September 5, 1974

MEMORANDUM TO: J. D. Dodson

FROM: F. J. Humenik, In Charge, Extension
Biological & Agricultural Engineering

Enclosed please find the Progress Report for Fiscal Year 1973-74 for the department of Biological & Agricultural Engineering Extension, and four success stories.

FJH:s
Enc.

PROGRESS REPORT FOR FISCAL YEAR 1973-74

Biological and Agricultural Engineering Extension

Overview

The diverse work activities in the Department of Biological and Agricultural Engineering have been positively related to revitalized national interest in the securement of adequate food and fiber at a reasonable cost within constraints of developing environmental and safety criteria. Emphasis during the last production season has been on the field testing of new technology and continued development of procedures for more efficient and economical production and processing of agricultural commodities. Departmental programs have emphasized new frontiers in single and multiple-pick harvesters; reduced tillage land preparation systems; new crop enterprises such as trellised tomatoes, processing tomatoes, integration of cucumber and tomato production, and ornamental crops; utilization of solar energy for crop drying and heating biological reactors; methods for better grain drying and storage; water management to optimize crop production and minimize frost and freeze damage; the continued development and implementation of trickle irrigation for more efficient crop production; testing to determine the efficiency and effectiveness of sprayers for disease and insect control; environmental control of animal production systems with emphasis on underfloor ventilation; and development of total agricultural waste management systems which emphasize energy recovery and ultimately return the waste to the land to eliminate point source discharges. Implementation of research results in production related areas and waste management has demonstrated the value of close cooperation between research and extension workers for the immediate transfer of technology to the actual producer.

The potential value of systems analysis and modeling has become more clearly visible over the past year. The total activity in related areas can be optimized by coordinated evaluation of the overall system. The systems analysis methodology

which expresses the scientific approach to conservation of work effort and optimization of results also provides a mechanism to record efforts in a form suitable to determine data gaps and facilitate more comprehensive analysis of the many components that influence the total effort. Computer modeling allows greater use and applicability of results pursuant to more competent direction of further efforts.

Educational activities have emphasized agent training by both in-service sessions and personal contacts, cooperative activity with state and federal agencies, and technology transfer through subject oriented meetings, and publications.

Comprehensive efforts have been made to help producers meet OSHA agricultural standards and state and federal regulations for agricultural waste management. Several work activities such as 4-H and Safety have received cooperative attention from the total staff.

Details of these activities as conducted by the individual specialists and outstanding success stories catalyzed by specialists' efforts either individually or in cooperation with others according to work area follow.

Horticultural Crops

Cucumber mechanization continued at a slow pace, with a few new harvesters of the onceover and the multiple-pick type brought into the state for the 1974 season. Mechanical difficulties plagued the self-propelled version of the multiple-pick harvester which was introduced this year. Performance was good but reliability was poor. Design improvements were made and incorporated by the manufacturer to remedy the situation. Onceover harvester performance once again proved to be highly dependent on the crop produced: if the field is clean and a good crop of cukes is on the vines, the machine will take them off and put them in bulk containers in an acceptable fashion. Profitable yield, harvest scheduling, and general management

difficulties continue to be the major problems with the onceover harvesting approach.

Considerable attention was given to assembling and evaluating new bed-shaping and cultivation equipment for cucumbers, with the objectives of reducing costs and power requirements while increasing the speed of those operations. The new devices, which are made up primarily of standard tillage tools, not power driven, proved equally as effective as the power driven rotary tiller currently being used for bed preparation and cultivation, and achieved the objectives set forth above.

The proper application of nematocides to cucumbers was stressed at several cucumber meetings, with the result that the major pickle companies' field coordinators have begun to make the application properly with suitable equipment, and will urge the practice on their growers.

Production of processing tomatoes incorporating mechanical harvesting was initiated in North Carolina in 1974, with 100 acres being grown by two farmers in Robeson County. Most of the acreage was transplanted, but 15 acres or more were direct-seeded in the field. A horticultural specialist and a biological and agricultural engineering specialist cooperated in assisting the growers with all phases of production planning and implementation. Bedding and seeding equipment was provided for establishing the crop, and use of an air-blast sprayer was arranged for disease and insect control on one of the farms. Experience and knowledge gained from this effort will be available for the benefit of extension workers and other growers who elect to produce processing tomatoes.

Additional tests to determine the efficacy of different types of sprayers for disease and insect control on vegetable crops, particularly tomatoes and cucumbers, were conducted during the 1974 season. It is anticipated that these tests will provide a sound basis for recommendations on types of sprayers best suited for these and similar crops, as well as proper operational techniques. A pocket-size sprayer calibration guide was prepared and distributed.

