ENVIRONMENTAL QUALITY RELATED TO RURAL AREAS[1/]

Cecil H. Wadleigh
Science Advisor
Office of Administrator
Agricultural Research Service
U. S. Department of Agriculture
Beltsville, Maryland

I am indeed honored to be a participant in your conference on the rural economy. I doubt that you could have a more important objective for the health and strength of our Nation.

There is no question that agriculture has a big job to do in curbing or allaying pollutants that may arise from agricultural endeavor.

President Nixon set forth a terse statement of the situation about a year ago:

> "Water pollution has three principal sources: municipal, industrial, and agricultural wastes.****Of these three, the most troublesome to control are those from agricultural sources: animal wastes, eroded soil, fertilizers and pesticides. Effective control will take time, and will require action on many fronts: modified agricultural practices, greater care in the disposal of animal wastes, better soil conservation methods, new kinds of fertilizers, new chemical pesticides, and more widespread use of natural pest control techniques."

All of you are aware that Lake Erie has become "Exhibit A" on what a horrible mess a major lake may become through pollution. The recently issued "Lake Erie Report" states that 50 percent of the pollutants are reaching the lake in runoff from agricultural land.

People ask: If farming and ranching are known to contribute pollutants to our environment such as occurs under excessive runoff, why do we not take steps to stop such pollution?

1/ Editor's note: The author presented this paper illustrated by 215 slides. Yet the clarity of his message remains intact in the written word as presented here.

In meeting this question, we must first consider some of the harsh constraints that weigh upon our stewards of the land. Tweeten points out that 75 percent of our farmers have annual labor incomes of $3,000 or less. Some of them have other sources of income, but their return from farming is strictly at or below the poverty level. Only about 3 percent have good labor incomes--$12,000 plus; and only about 10 percent have $6,500 plus.

Our top producers have an average investment of $300,000 in relation to their average net income of $17,400. The great mass of farmers have very modest investments indeed.

This means that most farmers are too poor to do much on their land that would benefit only offsite conditions and people.

Appalachia, the Ozarks, and the Lake States cut-over areas are particularly afflicted with rural poverty. Annual gross income per farm averages less than $5,000 a year. These marginal farmers often try to eke out a living from impoverished crops on droughty and eroded soils.

Many of the rural homes in Appalachia shelter families who know nothing of the meaning of affluence. This has an effect on the vigor of their social institutions.

The average farm in the South has a relatively low income. Even in the Great Plains, the farms and ranches are not overburdened with prosperity.

Senator Dole has pointed out that the average farm in Kansas had a net income of only $5,260 in 1967, $2,280 of which came from Federal payments. Average income from farming per se was at the poverty level.

If you folks were wearing the shoes of the average Kansas farmer, would you oppose Federal assistance? Would you use available technology to try to boost your income? How much expense would you go to on your land solely for the benefit of urban people miles downstream in the drainage basin?

There is much public concern about urban poverty. There should be. But net income of farm people has always lagged far behind that of non-farm folks. Rural poverty must also have public concern. We just simply must face the fact that there are thousands of farmers who completely lack the means of curbing polluted runoff from their lands--regardless of their good intentions.

What about the top echelon of farmers who are making reasonably good incomes from their farms and are enabled to have nice homesteads?

Executive Magazine published a chart showing that the rate of increase in efficiency of labor use in agriculture was far exceeding the rate of increase in all other phases of the economy. Since this chart shows the average for all farmers, it is obvious that the top producers have attained a truly remarkable rate of increase in efficiency.

In 1950, each farm worker produced enough for 15 persons. Today, he produces enough for about 45 persons. This tremendous average change is due to about 20 percent of our farmers who are most efficient.

This great increase in efficiency in production occurred because of rapid increase in mechanization, more effectively meeting soil fertility needs, much better control of crop pests, and use of better varieties.

Crops are planted with 8 to 12-row equipment precisely dropping superior seed, needed plant nutrients, and pest control chemicals in one fell swoop.

Statistics on our corn crop show the trend. Acreage of corn harvested has dropped from 88 million acres down to about 60.

Total corn production has increased from 2.4 billion bushels in 1940 to nearly 5 billion today.

Average yields per acre have rapidly risen from 27 bushels in 1940 to about 80. The latter part of this curve reflects the maintenance of better soil fertility for our superior hybrids.

And the price to corn purchasers has shown a steady downward trend for the past 30 years.

There are those who believe that intensive agriculture on an extensive scale is adverse to the public interests. We could revert to the agricultural technology of 100 years ago, but urban people would pay dearly for such retrogression.

