

WORKSHOP  
ON  
WATER RESOURCE PROBLEMS AND RESEARCH NEEDS  
RELATED TO AGRICULTURE  
IN THE  
COASTAL PLAINS OF NORTH CAROLINA

Kinston, North Carolina

March 14, 1969

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PROGRAM

- 8:30 a.m. "Seminar Objectives and Procedures"..... Dr. George J. Kriz
- 8:45 a.m. "Agriculture and the Water Environment..Dr. George W. Smith
- 9:05 a.m. Workshop I - Land Drainage  
 Preliminary Comments .....Dr. George J. Kriz  
 Group will break up into four sessions  
 each with discussion leader & recorder.
- 10:10 a.m. Workshop summaries by recorders
- 10:25 a.m. Coffee Break
- 10:40 a.m. Workshop II - Irrigation  
 Preliminary Comments ..... Mr. Ronald Sneed  
 Group will be redistributed into four  
 sessions with new discussion leaders  
 and recorders.
- 11:45 a.m. Workshop summaries by recorders
- 12:00 noon GROUP LUNCHEON
- 1:00 p.m. Workshop III - Agricultural Chemicals  
 Preliminary Comments ..... Dr. T. J. Sheets  
 Group will be redistributed into four  
 sessions with new discussion leaders  
 and recorders.
- 2:05 p.m. Workshop summaries by recorders
- 2:20 p.m. Coffee Break
- 2:35 p.m. Workshop IV - Animal and Human Wastes and  
 Farm Water Supplies  
 Preliminary Comments ..... Mr. D. H. Howells  
 Group will be redistributed into four  
 sessions with new discussion leaders  
 and recorders
- 3:40 p.m. Workshop summaries by recorders
- 3:55 p.m. Wrap-up..... Mr. D. H. Howells  
 Discussion
- 4:30 p.m. Adjournment

## INTRODUCTION

The objectives of this workshop were to:

explore and characterize problems associated with

land drainage,

irrigation,

agricultural chemicals,

animal and human wastes, and

farm water supplies;

identify and define specific research needs directed to recognized problems; and

suggest priorities among identified research needs.

Participants included University research and extension staff, representatives of state and federal agencies and private industry, county extension chairmen and farmers. Their fields of interest encompassed agriculture, forestry, planning, water resource management, public health and conservation.

While the initial workshop directed its attention to the Coastal Region, this report is generally applicable to the state as a whole. Copies of the report draft were circulated to all County Extension Chairmen throughout the state. Comments were received from 13 additional counties in the Coastal Region, 16 in the Piedmont and 6 in the Mountain Region, and are summarized in this report. There was general agreement with the initial report except for minor emphasis on drainage problems outside the Coastal Region.

Each participant was asked to assign a numerical priority to the research needs identified during the workshop. Those with an average in excess of 2.5 on the 1 to 5 scale were dropped and the remaining needs listed in order of priority. Additional suggestions concerning research

needs were added during review of the draft and these were listed separately.

This report will be used by the Institute as a guide to the development of its research program in the field of agricultural water use. Its limitations are recognized, however, and every encouragement is given to the flow of new ideas of promise which escaped recognition at this time.

David H. Howells  
Director

SUMMARY

## I. LAND DRAINAGE

In the Coastal Plains of North Carolina there are about three and one-half million acres of crop land, 400,000 acres of pasture and about eight million acres of forest and woodland. Of the total, about three million acres of poorly drained mineral and organic soils lie in the lower Coastal Plains. These areas have a common relationship in that they are flat (less than two percent slope) and generally are high in organic matter.

Shallow muck and peat soils make up about one million acres of the Coastal Plains. The organic soils formed from the cypress swamps contain extensive amounts of buried undercomposed wood. If the organic soils are adequately drained, there is the danger of subsidence and destruction by fire. In addition, the physical properties of the soils can change quite drastically upon drainage and may become unfit for cultivation.

The total drainage accomplished to date in the Coastal Plains is as follows:

1. 26,000 miles of farm channels at a cost of \$27 million
2. 545 miles of PL 556 channels at a cost of \$1.8 million
3. 10,400 miles of farm tile at a cost of \$25 million.

Maintenance of farm channels is an essential but often neglected part of drainage. If maintenance is not routinely performed, the cost of channel cleanout can equal the cost of initial construction.

### A. Problems associated with underdrainage and overdrainage:

#### Soils

Many drainage systems are installed before considering the suitability for drainage, the adverse effects, or the optimal water-table depth for a given soil type.

Subsidence, oxidation, and difficulty in rewetting the organic soils can occur because of improper water management.