In cooperation with a forestry extension specialist and a private grower, a piece of equipment was designed and assembled to prepare land for planting Fraser fir Christmas trees in the North Carolina mountains. The machine tills a strip approximately 20 inches wide and 4-6 inches deep, applies and incorporates fertilizer into this strip, and may be equipped with a seeding device to plant a cover crop such as rye in the tilled strip. The area between the tilled strips (rows of trees) is left in sod to control erosion. A test planting was established on the grower's farm in 1974, with tillage, types and rates of fertilizer, incorporated and not incorporated, as the variables evaluated. In addition to the test approximately 15,000 to 20,000 trees were set out by the grower in land prepared with the machine. The machine was displayed and discussed on the program of the Christmas Tree Growers Association.

Water Management

As has been true for the past several years, the water management program in 1973-74 continued to be quite diverse, but major emphasis was placed on inter-departmental applied research programs, to trickle or drop irrigation, to land application by sprinkler irrigation of animal wastes, to the use of sprinkler irrigation for frost and freeze protection, and to a study of agricultural water needs in North Carolina.

The water management specialist continues as a cooperator with the Department of Horticultural Science on a grape irrigation-cultural practices study, an apple irrigation-environmental control study, a greenhouse-vegetable study in which trickle or drop irrigation is one of the variables, and an apple irrigation-drip irrigation study.

During the past year considerable interest in using sprinkler irrigation for frost and freeze protection was developed among growers. The water management specialist has worked with several growers on the design and installation of

sprinkler irrigation systems for this purpose. All should be in operation for the 1975 crop year. Also in the past year several trickle irrigation systems for apples have been designed. Two of these systems were installed for the 1974 crop, and others will be installed for the 1975 crop.

Data will be collected from the frost and freeze protection system and from the drip irrigation systems. Each of these systems has been installed in cooperation with Dr. C. Richard Unrath, apple physiologist in the Department of Horticultural Science. In addition to these farmer installed systems, a system for frost and freeze protection and crop cooling was installed on five varieties of apples in an orchard in Henderson County. From earlier work on using sprinkler irrigation for crop cooling a journal article, "Evaporative Cooling of Delicious Apples - Economic Feasibility of Reducing Environmental Heat Stress," Journal of American Society of Horticultural Science, Vol. 94, No. 4, pp 372-375, was authored by Unrath and Sneed.

Work also continued on land application of wastes using sprinkler irrigation. An automated permanent irrigation system was designed and installed on Kentucky 31 fescue grass at the Unit II Swine Facility to study the effect of swine lagoon effluent to the grass and also the runoff from a Cecil clay soil. The Randleigh Dairy project which includes solid waste removal, multiple lagooning, land application through sprinklers, and re-use of waste water for floor flushing was completed and placed in operation. Two companies were assisted with rather extensive land application systems. Chick Sales, Inc., of Siler City, a new hatchery, and Nu-Way Packing Co., of Forest City, a new slaughterhouse and packing plant for beef and pork are installing waste management systems which include land application using sprinkler irrigation. This work was cooperative with the Office of Water and Air Resources and the Soil Conservation Service.

The Tenth Annual Conference of the North Carolina Irrigation Society, to which the water management specialist serves as technical advisor, was held in Raleigh in November 1973, with some 145 in attendance. The program theme was land application

of waste. This meeting was attended by some 20 agricultural extension agents.

The North Carolina Land Improvement Contractors Association was formed in 1973. The water management specialist serves as technical advisor, and J. C. Ferguson, retired Biological and Agricultural Engineering Extension Specialist, serves as executive secretary. These two people, plus Dr. George J. Kriz, were instrumental in the formation of this Association. The first annual conference was held in Raleigh during January 1974.

A project report covering Phases I and II of a study entitled "Agricultural Water Needs in North Carolina" was published in September 1973. Phase III of this study which is funded by the Office of Water Resources Research and the North Carolina Water Resources Research Institute is currently underway. This study which combined efforts of extension and research faculty is designed to provide tools to predict agricultural water usage and also to determine optimum crop mix under a limited water availability regime. Two areas are being studied in Phase III. These are Wake County and the Tar-Neuse River Basins. This second area is cooperative with the Soil Conservation Service.