However, production efficiency from the use of 6- to 12-row equipment has incurred a definite constraint on land treatment practices.

The old system of erosion control using contour terraces with their point rows and meandering terraces is out.

Where mechanical treatments for erosion abatement are necessary, the terraces should be broad based if possible so as to incur minimal interference with machine operations. When parallel strips are used to curb erosion, they must be adjusted to the side of field machinery. On steeper lands, grass backslope terraces may be necessary.

Sediment is by far the major water pollutant in terms of mass. Over four billion tons of sediment move from the land to watercourses in the average year.

The Mississippi River carries 435 million tons of sediment to the Gulf of Mexico during the average year.

We can still see tremendous sediment delivery from the Blacklands of Texas, the Brown Loam soils of Mississippi, the Cross Timbers areas of Oklahoma, and the Palouse region of Eastern Washington. We can see wheat fields in northeastern Montana where erosion has removed all of the topsoil. We find tremendous gullies with high sediment delivery in the deep loess soils of western Iowa, and even in the fertile valleys of California.

Sediment not only fills stream channels and destroys reservoirs, it may also cause fish kills, or make water unattractive for immersion sports or domestic use. It incurs high costs on taxpayers for dredging.

Cooperative research on experimental watersheds at Treynor, Iowa, is comparing the hydrologic effects of unterraced corn fields, terraced corn land, and continuous meadow.

For the past 6 years, surface runoff from the terraced land is only one-sixth of that from the unterraced, but total downstream water yield is not affected by terracing. Surface runoff from grassland is about one-third of that from unterraced corn fields, but total water yield appears to be impaired by grass cover. Terracing or grass cover essentially eliminated sediment delivery, but unterraced corn fields delivered 20 to 30 tons of sediment per acre per year to the water course. These findings are important to downstream water users.

We can still see potatoes planted with rows running down the slope in northern Maine. There is often tremendous soil erosion down the rows, with fertilizer and pesticides going off with the soil. Most potatoes grown in Aroostook County are produced under conservation farming. Pollution from runoff is effectively curbed and the scene is mighty easy on the eyes.

Tobacco is still grown in Maryland with rows running down the slopes. Running water is completely nondiscriminate. It will move whatever is movable, including soil, manure, plant residues, pesticides, plant nutrients, and infectious organisms. Tobacco is also grown under sound soil conservation methods that effectively minimize land runoff and consequent water pollution.

Fifteen years ago, Carroll County, Georgia, was characterized by badly eroded fields and rundown pastures carrying scrub critters. Local citizens initiated a watershed protection program on the Little Tallapoosa River. The impoverished fields were converted into tall fescue or Bermudagrass pastures that produce fat, sleek cattle. Control of pollution from land runoff is maximal.

Some economists find that a farmer cannot afford to install terraces and other mechanical erosion control practices in terms of short-run returns.

Terraces may break and thereby accentuate soil erosion.

There is a rapidly growing use of minimum or zero tillage practices to control soil erosion, avoid soil compaction, and cut down on field operations. Row crops are planted directly into grass sod, heavy grain stubble, and even into corn stubble.

Weeds are controlled by use of herbicides.

Studies at Coshocton, Ohio, show that 99 percent of the sediment delivery observed under conventional practices is eliminated by minimum tillage.

Observations during July 1969, a very wet month, were particularly spectacular. Soil loss was heavy under conventional methods, but minimum tillage provided nearly perfect protection.

Change Rings

Permit me to say a few words about animal wastes. They do at times cause environmental problems. Redolent odors may arise. Production of vermin may be fostered. Water may be polluted.

We Americans are carnivorous.

The average person's dinner plate accounts for 238 pounds of flesh per year. Three-fourths of this consumption is of red meat, and nearly half of the total is beef. Poultry now provides one-fifth of our total meat consumed, while lamb and fish account for a rather small percentage of the total.

We are eating just twice as much beef per capita today as we were 30 years ago. Production of broilers has increased 30-fold since 1935.

Our inventory of beef cattle has been increasing at about twice the rate of our population. Since our numbers of dairy cattle have been decreasing rather markedly during the past 20 years, total cattle population appears to be leveling off at about 110 million.

A big Holstein cow may produce over 100 pounds of fecal wastes a day, along with 20 to 30 pounds of liquid wastes. A little effort with a slide rule will

tell you that a 100-head dairy produces 1,800 tons of wastes a year, exclusive of bedding.

Cattle being fattened in feedlots daily produce between 35 and 60 pounds of fecal wastes and between 18 and 25 pounds of liquids. Beef steers out on the range may produce only 30 pounds of fecal wastes a day, and 15 to 20 pounds of liquids.