#### Research Needs

1. Better understanding of the downward and lateral movement of water through soils by soil type.
2. Information on conjunctive use of surface and subsurface drainage systems to minimize drainage costs.
3. Field techniques for rapidly determining soil drainage characteristics, especially the horizontal and vertical hydraulic conductivities.
4. Information on optimal depths of water tables in organic soils to maximize crop production with minimal subsidence and soil loss.

#### Agricultural Production

Inadequate water control presently limits optimum crop production in the Coastal Plains. Generally, underdrainage, resulting from improper drainage systems, is a more critical problem than overdrainage.

Very little attention has been given to alternative agricultural crop and fiber production that is more suitable to the existing water and soil conditions and less demanding as to drainage requirements.

#### Research Needs

1. Information on optimal depths of water tables in organic and inorganic soils for maximal crop production.
2. Alternative uses of organic soils for fiber production and other needs.

#### Fish and Wildlife

Wetlands important to fish and wildlife are being drained in the absence of overall planning necessary to assure protection of fish and wildlife habitat.

Drainage channels can be detrimental to fishlife. Overdrainage destroys wetland habitat with adverse effects on water fowl and other species.

No attention has been given to the effects of drainage waters from pocosins and related high-organic soils on fish and wildlife in receiving waters.

Questions have been raised as to the effect of land drainage in coastal areas on the fresh water-salt water balance.

#### Research Needs

1. Effects of Coastal Plains drainage on fish and wildlife habitat including both land areas and species distribution in the context of the total wetland resource available for fish and wildlife propagation.
2. Effects of drainage on the quality of receiving waters and related fish and wildlife populations.

Note: The emphasis on research needs should not cloud the fundamental need for overall land-wateruse planning, which is a matter for policy and administrative decision by state action agencies.

#### Forestry

Drainage has a marked effect on tree species including both germination and growth.

The optimum water level for forest production is unknown.

The drainage of wetlands essential to hardwoods is steadily decreasing the land available for this important forest resource.

#### Research Needs

1. Information on optimal water levels for forest production.
2. Effects of Coastal Plains drainage on forest hardwood production in the context of the total land area available for this purpose.

3. Additional information concerning differences in drainage response of conifer species versus the hardwoods.

#### Ground Water Recharge

Overdrainage reduces ground-water levels and is assumed to influence ground-water recharge. The drainage of recharge areas could have a marked effect on the ultimate ground water supply dependent upon these source areas. Knowledge of the Coastal Plains geology and the groundwater-surface-water systems is not sufficient to define causal relationships at the present time.

#### Research Needs

1. Better understanding of Coastal Plains geology as related to ground-water supplies.
  2. Physical description of the surfacewater-groundwater systems of the Coastal Plains and their dependence upon drainage areas as sources of supply.
  3. Importance of pocosins and bays as recharge areas.
- B. Balance between drainage for agricultural production, soil conservation ground-water recharge, forestry, fish and wildlife:

Present drainage practice in the Coastal Plains is largely oriented toward the needs of agriculture with only limited opportunity for consideration of the effects of drainage on forestry, fish and wildlife, and recreation. By and large, no institutional means exist whereby conflicting interests can be resolved in an optimal economic and social sense. Continuing effort should be made to provide opportunity for groups interested in each aspect of drainage to speak out with the objective of reaching mutually satisfactory solutions. All groups should be represented on such agencies as the Coastal Plains Regional Planning Commission. More comprehensive planning involving all interests affected by drainage should

be encouraged to assure that the needs for forestry, fish and wildlife, and recreation will not be overlooked.

#### Research Needs

1. Economic evaluation to determine the relative values of wetlands for swamp hardwoods, fish and wildlife, recreation and additional crop production.
2. Study of land-use trends as influenced by present drainage practice to determine the probable ultimate land-use pattern and its significance to Coastal Plains development objectives.
3. Institutional means to assure comprehensive planning for the optimal use of water and land resources in the Coastal Plains.

#### C. Alternatives to present drainage practice:

Current drainage practice, as with all of man's activities, tends to follow past precedents and to avoid critical review of alternative courses of action. Many of the present drainage projects have rather limited objectives, e.g., they are crop production, drainage, or irrigation oriented and do not fully consider the total land-water system involved. Considerable interest was shown in "water management" systems which could meet a multiplicity of needs and avoid many of the conflicts inherent in single-purpose drainage projects.

#### Research Needs

1. Areawide water management systems integrating drainage, irrigation, fish and wildlife, recreation, and other water uses.
2. Use of excess water for ground-water recharge, storage for irrigation, and other purposes.
3. Integrated use of land forming and water management for improved crop-production systems.

4. Critical assessment of alternative uses of wetlands from standpoint of environmental adaptation rather than transformation.

