduates go into selling jobs or jobs in the agribusiness field. Most employers wish to indoctrinate or to train their employees in the techniques, policies, and philosophies of their organization. It is my feeling that employers want graduates who have had good basic training in biological, physical and social sciences. They want graduates who can communicate effectively both in speaking and writing.

In summary, we are training students so that they can be productive in a highly organized complicated social organization. The purpose of college training is for the student to learn how to make a living and to learn how to live in this modern age.

How Well Are We Training Them?

My answer to this question is "Not as well as we might with the resources we have including the knowledge we have about the work into which our students go and the problems they face."

Naturally, my opinions are biased since I am a social scientist. I feel that our curriculums have not been changed sufficiently to keep up with the times. Let us go back to the jobs that our graduates get - mostly in the selling field. In selling, one can effectively use and should correctly interpret and understand basic statistics. A course in statistics is required only in the Agricultural Administration curriculum. Graduates entering the business world also need basic courses in economic principles, accounting, business organization, finance, and credit. Our agricultural graduates are inadequately trained in these areas.

We are turning out students that do not have the background desired by agribusiness employers. As a result, many employers go elsewhere to recruit employees.

Is Re-Orientation Needed and If So, In What Direction?

I shall summarize my remarks to this question in the following points:

1. There is a need for bringing course content up to date and keeping it up to date.

2. Duplication and splintering of courses are excessive. Several production courses and possibly others in other areas should be combined.

3. A better balance between basic and applied courses should be incorporated in agricultural curriculums.

4. Good teaching should be emphasized and given recognition and appropriate reward.

5. An effective student advisory system should be inaugurated throughout the School of Agriculture.

6. Additional attention should be given to assisting and working with students in job placement and in contacts with employers to better understand their needs.

7. It is imperative that the present concept of agriculture and the career opportunities available in this area of work be changed at the high school level.

Summary of Remarks by
D. B. Richards, Forestry Department
As A Part of A Panel Discussion
"The Agriculture Curriculum"
Annual Staff Conference, July 7, 1961

In planning courses and curricula it is very easy to use them to blow up the importance of one's own discipline, department, or school. The student is all too often treated as a "warm body" to be used to swell enrollment figures and hence justify our own existence without sufficient regard for the student's welfare. If we would take the time to figure out what is best for the student's total development in the long run, and provide for this development I believe enrollment figures would take care of themselves. We continually criticize the high schools for doing a poor job of preparing students for college, yet we repeat the crime by not providing our own students with training which is broad enough and basic enough to prepare them for graduate school.

All too often we require a freshman or a sophomore to make decisions about specialized curricula which he is ill prepared to make. We then penalize him a year or more of his life and one or two thousand dollars for making the wrong choice. Even after this process is completed the student often earns his living in a specialty other than the one in which he majored in college. In view of these facts I think it is very important that we offer the student an opportunity to get a broad basic education in the sciences and the humanities. While this is especially important for the talented student it has value for the student of more modest academic powers. Some of these more or less average students often develop later and rise to important positions where a broad training is invaluable.

Summary of Remarks by
Ken Ottis
Department of Zoology-Entomology
As A Part of A Panel Discussion
The Agricultural Curriculum
Annual Staff Conference, July 7, 1961

A good curriculum in agriculture not only must be tailored to fit the region it serves, it must also be adjusted from time to time as conditions change. Changes often consist of additions as interest develops in certain subject-matter fields or as new facilities become available. Often these actions are taken without thought of the basic changes which may be needed. Inertia is strong and major changes often may require action by more than one department within the School of Agriculture. It appears now that consideration should be given to training-in-depth in the basic sciences and a greater exposure to the humanities because of the demands of our complex society. Making room for such courses may require reduced requirements in applied agriculture and a careful check amongst the departmental offerings for needless duplication. I think that one thing we all here today can agree upon is that agriculture is becoming more and more specialized, and more and more scientific. It is the opinion of some that our majors should be better trained in the physical and social sciences rather than taking a little of this and a little of that in order to have a general education in agriculture. We have already entered an era in which a high degree of technical competence is demanded of the graduate in science. We should be training students for the future, not for the past. Why should a student be highly trained and indoctrinated with agricultural practices which are likely to be completely reversed in the next five to ten years. Why should it become necessary for the agriculture graduate to take two and three quarters of make-up work in the basic sciences before gaining admittance to the graduate program.