Tobacco Mechanization

Mechanical tobacco harvesters on North Carolina farms increased about sevenfold in '73. In 1972 there were 43 in operation in North Carolina. In '73 there were approximately 300. About 800 are estimated for '74. These 800 "combines" can harvest about 10% of North Carolina's crop. The acceptance of the harvester has brought into focus the need for sophisticated materials handling equipment for uncured tobacco. Experiment Station research using large mechanically filled curing containers was viewed by several innovative farmers in 1973. These farmers plan to "experiment" with similar systems in 1974. The objective of placing tobacco in the curing barn "never touched by the human hand" will probably become a reality for some

of these innovative farmers in 1974. This acceptance of research station schemes, largely unproven, and the private farm use of researchers' "ideas" are sound evidence of the rush to and need for mechanization.

Extension is playing a vital role in the rush to mechanization by evaluating proposed ideas and advising agents, farmers and manufacturers on engineering fundamentals in materials handling and curing requirements.

A farm test using a solar collector to reduce fuel costs is planned for '74. Estimates and preliminary tests promise a 10% to 15% reduction in fuel requirements by the use of a solar collector the size of the regular barn roof.

Farm Structures

Major emphasis was given to planning and development of swine and poultry housing systems, waste management and the revision of the Farm Service Buildings and Equipment Notebook.

Swine Housing. The housing systems under study continued to be well received by swine producers with millions of dollars being invested in new construction. Circular 481, Ventilation of Swine Buildings, is being printed. This circular details ventilation procedures for all types of swine buildings and places heavy emphasis on the widely acclaimed North Carolina Under Slat Ventilation System. ASAE paper 73-4511 presented at the winter meeting recorded the success of controlled environment in facilities for the breeding herd. One new building plan, No. 530, Sow Gestation House, was added to the plan service.

Poultry Housing. The second Poultry Housing Environmental Seminar was held in Greensboro, October 10, 1973, with over 125 in attendance. Industry supports this effort by their attendance and subsequent interest in another seminar scheduled for October 9, 1974.

Major emphasis has been directed to structurally stable poultry housing and

control of the environment. An article, Recommendations for Preventing Structural Weaknesses in Poultry Houses, was published in Poultry Digest in January 1974. Two presentations were given at the Housing Seminar. This specialist was an invited panelist to discuss the role of the environment in egg production at the Southeastern International Poultry convention in January 1974.

Cooperative efforts with research personnel enhance our opportunities. Efforts to date show significant potential for improved housing through better bird performance and fuel savings.

Miscellaneous. The Farm Service Buildings and Equipment Notebook was revised and sent to each county office. Also copies were made available to each FHA office and each Vocational Agriculture department.

Even though major emphasis is placed on the three previously discussed activity areas, this specialist does cooperate to the extent possible with other subject matter disciplines with subjects ranging from rabbit housing to root cellar ventilation.

Agricultural Waste Management

The major thrust of the agricultural waste management activities has been to keep producers updated on the current regulatory criteria for animal waste management and to implement research findings to provide practical solutions for acceptable waste management for individual producers. In-service training sessions on animal waste management were held in each extension district to review current and pending regulatory criteria and demonstrate the application and use of the animal waste management alternative bulletins for swine, poultry, dairy, and beef animals. These sessions were conducted by specialists in Biological and Agricultural Engineering, Soil Science, and Economics to provide interdisciplinary expertise for consideration and evaluation of the total production-waste management system design, operation,

and economics. These sessions were attended by extension personnel from each county and representatives from FHA, county and state board of health, state and regional offices of the North Carolina Water Quality Division, and SCS. The highest attendance of about 100 was in the western district where the regional SCS meeting was held in conjunction with the animal waste management in-service training session. These meetings along with the publications and individual contacts have had a positive educational impact.

Extension Leaflet 191, "Regulatory Criteria for Animal Waste Management," was prepared to critique the final effluent guidelines and limitations for the feedlot industry promulgated by EPA and published in the February 14, 1974, Federal Register. This leaflet along with permit information for the National Pollutant Discharge Elimination System (NPDES) has been distributed to all county extension chairmen and other appropriate agencies and personnel.

A workshop on the land disposal of wastewaters was conducted in association with the Water Resources Research Institute to acquaint officials of the North Carolina Department of Natural and Economic Resources, Office of Water and Air Resources, with the current state-of-the-art of technical and economic considerations for land disposal systems. Extension specialists from the Departments of Biological and Agricultural Engineering, Soil Science, and Economics participated in this program.

Supplemental research grants for work on agricultural waste management have been awarded by the Environmental Protection Agency for work on (1) swine waste state-of-the-art and runoff research and (2) pollution from rural land runoff. These studies will direct attention to non-point source discharges from agricultural lands and areas used for the terminal application of animal waste which is currently gaining increased attention since regulations on point source discharges have been finalized. It is anticipated that these research projects will accrue information to better

assess the magnitude of waste inputs or potential pollution associated with non-point source rainfall runoff from agricultural lands to more competently direct regulatory direction and decisions. Cost benefit considerations of controlling, restricting, or completely treating runoff from agricultural lands will play a major role in the development of final conclusions and recommendations.