#### D. Drainage Criteria

Drainage criteria are deficient for both organic and mineral soils. Wetland hydrology in the Coastal Plains needs additional study and refinement.

#### Research Needs

1. Better understanding of the rise and fall of the water table.
2. Improved drainage criteria for organic and mineral soils.
3. Effects of land forming on drainage criteria.
4. Simple field procedures to determine the depth and spacing of tile and open ditches.

## II. IRRIGATION

Although eastern North Carolina has an annual average rainfall of more than forty-five inches, dry periods do occur. Thus, irrigation must become an essential part of any program for optimum crop production.

Irrigation is normally considered to be supplemental to rainfall. It might be more appropriate, however, to view rainfall as supplemental to irrigation. In the latter sense water is applied to a crop when the soil reaches some predetermined moisture level. In order to practice this type of irrigation, it is essential that surface drainage systems be designed to handle any excess rain that falls at any time, especially immediately after irrigation has taken place.

A recent study of corn production research plots at agricultural experiment stations in the Coastal Plains indicated that 70 percent of the variation in crop yield (0 - 149 bushels per acre) could be accounted for by drought or inadequate soil moisture. In 1968, many tobacco farmers experienced a 20 percent improvement in tobacco quality with irrigation. Peanut yields were increased 1500 lbs. per acre with irrigation. In the absence of irrigation, however, soybeans completely failed in some areas; fall pickling cucumbers failed and peppers dehydrated and rotted in the field. It is estimated that North Carolina farmers experienced a \$143 million loss in 1968 due to drought.

Irrigated acreage in the Coastal Plains has grown and paid dividends despite poor irrigation practice on the part of many farmers who often wait until the crop is suffering before irrigating. Despite such obstacles, irrigated acreage is expected to increase in the future. The traditional hand-move equipment will be replaced by laborless irrigation equipment such as mechanical move, solid set or permanent systems. More acres of traditionally non-irrigated crops such as corn, cotton, peanuts, soybeans and certain truck crops will be irrigated.

Growers will have such large investments in these crops that they cannot afford the financial risk of deficit soil moisture conditions.

Irrigation is expected to become a production tool as well as insurance against dry weather. Sprinkler irrigation equipment will be used for more purposes such as frost and freeze protection, crop cooling, distributing waste effluent from processing plants, cooling buildings, and spreading liquid manure. A sprinkler system in California, for instance, has been designed for the control of heat, frost and humidity, and the application of fertilizers, insecticides and gypsum, and controlling soil moisture. With all its versatility, it reduces labor, minimizes maintenance, cuts the fertilizer bill in half, and doubles production.

There is need for better reporting on land under irrigation and present irrigation practice including weather prediction and related decisions on irrigation. Very little information is available on existing or potential irrigation in the Coastal Plains of North Carolina.

Individual farmers normally use irrigation as a last resort and without a preplanned program. Because of costs, irrigation is presently restricted to high-valued crops. Current irrigation criteria are based more on value of crop than cost of production. There is no satisfactory basis at the present time for the projection of future irrigation water demand.

Principal sources of water for irrigation in the Coastal Plains are farm ponds and dug irrigation pits. Groundwater will be used increasingly in the future. Numerous farmers ran short of irrigation water in 1968. It is estimated that in the past two decades irrigation has returned North Carolina farmers more than \$100 million. With better use of equipment the return might have been doubled. Sprinkler irrigation equipment can now be used for spreading wastes, fertilizer

and pesticides; frost and freeze protection; crop cooling; as well as for applying irrigation water. Principal crops now being irrigated are tobacco, vegetables, small fruits and nursery stock. Irrigation as a part of a total water management program is considered to be the key to agricultural progress in the Coastal Plains of North Carolina.

#### Research Needs

1. Estimation of future irrigation water demand in light of present practice, most probable type of agricultural development, technological change, competing demands, increasing efficiency of use, and the total available water supply.
2. Study of present irrigation demand including location, area and crops irrigated, frequency and amounts of water used, and criteria used as a basis for decision to irrigate.
3. Evaluation of shallow groundwater supplies as a source of water for irrigation and the effect of increasing use of this source on the recharge of deeper aquifers.
4. Improved surface and subsurface irrigation criteria and techniques with and without land forming.
5. Criteria for timing and amounts of irrigation water required for various crops and soil conditions.
6. Reduction in labor requirements of irrigation systems through mechanization, automation, etc.