Total cattle wastes alone in the U.S. amount to about 1.4 billion tons a year. Wastes from all of our domestic livestock come to 1.6 billion tons; and when bedding, dead carcasses, and the offal of abattoirs are added, the total is close to 2 billion tons a year. Cattle are the main producers. Obviously, large feedlots carrying 50,000 to 100,000 head of cattle produce tremendous masses of material that may pose disposal problems.

There is no feasible way to give this stuff the aroma of Chanel #5.

And so it is that urbanites build homes out in the countryside to enjoy a rural atmosphere and then complain vigorously about some of the atmosphere they receive.

However, we must emphasize that most of the cattle excrement is deposited out on rangelands or pastures. The procedure is no different than that used by wild animals and who would criticize our wild creatures for their natural processes.

Nevertheless, cattle may have a direct effect on water quality.

Many of the fine dairy farms in the Northeast were laid out years ago so that the barnyard would drain directly into a passing stream.

Similarly, feedlots in the Middle West often traversed a stream that would provide good drainage.

Others were located on slopes so that there would be good surface drainage from the lot. The runoff usually went into a stream.

It has been customary for farmers in the Northern states to spread manure during the wintertime, even on top of an accumulation of snow.

This practice does not do much to enhance the natural beauty of the country side; but winter is the time when the demands of other tasks upon the farmer are at a minimum.

If snowmelt comes slowly, no harm is done.

If snowmelt is rapid with the aid of a warm rain, there may be runoff of seriously polluted water from the manured fields. Manuring frozen ground is being banned in some states.

Manure drainage has been blamed for many serious fish kills.

The Federal Water Quality Administration reported that of the eight major fish kills in 1967, three of them were caused by manure drainage.

Studies in Kansas by Smith and Miner show what may happen in a stream receiving drainage from a feedlot. Their studies on the Fox River were made at a point about a mile below a feedlot during November. In 20 hours after a 1-inch storm, the water in the stream one mile below the feedlot contained 90 p.p.m. of BOD and just about 0 p.p.m. of oxygen. Most fish cannot survive if oxygen content of water falls below 4 p.p.m. At the point of sampling, the BOD dissipated rapidly and the oxygen content of the water recovered. Unfortunately, the data did not provide information as to how rapidly these adverse water quality conditions that kill fish moved downstream. We are exceedingly deficient in research that will provide needed information.

If is also important to note that in this study Smith and Miner found the pollution from fecal coliform bacteria rose to a tremendous level 20 hours after the storm and then dissipated rather rapidly. By contrast, the count for fecal streptococcus bacteria rose to an enormous count and continued at that high level of infestation for the duration of the sampling period.

Animal scientists tell us that the average 1,000-pound steer will excrete 110 pounds of N, 22 pounds of P, 125 pounds of K, and 365 pounds of BOD in a year's time.

There are feedlots that stock at the rate of over 400 head per acre. Let us consider a stocking of 200 1,000-pound steers per acre.

Such an acre would receive 11 tons of nitrogen, over 2 tons of P, over 12 tons of K, and about 37 tons of BOD in a year of continuous stocking. This one acre would receive more than its fair share of fertilizing materials.

Organic matter and plant nutrients in runoff water abet the growth of algae and unwanted weeds in lakes.

Consider Lake Mendota near the University of Wisconsin. Many coves have intensive growths of water weeds. A bathing beauty could dive in and come up fully decorated. Samples of the surface water could pass as concentrated sewage.

Research at the University of Wisconsin indicates that spring runoff from barnyards of fields manured on frozen ground contributed to the deterioration of Lake Mendota. The latter practice is being stopped.

Nevertheless, soil conservationists recognize that the place for animal wastes is on the land. This is inherent in sound waste management practice of recycling.

Fields on sloping land that are manured should have grassed waterways. Growing grass removes most of the pollutants in runoff.

Let us consider what is being done in a big livestock operation such as Monfort Feedlot near Greeley, Colorado. Mr. Monfort carries 100,000 head of feeders on 320 acres of land. Wastes are picked up by conventional front-end loaders and applied to some 20,000 acres of ensilage corn grown under contract. The forage is harvested and ensiled in trench silos; and then fed to the cattle along with steam-cooked grain. This is an excellent system of recycling.

Mr. Hansell of Ordnance, Oregon, has a large hog operation involving over 15,000 head. Water flows continuously in gutters through the hog pens and is collected in lagoons. The "hogwash" is sprinkled onto forage land by "raincats" that automatically irrigate 140 acres in one swivel around the pivot. Mr. Hansell produces over 10 tons of alfalfa hay per acre under irrigation with "hogwash." The hay is dried, ground, and fed back to the hogs. It is also an excellent example of recycling.