Research results on unit processes and systems for agricultural waste management have been implemented in the field to help producers upgrade existing systems or secure permit approval for new treatment systems. Although the research on methane generation from swine waste with a solar reactor has gained national attention, this work is not to the point that practical recommendations can be made and systems designed for actual units. However, a complete waste management system was designed and installed for a swine producer whose single unaerated lagoon was odorous and overflowing into a creek that lead to a recreational lake. This total waste management system consists of an aerated lagoon followed by the original unaerated lagoon with excess water being irrigated to land. In addition, the irrigation system conveys wastewater to an overland flow treatment plot and also to the underfloor manure storage pits for precharge and positive cleaning after pit dumping. Waste treatment systems have also been designed for a hatchery and packing house which consist of pretreatment, solids or grease removal, followed by an aerated unit and a storage pond with excess water being irrigated to combined fescue and Coastal Bermuda grass pastures.

Animal producers whose waste treatment systems do not involve a point source discharge are not required to obtain a permit in North Carolina, but industries such as hatcheries or packing houses must obtain a permit regardless of the waste treatment strategy. Therefore, considerable effort continues to be directed to working with regulatory agencies to clarify particulars required for the design, construction,

and operation of a waste treatment system that meets federal criteria and complies with requirements for a state permit. The demonstration waste treatment systems being developed in concert with extension assistance will be monitored to evaluate effectiveness so that this actual performance information can be used to determine the validity of current design strategies and thus lead to more routine design and permitting in the future.

Field Crops

The major emphasis was placed on chemical application equipment, grain drying, curing peanuts, and storage of grain and peanuts.

Forty-one extension agents from across the state received extensive training in agricultural chemicals and chemical application, and these agents conducted training schools for dealers and applicators who must be licensed under the North Carolina Pesticide Act. The pesticide training manual was completed for this training and has received wide distribution. The extension agricultural engineer prepared the equipment section and the calibration section of the manual, and conducted the agent training in the machinery and calibration areas. A special school was also conducted for aerial applicators. An extension folder was prepared on sprayer calibration for use out in the field.

Since peanuts are all mechanically harvested and cured, the marketing time has been shortened. This along with marketing program changes has created a marketing problem during the harvesting season. Alternative ways to store the peanuts on the farm have been studied, along with a continuing program on quality peanut curing.

An extension bulletin was prepared on grain drying and is now in press. Grain drying is rapidly expanding in North Carolina, and extensive extension work in this area is continuing.

Power Machinery

A tractor pulling contest was conducted at the North Carolina State Fair and was a great success. The extension agricultural engineer is continuing to serve as co-chairman of this event, and plans have been made for another pulling contest.

4-H

4-H work received a major emphasis this year. A series of one-day training schools for extension agents was conducted in each district on energy conservation. One of the 4-H electric project manuals was also revised to include energy conservation.

The 27th 4-H Electric Congress was conducted at Durham with approximately 180 boys and girls and 75 adults attending. The Electric Congress is sponsored by the electric companies in North Carolina and is an award for work in the 4-H Electric Project. The program consists of an education program, tours, recreation, and presentation of awards.

4-H electric demonstration district contests were conducted in each extension district with a State Demonstration Contest during 4-H Congress.

An Auto Skill Driving Contest was also conducted during 4-H Congress, and a regional skill driving contest was conducted in North Carolina for the southern states by the extension agricultural engineer and the 4-H specialist.

Additional funding was secured for the 4-H petroleum power program to allow expansion of the small engines demonstration statewide contest.

Three new units on safety dealing with power tools, lawn and garden equipment, and medicine and household chemicals were submitted for review pursuant to publication as 4-H program guides.

Safety

Safety in agricultural operations was given considerable attention in 1974. An Extension Safety Coordinating Committee was formed, with BAE specialist as chairman of the OSHA Subcommittee. The takeover of the OSHA administration by the North Carolina Department of Labor, OSHA Division, brought about the need for educational work relative to OSHA in agriculture, in which Extension cooperated with NCDL. New agricultural standards on roll over protective structures for tractors and agricultural machine guarding were proposed by the Federal OSHA Standards Office, and Extension efforts were brought to bear on modifying certain provisions of these standards before they were implemented, and informing agricultural interests of the proposed standards and their implications. General safety educational efforts continued at an accelerated pace.