### III. AGRICULTURAL CHEMICALS

Agricultural chemicals are essential to the production of corn, cotton, tobacco, soybeans, peanuts and other crops in the Coastal Plains. The importance of these crops to the agricultural economy of the region and as potential sources of pollution from pesticides and fertilizer nutrients in land runoff is shown by the following crop acreages (1966 data):

Corn .....	1,022,500	acres
Soybeans .....	683,500	"
Tobacco .....	262,350	"
Peanuts .....	166,395	"
Cotton .....	104,670	"
Wheat .....	51,150	"

#### A. Pesticides

Current data demonstrate the existence of pesticides nearly everywhere. It is generally assumed they enter the water environment from overland flow, though some data suggest movement through the soil profile. There is little information available on the mechanisms of pesticide transport as related to adsorption, soil properties and climate. Transport through the ecological systems and biological accumulation has been demonstrated.

Pesticides exert their effects through death, reproductive impairment, disruption of species balance, and behavioral alteration. The overall effect, especially of long-term exposure to low concentrations, has not been determined and cannot be predicted.

Pesticides are essential to Coastal Plains agriculture. However, there are hazards to the environment that arise from pesticide use, and these must be recognized. Adverse effects are generally noted through lethal effects in the form of dramatic episodes such as the massive fish kill\* on

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\*Result of careless disposal by supplier and not agricultural use.

the N. E. Cape Fear River last year. The ecological effects on normal insect populations and sublethal effects on fish and wildlife foodchain organisms are much more subtle and poorly understood. Knowledge concerning human exposure to subacute levels and the incidence of clinical and subclinical effects are likewise very incomplete.

Methods of application to crops are not developed sufficiently to assure accurate placement and retention on the site of application. This is particularly true for applications by aircraft. Instructions as to choice of pesticides and the amounts and timing of application are not always followed. There are continuing problems arising from the improper disposal of pesticide containers and from haphazard preparation and clean-up procedures. There is great need for repetitive training efforts through the Extension Service and other means to encourage responsible use and minimize hazards to persons working with these materials and to the environment at large. Increased awareness of punitive damages imposed by the State Board of Water and Air Resources for fish kills resulting from improper use of pesticides might be useful. The heterogenous nature of pesticide use in urban areas is such as to create concern over the contribution of urban-land runoff to pesticides in the environment. Use in urban areas, in forestry, and in mosquito control must be considered in conjunction with agricultural use for a balanced assessment of the problem.

The introduction of high potency, low-volume pesticides multiplies the potential for adverse side effects and underscores the importance of proper pesticide application and handling procedures.

Present monitoring for pesticides in the environment is completely inadequate. Routine biological, water and sediment samples in conformance with established patterns of pesticide use should be taken and analyzed in such number and frequency to disclose pesticide contamination of the environment.

### Research Needs

1. Extent of pollution of ground and surface waters by pesticides used in agriculture, forestry, and mosquito control.
2. Tracing of pesticide cycling and ultimate fate in the soil and water environments.
3. Continuing research for biological substitutes for chemical pesticides, including predators, enzyme systems, pest diseases, and so forth.
4. Critical review of criteria for the application of pesticides with respect to pollution of ground and surface waters.
5. Determination of the sublethal effects of pesticides on fish and food-chain organisms and fish predators, including reproduction, genetic change, growth, and accumulative effects.
6. Additional information on the interaction of agricultural chemicals in soil and water with regard to toxicity and persistence.
7. Critical review of recommended pesticide application techniques and equipment with respect to pollution of ground and surface waters.
8. Assessment of special problems associated with the use of high potency, low-volume pesticides with respect to effect on aquatic systems.
9. Contribution of urban land runoff to pesticide contamination of ground and surface waters.

### B. Fertilizers

Eutrophication is generally attributed to excessive amounts of nitrogen, phosphorus, and possibly micro nutrients. This is becoming more of a problem in North Carolina's lakes, streams and estuaries. It is a matter of immediate concern in the Pamlico Sound as a result of phosphorus buildups from phosphate mining and processing operations.

Municipal and industrial wastes are known to be important sources of

these two elements. Agricultural fertilizers are recognized as a probable contributing sources of nitrogen and possible source of phosphorus. Accurate information is not available, however, on the amounts contributed or the conditions under which these substances reach ground and surface waters. Overfertilization is a possible causative factor.

#### Research Needs

1. Rates of leaching and sediment transport of fertilizer nutrients with regard to soil types, top dressing, fertilizer types and timing of application.
2. Significance of fertilizer loss to ground and surface waters.

#### IV. FARM WASTES AND WATER SUPPLIES

##### A. Animal Wastes

Runoff from agricultural land is alleged to exert an important influence on water quality. However, little factual information has been produced concerning the nature and extent of the problem. The many generalizations being made about agricultural wastes and their importance as pollutants are, to a large extent, dependent upon inferences, supported at best, by very limited field studies. While it seems logical to assume that agricultural wastes are important and must be considered in water quality management, the problem has not been adequately defined.

