# ECONOMICS OF SOIL CONSERVATION, RECLAMATION AND REHABILITATION

*– by –*

E. L. Sauer[1]

*Visiting Fulbright Professor, University of the West Indies*

Conservation, the wise use of resources, includes several elements : economical output of goods and services from land and water in accordance with needs ; the particular goods and services that people want ; and a continued flow of products and services indefinitely into the future.

This idea of conservation means that resources should be used — but used for the maximum benefit of man, both now and in the future. The use of land resources must be geared to the demands of consumers in terms of the kinds, amounts, and qualities of goods and services forthcoming from lands. Costs of units of goods and services must be rendered as low as technology and continued productivity will permit.

Land resources include all the attributes that go with a particular space of the earth, i.e., soils, water, climate, vegetation, wild life and location. These resources of land are the natural foundation of the economy. From these are derived food, clothing, shelter, and the raw materials for industry as well as the setting for many recreational activities. Land and water resources are not only essential for life itself, but are necessary for raising standards of living. How well land and water resources are protected, improved and utilised, will have a direct bearing on the future standards of living of individual countries and of the world.

In thinking of conservation, we must consider not only the immediate damage and waste from inadequate conservation measures, but the needs of growing populations and expanding economies. A balanced programme of conservation, including the improvement, wise use, and development of land, water, and related, natural resources is indispensable for maintaining and improving the standard of living of growing populations.

---

[1] Professor, Rural Development Extension, University of Illinois, U.S.A., and Visiting Fulbright Professor, University of the West Indies, St. Augustine, Trinidad.

### *Physical, Economic and Legal Dimensions of Resource Use*

The use of land takes place within three dimensions—physical, economic and legal. Each dimension is interlaced with the other.

The physical dimension is concerned with the capability of the soil in terms of land uses. It deals with kinds of plants; yields of various plants, cultivation methods, applications of fertilisers, water, insecticides, herbicides and the rates of applying them.

It also includes effects of various practices, such as contouring, strip-cropping, mulching, terracing, water retention structures, and their effects upon run-off, erosion, siltation, infiltration, crop yields, etc.

The physical range of possibilities of conservation is being extended constantly through research and developments in technology.

Before recommendations about the use of land may be made, we must consider the economic dimension, which includes the prices of products, costs of productive factors, and relationship between and among products and the labour and capital needed to get them.

The economic possibilities of conservation are constantly changing through prices, which reflect changing demands of consumers, and through costs or profits, which reflect scientific developments and other conditions.

Finally, attention must be given to the legal dimension ,which tells what is legally permissible.

The legal dimension consists of a set of rules, customs, and laws that were made by man and may be changed by man to fit the needs of conservation of land and water resources.

### *Flow and Fund Resources*

Land and water resources vary in their origin, availability, and nature. This is particularly true of soils, water, and plant life—the principal agricultural land resources. Two groups of land resources are basic — flow and fund.

Flow resources — like rainfall — become available in certain amounts each year. They become available periodically, regardless of use. Flow resources may be used either as they become available or, within limits, may be stored for future use.

Fund resources are stored-up productivity available for use. Certain soils and forests exhibit this characteristic.

Fund and flow are based on the amount of resources available, the amount of resources becoming available periodically, and the possibilities that the resources may be renewed and restored.

Inexhaustible resources include certain soil elements and underground water reservoirs that appear sufficient to meet all future demands.

Exhaustible but renewable resources may be depleted currently, although they may be renewed by human actions. Some elements in soil, such as nitrogen, phosphate, calcium, and humus, may be exhausted through use, but they may be added again in fertilisers and amendments.

Exhaustible but non-renewable resources may be exhausted through current use and may not be renewable through human action within economic limits. Erosion of shallow soils underlain by rock and severe gullying on deeper soils are examples of this type of exhaustion.

Some soils have composite characteristics, some of which are inexhaustible, some are flow in nature, and some are exhaustible.