For purposes of discussion, let us look at our Agricultural Science Curriculum. It is a "rule of thumb" here on Ag-Hill that the best prospects for the graduate program are recruited from this group. I'll admit that my interests are slanted toward the graduate program. Upon examination, we find that the agriculture science curriculum contains 95 hours of applied courses, 60 hours of basic sciences and humanities, and some 30 hours plus, of electives. Notable for their absence is organic chemistry, quantitative analysis, social science or philosophy. The physics course, PS 204, is not a comprehensive course, but rather of a survey nature.

To make room for more basic science subjects might we make two suggestions: 1) reduce some of the applied courses from five hour to three hour; 2) place some of these applied courses on the elective list. This, then, would leave room for such basics as organic chemistry 207 and 208, quantitative analysis, a good two-quarter sequence in physics, and possibly more work in the basic plant and animal sciences.

(A short discussion followed at this point. The main point raised seemed to be the fear that these changes would do away with our Ag curricula)

Might I address myself immediately to the charge that our ag curricula would lose, in some way, their identity if these changes were made. This I do not believe. No curricula was ever damaged by strengthening it. I never recommended doing away with the applied courses, rather I asked if it were not possible to build a stronger base of physical and biological sciences upon which to construct the applied phases of agriculture. I most certainly do believe in the philosophy of the Land Grant College. I chose to take my two major degrees from one of the best and have never regretted it. We are simply saying here today that it is for us, within the School of Agriculture, to study and to re-evaluate our curricula in terms of the highly technical, the highly scientific world that our graduates are going to step into once they leave our campus.

Concluding my part of this panel discussion, I should like to say that good teaching in the biological sciences, and all other disciplines for that matter, results when competent teachers function in a well-planned curriculum. There is doubtless much to be learned from other educational fields which will be helpful in planning our curricula and improving our teaching methods. This we hope to accrue from our self-study program just initiated. While we seek new ideas, we should bear in mind, at all times, the differences between agriculture in general and other academic areas, however, we must face up to the fact that our graduates need a strong foundation in the basic physical and biological sciences and a greater exposure to the humanities if he is to compete successfully in this highly scientific world of ours. I repeat, we are entering an era of highly specialized agriculture. We should be training students for the future, not for the past.

Miss Farley Lee

At the Annual Staff Banquet of the School of Agriculture and the Agricultural Experiment Station System, Auburn University, conducted on July 5, 1961, a fitting tribute was made to Miss Farley Lee, Librarian of the Agricultural Library, who contributed so much and rendered such fine services to staff members, graduate students, and undergraduate students in agriculture. Dean E. V. Smith presented to Miss Lee at the banquet a silver tray on which was engraved:

> Farley Lee - a friend and colleague, with deepest appreciation from the School of Agriculture and the Agricultural Experiment Station.

The tray and a cash gift of $121.00 represented contributions from the senior and junior staff members in all of the departments of the School of Agriculture and the Agricultural Experiment Station. A letter of appreciation from Miss Lee is reproduced below.

COPY

Dean E. V. Smith
School of Agriculture and Experiment Station
Comer Hall
Auburn, Alabama

Dear Dr. Smith:

I'm sure you realize that I was deeply touched by the recognition the School of Agriculture and the Experiment Stations gave me the night of the banquet. I shall always consider that a bright spot in my life. Of course I can not thank the many who had a part in the expression of friendship and interest. Perhaps you will have opportunities to let members of the faculty and the staff of the station know that I enjoyed my years on Ag. Hill and that I appreciate their good-will.

Sincerely yours,

Farley Lee