The most important potential source of pollution from agricultural activities is animal manures. North Carolina is experiencing rapid development in the production of poultry, swine, and beef cattle. Confinement housing now calls for poultry units that will accommodate 100,000 birds with only 64 sq. in. per bird. The swine industry is considering facilities for 3,000 to 10,000 animals per year with minimal area per animal. Feed lots for finishing thousands of beef cattle provide no more than 100 sq. ft. per animal. Animal population in North Carolina is approximately as follows:

Dairy .....	340,000
Beef cattle ....	631,000
Swine .....	1,273,000
Broiler .....	245,000,000
Laying hens ....	14,000,000
Turkeys .....	7,000,000

The potential significance of animal waste as water pollutants is apparent when they are viewed in terms of human equivalents: Cow = 16; swine = 2; poultry = 1/7. In North Carolina the wastes from farm animals are equivalent to wastes from a human population of more than fifteen million. For

the nation as a whole, farm animals produce ten times as much waste as the human population. The extent to which such wastes are retained on the land or reach water courses is not understood. It is clear, however, that intensified animal production produces large quantities of manure which must be disposed of under conditions approximating municipal and industrial waste problems.

Swine wastes are normally discharged to lagoons for some degree of anaerobic treatment, directly discharged to water courses or spread over the land. Poultry, turkey and livestock wastes are stored for various periods of time and spread over the land. Fly breeding is a recognized problem, but one which good sanitation practice can adequately control. The amounts of these wastes reaching ground and surface waters and their effects on water quality have not been investigated except for one current study dealing with swine wastes. It is a problem of mounting potential significance which should receive immediate attention.

#### Research Needs

1. Extent and nature of surface and ground water pollution from animal wastes.
2. Characterization of animal wastes in terms of pollution potential.
3. Improved methods of waste storage, treatment and disposal.

#### B. Human Wastes

A recent study by the State Board of Health disclosed that an estimated 80 percent of the rural population of a Coastal Plains county was served by inadequate sewage disposal systems. Intestinal parasite infestation as high as 35 percent of the total population was found in one county. Poor sewage disposal and water supply systems generally go hand in hand. Poverty, ignorance and lack of education are causes. The solution to this problem

lies in education, more vigorous leadership by local authorities and possibly financial assistance--not additional research.

### C. Farm Water Supplies

Information concerning the bacteriological and chemical quality of farm water supplies in the Coastal Plain is sparse. Slime growths sufficient to limit ground water supplies have been reported at a number of locations. Nitrate contamination from animal and human wastes and fertilizer is likely in some areas, but the extent is unknown.

Because of the importance of water quality to human health and possible debility and loss of efficiency and well being at subtoxic levels, it is important to know more about the quality of water currently consumed by the rural population.

#### Research Needs

1. Contamination of farm water supplies by animal and human wastes together with necessary remedial actions.
2. Relationship of the quality of farm water supplies to human and animal health.

COMMENTS

BY

NON-PARTICIPATING COUNTY EXTENSION CHAIRMEN

IN THE

COASTAL, PIEDMONT AND MOUNTAIN REGIONS

Coastal Region

## Camden County

More groundwater studies are needed.

Interest in irrigation from rivers and information on salt content would be useful.

Hopeful of industrial development. Recent effort to locate major cannery with 3 million gal./day water demand left local people surprised at volume of water required.

## Craven County

Water resource problems of the Coastal Plain correctly identified.

## Cumberland County

Problems are common to Cumberland County.

Most important areas are drainage and irrigation.

Need to study effects of agricultural chemicals and farm wastes on water supplies.

## Greene County

A local conference was held to evaluate the Workshop Summary. Participants agreed that problems and needs were adequately identified and covered Greene County very well.

## Hyde County

Summary correctly identifies the problems of the Coastal Plain and Hyde County.

Land drainage involving high organic soils is considered to be most important locally.

## Onslow County

No problems not cover in report.

## Pender County

Industrial pollution affects farm production and recreation of rural people and might have been included.

#### Richmond County

Land drainage not a problem with most soil types in the sandhills.

Primary problem is lack of moisture during certain periods of the year. Need more impoundments and irrigation supply lines to farm lands so that more cropland can be irrigated.

There is some possibility that ground water might be the best source in some areas of the county. After discussion with geologists and others familiar with ground water supplies, many persons feel that surplus water is their best bet as a source of water for irrigation, recreation, industry and other needs.

#### Robeson County

County conditions and needs are very similar to those discussed in Summary and recommendations are applicable.

#### Sampson County

Summary is indicative of water resource problems and research needs in Sampson County.