*Limits And Economics of Conserving Use*

There are two limits of conserving use and they apply to both renewable and non-renewable exhaustible resources.

The lower limit of use is the point where renewability cannot be achieved economically. Excessive erosion, for example, should not be permitted to proceed to the point where the productivity of the soil cannot be regained through an economic investment of resources.

An upper limit may be identified as non-use or investment in improvement beyond what appears to be justified by present and potential demand for products and services coming from the resources. An example would be non-use of virgin soils.

Within the two limits, three choices are available : *Investment,* the expenditure of funds on land and water resources in order to increase future productivity ; *maintenance,* the expenditure of funds on resources in order to maintain current productivity indefinitely ; and *dis-investment,* the mining of the resource so that current production dissipates future productivity potential.

Whether we should invest, maintain, or disinvest in particular land resources depends on whether one or the other is economic or uneconomic. The criterion is the maximum output of the products and services people demand and will demand at the least cost per unit of product.

The economics of investment, maintenance, and disinvestment of a resource vary with the interest of the individual, the public, and/or, groups of users. The interests may or may not be in conflict.

Problems arise when individual interest conflicts with group and public interests. A tenant with a 1-year lease, for example, may want to plant intertilled crops and disregard conservation practices because he feels his profits will be greatest, regardless of whether he may cause water and silt damage to farms lower in the watershed and damage to the farm he operates.

Another example is a farmer who may plow a steeply rolling meadow because he can realise more profit for a few years from that land in cultivated crops than in meadow, although farmers and public interests farther down the watershed are damaged from more runoff and siltation.

A third example of levels of economic interest is a large water-retention structure on a sub-watershed of a major river. Neither the individual farmer nor the farmers in the sub-watershed could afford to build and maintain the structure, but the public might afford the investment because damages from flooding downstream would be less, and a municipal water supply and a public recreation area might be created by the structure.

*Achieving Conservation On Farm Land*

The major purpose of conservation measures is the protection of land water resources while they are being used productively. A conservation plan for a farm usually includes measures that will not only build up current productivity but will also give protection for future years.

"Conservation," as generally considered in connection with a conservation farm plan, includes the use of land in accordance with its capabilities ; the use of practices that will lessen or prevent harmful soil erosion and water runoff, and improve drainage ; and the maintenance or improvement of soil fertility and productivity.

Many farmers are interested in conservation as a means of securing larger future incomes over a long-term ; almost all are interested in securing higher production and optimum farm income

in the near future. Many present farming programmes need to be changed. Generally, there can be no progress without change. To do so, may require the outlay of additional capital and a temporary reduction in current income.

The farmer (and those assisting him in working out a conservation plan for his farm) needs to distinguish between reduced fertility that has resulted from long-continued cropping and deterioration that has resulted from erosion of the soil. Reduced fertility can be remedied by applying proper fertilisers; but to control erosion may call for a shift in the use of the land, for changes in rotation, and for better disposal of surplus water.

On sloping land some run-off is likely to occur under any cropping system. If the topsoil is deep and the subsoil is productive, this slight erosion may not be serious. But on soils where much of the topsoil is gone and the subsoil cannot be made productive, an effective means of controlling erosion must be developed, such as : adopt cropping systems that cover the land with sod crops part or most of the time ; build terraces and control waterways to help hold the soil in place while it is in crops ; and a generous amount of grass and legumes in the cropping plan. With an increase of sod crops, a farmer has to make changes in his general system of farming.

In order to carry out sound soil conservation plans on tenant-operated farms when the land is subject to harmful erosion, it is necessary for tenants and landlords to agree on a programme of proper land use.

### *The Test of Conservation Benefits*

The real test of soil and water conservation measures is their effect on crop yields, total farm production, and farm earnings. Some conservation practices will result in immediate returns while other practices may not show benefits for several years. Land that has been badly eroded and depleted will require heavy expenditures of labour and capital to make it highly productive. Efficient, high volume production per acre is essential in maximising farm returns. High per acre yields help to reduce fixed production costs. Investments in measures to improve the land and to conserve soil and water, including the application of fertilisers and lime, and conservation practices such as contouring, terraces, waterways and drainage, pay off in larger per acre crop yields and in higher quality crops and forages. Total farm output and the net farm returns are increased by a sufficient amount of well-managed livestock to utilise forages produced under conservation plans.