Each barnyard or feedlot should be equipped with water diversions and lagoons to minimize chances of stream pollution.

If our people demand animal products on the dinner table, then they must also recognize that livestock produce wastes; and a livestock operator cannot pick up and move overnight because some citizen is offended by the redolence of the unavoidable by-products.

Let us consider the use of chemical fertilizers on the land. Some people are alarmed that we are now using 7 million tons of nitrogen and over 2 million tons of phosphorus as chemical fertilizers. One can read statements saying that: "The runoff of water carrying chemical fertilizer from the world's farmlands is converting fresh water bodies into algae laden swamps throughout the world."

Certainly, one can find serious weed growth in the canals of southern Florida,

the coves along the Patuxent River in Maryland,

And in the roadside ditches in Western Minnesota.

One can see such growth in some of Minnesota's wonderful lakes. It is simple to indict agricultural runoff as the cause.

And one can find evidence of high nutrient loss from the land into drainage ditches. Johnston, et al., found high losses of fertilizers into drains of the San Joaquin Valley of California. In one study in which 261 pounds of nitrogen were applied per acre, a loss of 109 pounds was found in the drains. This not only shows poor soil management, it gives rise to alarm over nutrient pollution from farmland.

The Agriculture Research Service is studying runoff and nutrient loss from a 1,000-acre orange grove near Riverside, California. The grove sits on a granite pocket that prevents deep percolation. All excess water goes out through a central gauging station. The water is monitored for dissolved solids. The grower applies 125 pounds of nitrogen per acre per year. During 1966 and 1967, 52 percent of the applied nitrogen went out through the gauging station. The grower did not attain maximum beneficial use of applied nitrogen.

Soil and nutrient losses are being studied on carefully instrumented plots at Morris, Minnesota. The effect of continuous corn is being compared with continuous fallow and a sound system of crop rotation.

Total nutrient losses from the plots were seriously high, especially from the fallow plots. Annual soil losses were very high under fallow and unacceptably high under continuous corn. If we distinguish between nitrogen carried on the soil particles and that in true solution, then we find that 97 percent of the lost nitrogen was carried by sediment delivery. About 92 percent of the lost phosphorus was carried on the eroding soil particles.

Sound soil conservation measures are exceedingly important in curbing delivery of plant nutrients to streams and lakes.

Consider a couple of recently established lakes near Lincoln, Nebraska. The Corps of Engineers completed construction of Stagecoach Lake, CE9, and Wagon Train Lake, CE8, in 1963. When I visited these lakes last summer, Stagecoach was a deplorable mess from the growth of water plants. It contained the greatest expanse of blue-green algae that I have ever seen. Inlets into this

lake pass through large acreages of marshland producing vigorous vegetative growth. As this vegetation dies and rots, it releases all the entities needed for algal growth.

There were no algal scums or other evidences of water vegetation on Wagon Train Lake. An air view showed the water in the lake to be cloudy with dispersed sediment. The water in Wagon Train was reported to carry three times the concentration of soluble phosphorus as did that in Stagecoach.

There are no significant differences in the soils and farming practices in the watersheds of the two lakes.

Let us look at Geological Survey's topographic maps in the areas of the two lakes. The shore of Wagon Train is associated with relatively steep declivities. There are no marshy areas around Wagon Train. By contrast, Stagecoach is associated with rather low declivity along the shore. There are about 175 acres of marshlands contiguous with the lake.

How can any lake avoid eutrophy if it receives a goodly supply of organic matter from rich soil, decaying vegetation, manure, or sewage?

Change Rings

There is another side to the alleged excessive use of chemical fertilizers in the United States. Many people are not aware of the nutrient depletion of our cultivated soils over the last hundred years.

In 1918, C. F. Marbut presented a study of the organic nitrogen content of the virgin soils of the United States. The Corn Belt and Northern Great Plains soils contained an average of 8 tons of organic nitrogen per acre. Contiguous United States had a wealth of nearly 10 billion tons of organic nitrogen in its soils when Europeans first came here.

Professor Hans Jenny of the University of California found that our soils lose about 40 percent of their organic nitrogen over 50 years of cultivation. Haas, et al., found that Chernozem soils in the Northern Great Plains may produce as much as 400 pounds of nitrate nitrogen per acre through mineralization of organic matter. Dr. Stanford has made a careful study of the evidence and concludes that our cultivated soils have lost 1.75 billion tons of organic nitrogen over the past hundred years. Against this loss, we've added a total of 100 million tons of chemical nitrogen fertilizer since we first started using chemical sources of nitrogen. We are still robbing the soil nitrogen bank. Just four of our crops removed 8 million tons of nitrogen from our soils in 1968.