#### Tyrrell County

The research problems related to land drainage are excellent. The idea of designing drainage systems with farm operation, forestry, and fish and wildlife all in mind is appealing. Overdrainage needs consideration and could be delineated for special crops. The effects of land forming on drainage criteria has special need. Studies to determine the depth and spacing of tile and open ditches has a great deal of merit.

The evaluation of shallow ground water supplies for irrigation and the effect of increasing use of this source on the recharge of deeper aquifers is a real need.

Improved surface and subsurface irrigation criteria and techniques with and without land forming is an interesting subject for study.

Observations of the manner in which farmers handle pesticides underscores the importance of more education and study.

#### Washington County

The report appears to be very comprehensive as to the present situation and water resource needs in this area. No additional suggestions.

## Wayne County

The program was very worthwhile and involved the right organizations. Several points that came to mind in reviewing the summary are:

1. The need for some group to promote a more workable understanding and pooling of ideas related to watershed projects between the conservation and wildlife interests and the agricultural land owners. This may be holding up development in some watersheds.
2. In the Coastal Plains fishing in the streams is big business. Research on means to increase the fish population and growth is needed. This should include the effects of sediment and aquatic plants.
3. There is need for information on the real progress being made in handling wastes and water pollution. This should include identification of the greatest offenders.
4. A lot of joint work between cities, towns, county commissioners and agriculture and woodland owners is needed. Wayne County has 4 small watersheds in which work is underway plus 3 others on the county line that affect Wayne County. Work on these projects has shown lack of knowledge concerning the following:
  - a. Vast areas of the County are producing only a small part of their potential of forest products, wildlife and agricultural products. The main limiting factors are flooding and poor drainage.
  - b. Landowners and public officials do not fully appreciate the vast potential for development of recreation, forestry, agricultural and industrial growth.

It is hoped that more meetings like this one can be held for leaders in the counties.

## Piedmont Region

### Alamance County

The Alamance County five-year plan, "Target Two," two of the main goals are:

1. Lack of knowledge and understanding in developing a sanitary water supply to meet present and future needs.
2. Lack of knowledge and understanding of land use planning, its needs and alternatives.

### Caswell County

There is very great need for the type of information covered in the workshop adapted to Caswell County.

### Chatham County

Most of the topics are of concern in Chatham County, particularly irrigation, agricultural chemicals, animal and human wastes, and farm water supplies.

### Cleveland County

Cleveland County, like many other counties in the Piedmont, is growing industrially and, at the same time is maintaining a high level of agricultural activity. Cotton is still an important crop, involving the use of high rates of fertilizer and relatively large amounts of pesticides. The livestock phase is increasing annually, and the trend toward more apple production and vegetable production is up.

The 1966 Conservation Needs Inventory Records show 1,358 acres of Class 2-W, 3-W, and 4-W land as needing drainage. Percentagewise, this is not a serious problem in Cleveland County.

A large number of the creeks and First Broad River are polluted with domestic, industrial and municipal waste and spoils from mining operations. The industrial waste, mostly textiles, contains a heavy chemical content. The three larger towns (Shelby, Kings Mountain and Boiling Springs) have or are now in the process of installing modern sewage disposal plants. The smaller towns or villages, such as Fallston, Lawndale, Earl, Grover, Lattimore, do not have municipal sewage disposal systems.

Many of the people who once lived and worked on the farm are now working in industry, but prefer to live in the rural area; consequently, rural non-farm communities are developing. Most of these with wells, septic tanks - many of which are already faced with problems of pollution.

With the expansion of vegetable and fruit production, irrigation will become more of a necessity. One of the problems will be finding an adequate amount of water that is free of contamination. The use of agricultural chemicals is necessary in the production of all crops. The use of these chemicals will probably become greater instead of lesser. Research is needed to determine the effect of these chemicals on the water supply and ways must be found for the safe, continued use of these chemicals. Cleveland County has, at the present time, a County Planning Board which is involved in water use and zoning. Information of actual and proven nature is needed to provide this Board with the proper information in making wise and consistent decisions.

### Davidson County

Practically all farmers and others in Davidson who want water can be served by one of the water systems currently being installed. The source is the Yadkin River.

Land drainage is not a problem. More irrigation systems for vegetable growers and tobacco farmers could be used. Useful information on this was provided by the Duke Power Company at its recent Workshop on Materials Handling.

Many questions are asked regarding agricultural chemicals and more timely information could be used.

The Duke Power Workshop provided a good deal of information about animal wastes, but more can be used. There seems to be so many ideas and systems that no one knows the exact amount of space or density to allow for animal waste. There needs to be some usable research as a basis for making recommendations. For instance, recommendations for swine lagoons range all the way from 60 to 240 cubic feet per hog. With help from the County Health Department sufficient information on human waste disposal is available.