*Economic Returns From Conservation in the United States*

Long-time studies in the United States clearly demonstrate that conservation farming is profitable under a wide variety of conditions and types of farms. A 10-year study in three Midwestern areas demonstrates that higher farm production and higher net earnings were the measurable results of soil conservation practices and programmes. The long-time benefits of conservation were significant in each area studied. Conservation and improvement practices, such as fertilisers and contour farming, generally increased production and income the first year.

A random sample of Illinois operators who followed recommended soil conservation practices, spent about 100 per cent more for fertiliser and other land improvements than farmers with similar land who did not follow a recommended conservation programme. *Net returns* were 40 per cent higher for the conservation farms. Studies in different parts of Illinois show that returns from conservation investments are a safe basis for the credit often needed for establishing a conservation farm plan. Although net income may be reduced temporarily, the productive value of the land increases immediately, thus protecting the financial position of the land-owner until the long-time benefits of his investment accrue.

Ten-year studies of "high"-and-"low" conservation farms in Midwestern states show that the differences in crop yields, livestock production, and net incomes between the high—and low—conservation farms are becoming wider as time goes on. Production on the high farms is increasing relative to that on the low farms. In years of adverse weather the yield and production differences between the high and low farms have been even more pronounced than in years of favourable weather. In wet years, the high farms, with more abundant and better quality forage, have produced more livestock and have not been affected so adversely by the weather. In dry years they have not "burned up" as rapidly as the low-conservation farms.

In addition to cash outlays for their soil conservation programmes, the high-conservation farmers usually put in considerable labour and machine work on terraces, waterways, contouring, fence moving, etc., for which there was no direct cash outlay.

The high-conservation farms used their resources more efficiently than the low-conservation farms. They reduced soil losses and improved the fertility of their farms by erosion-control practices, land-use programmes in accordance with soil capabilities, and the use of fertilisers in accordance with soil tests. Higher yields

of grain and forage crops enabled the high-conservation farms to produce more livestock than the low-conservation farms.

*Conservation And Improved Management*

In general, the high-conservation farmers managed all phases of their farm businesses more efficiently than the low-conservation farmers. Farm account records show that as they put their conservation plans into effect, they also tended to improve the management of their farms. They made better use of their capital than the low-conservation farmers, both for conservation and for increased production. They increased their livestock returns by adjusting their businesses to make use of the larger quantities and higher quality hay and pasture resulting from soil treatment and erosion control.

The more complete farm plans followed by the high-conservation farmers included : (1) testing and fertilising soil in accordance with needs ; (2) using each field and tract of land in accordance with its soil capabilities ; (3) using recommended rotations and cropping sequences, including ample acreages of deep-rooting legumes ; and (4) using the types of water disposal best suited to their needs : grass waterways, contouring, strip-cropping, terracing, and tile and open-ditch drainage. These farmers also utilised their forage crops either as feed for livestock, for seed production, or as a green-manure crop and they utilised all crop residues as mulch or "plow down" to increase soil organic matter instead of wastefully burning them.

A number of the high-conservation farmers demonstrated the possibility of successfully rebuilding a run-down farm. They also showed that it pays to use capital to hasten the improvement of the productive capacity of the farm.

*Conservation Alternatives*

Conservation practices and plans, like every other farm operation or practice, must be both physically and economically feasible, if they are to be used by farmers. In applying conservation and fertility improvement plans, farmers have a choice between alternative combinations of land use, fertiliser applications, and erosion control practices. Within limits, they may choose between different rotations or crop sequences and different fertiliser applications combined with different erosion control practices and still farm the land in accordance with the soil capabilities.