Many of our soils are naturally so deficient in phosphorus that animals eating the forage produced will develop osteomataical diseases. Sheep on range lands in Montana may show these symptoms. Cattle grazing on phosphorus deficient lands give birth to "crooked" calves.

Why do people say that phosphate is "poisoning" our streams when orthophosphate has never poisoned any living thing. Rather, it is just as essential as oxygen to the physiological processes in all living tissue. I refer to the transfer of physiological energy by means of the adenosine diphosphate--adenosine triphosphate system.

How can people, cattle, or sheep build a strong framework without phosphate when it is fundamental to the structure of all animal bones?

I commend to your reading an article by Boyle in a recent issue of Audubon on fish production in the Hudson River. The findings showed that the Middle Hudson is probably the most productive of excellent fish of any body of water extant. Boyle states that the river is so highly productive because it receives a goodly supply of plant nutrients from land runoff and especially from the sewage of Albany and Troy. By contrast, the upper reaches of the Hudson in the Adirondack Conservancy Area are very non-productive of fish because few nutrients enter the stream from the granitic soils. The lower Hudson is a mess.

Runoff from the land may carry pesticides as well as soil, plant nutrients, or infectious organisms.

The Agricultural Research Service and the Maine Agricultural Experiment Station are studying pesticide loss in the runoff from potato plots in Presque Isle, Maine. DDT was not applied during the year of study even though it had been applied previously. The first application of endrin occurred on July 9. Appreciable endrin was in the runoff from the storm of July 13. Following cultivation, there was a marked decrease in the amount of endrin in the runoff for the storm of July 29. DDT was found in every runoff event as would be expected from its known persistence. One gains the same picture when the pesticide loss is calculated in grams per acre rather than parts per billion.

Monitoring studies by ARS show that residual DDT in the soils near Greenville, Mississippi, are fairly well related to the amount that had been previously applied. Of the DDT in the runoff, essentially all of it was absorbed on the sediment particles, and virtually none appeared as a soluble in the water. Control of sediment delivery is fundamental to controlling movement of chlorinated hydrocarbon insecticides.

A nasty problem has arisen on the rangelands of northeastern New Mexico. An outbreak of the rangeland caterpillar is threatening destruction of millions of acres of grasslands. These caterpillars are exceedingly voracious. They will completely denude rangeland. As a consequence the ranchers' source of income is destroyed and the land becomes highly susceptible to erosion. In past years, toxaphene at the rate of 1 pound per acre has been used to destroy the caterpillars. But toxaphene is a potent fish killer. Water users on the Canadian River are vigorously opposing use of toxaphene. Other insecticides have not been found satisfactory.

How does one control an exceedingly destructive insect without jeopardizing water supplies and fish life?

It would be the ultimate desideratum if all noxious insects could be controlled as the screw worm fly was eliminated from Florida where it was incurring terrible destruction on cattle. This fly lays its eggs in open lesions of an animal. The larvae bore in and make a most ugly sight of ulcerous wounds. The larvae can destroy the eyes of a lamb, or bring on the death of a goat. They had a horrendous effect on cattle, especially the calves.

Screw worm flies are peculiar insects in that they mate only once in a life time. If the mating male is sterile, all the eggs will be sterile. Billions of sterile males were produced by treating them with radioactive cobalt. These males were released over the infested areas in Florida and in due course the whole screw worm population was eliminated.

Unfortunately, entomologists have not been able to teach other insects that they should mate only once in a life time.

There is another aspect of insecticide application to the land that needs more consideration. I speak of volatization. When dieldrin was applied to the land at the Coshocton Hydrologic Field Station, much of it could not be accounted for in the soil or the runoff water going off through the gauging station. Dieldrin in the runoff decreased very rapidly with time. Air sampling equipment was also set up in fields that had been treated with dieldrin or heptachlor. Analysis of the air samples revealed that appreciable amounts of these soil insecticides are very volatilizing into the air.

There is no point in smugly smiling and saying that there are no problems in pollution from agricultural endeavor. These problems exist. In most instances, water is the main transporter of sediment, animal waste, fertilizers, and pesticides to places where they are not wanted.

One cannot escape the conclusion that sound and feasible soil conservation measures that minimize runoff and sediment delivery are more essential now than ever.

Every watershed should be completely protected by effective measures of soil conservation.

Theoretically, the tasks of soil conservation and pollution abatement will not be done in these United States until every stream runs clear and uncontaminated.