Much information on pumps and water systems was provided at the Duke Power Workshop and this appears to be sufficient.

### Durham County

Water resources in Durham County may be critical unless some advance planning is carried out. The Durham City Water Resources Department has done some planning in this area. The Research Triangle planners have completed some projections tied in with population growth. There should be concern for the large and rapid population growth as well as the increase in livestock population in the area.

### Gaston County

Water resource problems are somewhat different in Piedmont North Carolina--no specific comments as to the nature of the differences.

### Granville County

Granville County has some 12,000 acres of tobacco and other crops and the need for ample water for irrigation is evident. It has many of the same problems as the Coastal Plains with the exception of drainage which is not a major problem in this area.

One matter of increasing importance is the problem with new home owners in rural areas being able to obtain water at any depth. Often three or four wells must be drilled and then the owners may not be

satisfied with quality or quantity of water. Increasing numbers of home owners are reporting problems of high mineral contents. Some work needs to be done here both on location of ground water and its mineral content.

#### Mecklenberg County

With the exception of drainage, many of the problems described in the report are present in the Piedmont area. The need for irrigation is even more pronounced. The pesticide problem is not so severe, and fertilizer residues are not generally considered to be excessive.

The potential for pollution from livestock and poultry certainly is increasing. Fly breeding, odors, and waste disposal are acute on some of the farms surrounding the perimeter area of Charlotte. Inadequate sewage disposal of human waste is a well known problem throughout the Piedmont.

#### Orange County

A copy of the recent report of the North Central Piedmont Resource Conservation and Development Project Plan was submitted in lieu of comments. The area served includes: Alamance, Caswell, Chatham, Guilford, Orange and Rockingham. The report summarized findings with regard to water resources as follows:

One of the major problems and project objectives is the development of water resources. Municipalities have been the promoters and developers of most water systems except for about 75 miles of rural water lines in Rockingham County. However, the limited finances of municipalities creates a problem in the extension of water and sewer facilities into rural areas where industry is now prone to locate.

Current daily water use is estimated to be 69 million gallons. With a projected population of 1,367,000 people by the year 2020, and estimated increased daily usage from 127 to 250 gallons per capita, total needs will be about 350 million gallons per day by that time. The present available stored water supply is estimated to be less than 10 billion gallons in the six-county project area. Therefore, it will be necessary to plan for the full development of water resource potentials within the entire region and possible areas beyond. River basins such as the Yadkin, Roanoke, and Neuse may at some future time be considered for additional water.

Another problem has been the lack of regional thinking and planning for water storage, distribution, and quality controls. All governments of the area are faced with the responsibility of finding legal ways to cross territorial boundaries in order to participate in the timely planning, development, and distribution of water so as to adequately serve all interests. Obviously, collective effort is necessary to the development of water supply in the three major watersheds which will satisfy the needs of people and industry as their interest may appear.

The U. S. Department of Agriculture and Department of Army, in cooperation with federal and state agencies, are currently working on a joint study of the Upper Cape Fear River Basin. The findings of this study, expected to be completed in the next year or shortly thereafter, will help direct development of watersheds which can be justified economically. In planning for development of such watersheds, downstream interest will be considered along with those within watershed boundaries. Supporting projects to be evaluated by these agencies are included in this plan.

Problems and opportunities are varied and numerous. However, the development of adequate water supplies and water quality control measures are the most urgent. With the rapidly expanding population and changing land use, time is of the essence, especially in planning for water supply and quality control.

#### Rockingham County

The greatest problems faced in this area are associated with water availability and water contamination, either by agricultural chemicals or improper waste disposal.

#### Rowan County

The County does not share the drainage problems of the Coastal Region. It does have some flooding along stream channels in the bottomland and has a real problem of enough water for municipal, industrial and agricultural uses.

#### Vance County

Vance County is fortunate in having most of Kerr Lake in North Carolina located in this county. Some farmers do irrigate from this source. In addition, a large number of farmers have one or more farm ponds for irrigation, recreation, watering livestock, and other uses.

Insofar as drainage is concerned, much of the land is sloping and is well drained. Terraces have been constructed on most farms to slow down the speed of water and conserve soil.

At times, agricultural chemicals do cause a problem in farm ponds by killing fish.

In some years, extended droughts do occur and farm water supplies are inadequate for some families. Animal and human waste could be a problem on some farms, but this would vary from one family to another.

### Wake County

The County does not have the drainage problems of the Coastal Region. It has similar needs, however, with regard to irrigation. There may be more problems associated with pesticides and animal wastes because of steeper slopes and lower soil permeability. Population projections of 600,000 by the year 2020 indicate that human waste disposal will be an increasing problem.

### Warren County

In general agreement with summary report.