While land use in accordance with soil capabilities and appropriate fertilisation is basic to soil conservation, these measures

need to be supplemented by supporting conservation practices such as contouring, sod waterways, mulching, drainage, dams, flumes, etc., if soil is to be conserved and improved most efficiently.

Most farmers have alternatives to choose from in developing a sound conservation farm plan. Putting a high proportion of the cropland into meadow will generally control erosion, improve soil tilth and fertility, and also be profitable if the meadow is marketed through efficient livestock. But planting a high proportion of the land to the more profitable cash cultivated row and grain crops necessitates use of erosion-control practices plus high fertilisation on land subject to run-off and erosion.

Making the most effective use of available land and water resources is a basic economic problem. A fundamental principle of resource use is the apportioning of available resources among competing alternatives so as to maximise returns derived from their use. Their comparative productivity in alternative uses is the primary basis for apportioning resources. Under a system of private property, the individual farmer makes the comparisons (value judgments) and decides how the resources will be used, i.e., whether a conservation and improvement, maintenance, or exploitative system of farming will be followed.

Successful conservation farming (that system which will increase total farm production, build up soil fertility, control erosion and maximise earnings) cannot be tailor-made to fit all farms but involves consideration of each individual situation. The farmer (and technicians working with him) must analyse his problem to determine his costs and returns for the farm as a whole under alternative combinations of crops, fertilisation, and supporting conservation measures to determine which system will best fit his capital position and his personal abilities and still do the conservation job.

Some conservation measures may not work out as expected because of adverse weather or because they are poorly adapted to the individual or his farm. Farmers need to get the best advice available, and they may also need to do some experimenting. For this reason, it is probably best to work gradually with the conservation plan rather than make a heavy investment all at one time. This is particularly important to farmers who may be in debt.

*Reclamation And Rehabilitation*

The development and use of improved power construction machinery and engineering skills has brought vast reclamation projects within economic reach. "Bulldozers" and other heavy

tractor equipment for land clearing and drainage make it possible to convert unproductive "bush" and swamp land into cropland for intensive producton. This type of equipment also makes it possible to clear and re-shape rolling to steep land into crop and pasture lands. This use of machinery and technology, along with the use of fertilisers, makes possible both greater conservation and greater exploitation of soil and water resources. In the developed countries, this technology has tended to concentrate the more exploitative crops on the better land. We note in other instances that this technology has enabled and resulted in cultivation of lands that should, by any standards of land use in accordance with soil capabilities, remain in permanent vegetation (trees or grass).

The improved technology in reclamation and rehabilitation of lands for productive agriculture has widened the competitive agricultural production gap between the developed and the developing nations. A man with a cutlass, spade and hoe as equipment can hardly compete with bulldozers, tractors, and other mechanised equipment.

In the United States, land improvement contractors are playing an important part in land reclamation and rehabilitation, and in applying soil and water conservation practices on the land. These contractors construct and assist farmers in constructing ponds, reservoirs, soil saving and water holding dams, terraces, waterways, drainage (surface and tile), land forming (for drainage, irrigation or terracing), brush and timber clearing, gully control, etc.

The reclamation and restoration of surface mined areas (coal, sand, gravel, stone, clay, copper and iron) is receiving increased attention in many countries. The Soil Conservation Society of America (with membership in over 45 countries) has a technical committee on "Mined Areas Restoration" which has been studying and encouraging work on this subject for the past 10 years.

The principles and generalisations learned from mined area restoration studies are applicable to reclamation and rehabilitation of other land areas.

*Agricultural Development, Conservation And Management of Tropical Soils*

I bring to your attention the contribution of Dr. Charles E. Kellogg (Deputy Administrator for Soil Survey, Soil Conservation Service, U.S. Department of Agriculture) in his papers "Fertility and Management of Tropical Soils," Agricultural Research Institute, 14th Annual Meeting of National Academy of Sciences, 1965, and "Inter-actions in Agricultural Development," U.N. Conference

paper on the Application of Science and Technology for the Benefit of the Less Developed Areas, 1965.

Some quotations from these papers of Dr. Kellogg follow :

"Most soils in the tropics and sub-tropics give poor harvests under simple management. Yet many natural soils in the tropics are highly responsive to adapted combinations of practices specifically designed to develop productive arable soils."

"The goal of soil management is to produce and maintain an arable soil as nearly ideal for the planned production as is economically feasible considering skills, facilities, and markets."

"Only a few tropical soils can be expected to produce even moderately well without substantial additions of fertilisers. *But fertilisers are economically effective in producing a crop only if the correct kinds and amounts are used for the local kinds of soil and if the needed practices to meet the other requirements for good harvests are adapted.*"

"Although laboratory and station research is needed, the great, immediate need in most newly developing countries is for scientific and technical work in the field."

"Regardless of sincerity, professional people who do things only *for* and *to* cultivators rarely gain their confidence."

"First emphasis should be placed on industries that service agriculture, such as chemical industries, machinery industries, transport, marketing, and the like."

"We have a dramatic example in the United States of highly productive farming on soils of exceedingly low productivity under simple management. Most of the soils of Florida would produce little with the skills and facilities available to the majority of cultivators in the tropics. But the people of Florida have had a good market. They have had access to advanced science and technology. They have been able to obtain excellent fertilisers, machines, and electric power. Plant breeders have developed varieties adapted to good, arable soils made by the farmers."

"In terms of the sciences basic to farming, what has been done in Florida can be done just as well over a tremendous part of the tropics. The soils are there and the research skills are available. The big problem is the one of developing institutions to make it possible to do there what has been done in Florida and elsewhere with soils that are highly responsive to specific technology worked out with the full use of modern science and the products of industry."

*Peasants vs. Farmers in Conservation And Agricultural Development*

Two major factors that serve as deterrents to conservation and agricultural improvement in the tropics are size of farm holdings and the low social status of rural peoples.

I note that farmers in the tropics are generally called "peasants" and are generally looked upon as second rate citizens. Although a newcomer to tropical agriculture, but as one interested in the economic and social development of the "tiller of the soil", I contend this centuries-old idea that a farmer as a peasant is out of place in modern agriculture. A part of a true extension education programme in agriculture in the tropics should include bringing to the attention of influential people, whether land-owner, pastor of a church, merchant, banker, teacher, restaurant or hotel operator, the benefit to the whole community in recognising that a modern efficient farmer must essentially be :

(1) a practising scientist
(2) a skilled mechanic
(3) a technician
(4) a businessman and
(5) a humanitarian.

and in the words of one of my kindly and wise "Profs" he must have a good "teakettle engineer" at his side, so look to the education of the farmer's wife also.

It is my belief that any country which looks upon and treats its "tillers of the soil" (farmers) as peasants, will have a peasant agriculture - inefficiency, low production, low returns to agricultural labour ; and will find it difficult to build up and maintain strong, economic development.

Historically, the rural farm population share of total population declines with economic development, and size of farm operations increases. With the increased size of farm operations, come increased production and marketing per unit (acre) of land resources. Population growth, including agricultural population, is increasing much faster in the less developed than in the more developed countries. Because of rapid population growth and limited land resources, crop yields and agricultural production must increase 3 to 4 per cent each year in most developing countries in order to meet expanding food needs, compared to a need for increases of 1 to 2 per cent in developed countries. There is governmental pressure and the feeling by many in the less developed countries that agricultural production can be in-

creased by dividing land holdings into smaller and smaller units and putting more and more people (regardless of agricultural training or ability) on the land. This is counter to historical records, which show that splitting of land holdings into small, inefficient units lowers total production (management abilities, capital inputs and fertiliser, etc. are lowered). To increase production in many of the developing countries, fragmented land holdings need to be consolidated. Historically it has been difficult to achieve conservation and land improvement on the small and inefficiently operated land holdings.