Water is a problem in Warren County every dry year. The County Soil Conservation Service would like to see more done on keeping polluted water on the farms. Sediment from fields and roads is considered to be a problem.

### Yadkin County

Land drainage in Yadkin County is not considered to be a problem, with the exception of a few acres of river bottom or creek bottom land.

Irrigation is extremely important to production of some crops in Yadkin County. Most farms are able to construct farm ponds that are suitable for water storage without too much trouble. There is need for more farm ponds and irrigation systems in the county.

Each year there is an increase in the use of chemicals on the farms in the county and evidence of much need to get information to the farmers on the use of these chemicals. Just about every year there is a sad experience through misuse. With rolling land, stream pollution is possible.

Over the years the water table in the county has lowered. In former years a dug well was adequate. Now most farmers must drill one to deeper areas in order to secure a good supply. There is some interest in the county at present for a countywide water system.

There have been a few complaints in the county from swine operations that allow their waste to empty into a local stream. As swine operations increase this could become a problem.

## Mountain Region

### Jackson County

Of the 20,000 acres of cropland, 5,240 acres are classified as having drainage problems. Most of this land is along creek or river bottoms and much is hard to drain because of wet spots in the fields being lower than the stream. Other problems include small field size and the fact that

drainage must be undertaken by adjoining land owners to complete the job satisfactorily in many cases. Meandering streams contribute to the wet land problem as well as subject the stream side fields to flooding during long periods of heavy rain. Stream channels improvement would serve the purposes of drainage and flood control in many areas.

Irrigation is used extensively by cabbage producers in the Hamburg township of Jackson County. It is looked upon as necessary insurance for a crop although it is not used every season. Farmers in other commodities such as tobacco and vine ripened tomatoes are looking at the prospects of irrigation. Problems concerning irrigation include topography, water source, and cost of equipment. Many farmers are using ponds for trout rearing for summer recreation for tourists, as well as for irrigation. Not enough is being done regarding irrigation.

Large quantities of pesticides are used by Jackson County farmers each year. They are essential to agriculture. More complete information is needed and a larger educational program is needed regarding their use.

There is no information on the effect of fertilizers on mountain streams and lakes from field runoff. It is doubted that fertilizing is heavy enough to do any damage.

Municipal and industrial wastes are a very definite problem. Studies are currently being conducted by the planning board. Sylva and Cullowhee have sewage treatment facilities. The remainder of the county depends on septic tank type of treatment. Water systems outside Sylva, Cullowhee, Webster and Dillsboro are wells and spring fed reservoirs. These are being studied by the Planning Board along with sewage disposal problems.

#### McDowell County

No problems cited

#### Polk County

Problems associated with animal and human wastes are of greatest significance.

Development of water systems for non-agricultural uses seems to be the most serious drawback to resource development in most areas of the county. No system is now available for this purpose.

#### Transylvania County

Transylvania County is in the upper French Broad River Valley and there is need for flood control, channel improvements, and drainage. The Upper French Broad watershed, which consists of five counties, has a proposed plan by the TVA. This project is to cost approximately ninety million dollars, which may or may not become a reality.

Transylvania County is small in farm land area. The majority is covered in forest, which includes a portion of Pisgah National Forest. Due to the high rainfall there is little need for irrigation, with the exception of flowers.

There are some human and animal wastes in the streams, but not in large quantity and some agricultural chemical residue pollution.

#### Wilkes County

Rural water systems are under development. No problems cited.

#### Yancey County

There is much interest in irrigation for tomatoes, strawberries, tobacco and other crops. Stream pollution is a very important problem in this area.

SUPPLEMENTARY SUGGESTIONS

AS TO

RESEARCH NEEDS

## Supplementary Suggestions

as to

## Research Needs

## Land Drainage

## Soils

Physical and chemical changes which occur with change in water regime.  
(Klawitter)

Surface water control and disposal. (McCracken)

Drainage designs on soil types with clay-rich subsoils. (McCracken)

## Fish and Wildlife

Water requirements of fish and wildlife associated with wetlands.  
(Klawitter)

## Drainage criteria

Effects of open ditches on rate of water table drawdown for various  
soil conditions. (Klawitter)

## Irrigation

Feasibility of applying fertilizers and insecticides through irrigation  
systems. (McCracken)

Interaction of irrigation and fertilizer applications, soil fertility,  
etc. (McCracken)

Fertilizer and crop management using rain as supplement to irrigation.

(McCracken)

Economics of various types of irrigation rigs. (McCracken)

## Agricultural chemicals

## Fertilizers

Agriculture vs. other sources in regard to eutrophication. (McCracken)

## Farm water supplies

Rural solid waste disposal. (Fox)

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