"Land reform" should have an affirmative goal to increase the number of people who own and operate farms of *efficient size, in an efficient manner* and with adequate equipment and working capital. Too often "land reform" has been identified exclusively with the division of existing properties. The Research and Policy Committee of the Committee for Economic Development found in their studies of "Co-operation for Progress in Latin America" that "mere division of land under cultivation among the rural population reduces the productivity and incomes of the people in most cases — the new owners are commonly less efficient farm operators than existing managers, and experience difficulty in assembling capital for fertiliser and equipment."

Puerto Rico is an example in the tropics where size of farms and production per worker and per farm have increased. The per cent of the total labour force that was employed in rural agriculture declined from 67 in 1930 to 31 in 1962. A positive and dynamic, agricultural research, demonstration, technical assistance, and extension programme helped to bring about the changes that resulted in Puerto Rico's improved agricultural picture.

In the United States only about 20 per cent of the total labour force engaged in present day agriculture work on and operate the farms. Approximately 80 per cent work in the service and industrial phases of agriculture, including farm machinery and equipment, farm fuels, fertilisers, marketing, processing, storage and transport of foods, farm credit, farm management, farm publications, farm accounting, agricultural research, extension and teaching.

*Conservation In The Caribbean And Latin America*

An analysis of soil conservation activities in the Caribbean and Latin America indicates a real concern for resource conservation and improvement and, for most countries, work is underway to achieve this goal. A few illustrations follow.

Barbados has underway a bold programme to control erosion and stabilise the soils of the Scotland District for continued and

improved production. The conservation problems are being attacked on a drainage area or watershed basis with considerable success. Multiple measures, including underground drainage pipes, terracing, dams and erosion control structures, land re-shaping, re-seeding, and re-afforestation are being applied. The Ministry of Agriculture is taking the lead in applying the programme. Jamaica has a Land Use Office attached to the Soils Division of the Ministry of Agriculture. This agency deals with conservation problems of the large number of small farms that are inadequately financed.

Argentina and Chile have agencies concerned with soil conservation and land use problems. Mexico has a Soil Conservation Service of the Department of Agriculture and works through soil conservation districts that cover the country. Some Brazilian states have active state agencies to provide farmers with technical assistance for solving conservation problems. A number of countries are actively engaged in soil surveys and the preparation of land use capability maps.

Puerto Rico and the Virgin Islands have underway a comprehensive soil and water conservation programme. The Agricultural Research Service, U.S. Department of Agriculture and the Agricultural Experiment Station, University of Puerto Rico have conducted extensive research in soil and water conservation and related fields. Detailed guides have been developed for numerous conservation practices to assist soil conservation district co-operators (farmers) in making the farm planning decisions necessary to develop a complete soil and water conservation farm plan. The Soil Conservation Service of the U.S. Department of Agriculture provides technical assistance, through local Soil Conservation Districts, to all farmers in the Islands. A visit to comparatively nearby Puerto Rico to see and study the conservation work would be most helpful to those engaged in conservation work in other Caribbean countries.

### *Youth And Conservation*

More and more countries are developing programmes to acquaint members of youth groups, both in town and in country, with resource problems and the needs for conservation. The youth of today are the farmers and landowners of tomorrow — as well as the consumers of tomorrow —and all consumers have an interest (directly or indirectly) in conservation.

Projects and programmes of 4-H Clubs afford an excellent avenue to teach youth the many and varied aspects of conservation. Parent co-operation is required in the actual programmes. Conservation education and training for youth not only help to

inform them of the importance of the soil and water resources—they, in turn, often educate the parents.

I cannot recommend too highly the projects and programmes of 4-H clubs which begin with the boy of 10 and the girl of 8, living in cities, towns and villages as well as in rural areas. Practical farm and home skills feature every phase of self-development, industry, thrift, recreation and leadership.

*Soil Stewardship*

The 1966 Soil Stewardship Week bulletin, published by the National Association of Soil Conservation Districts, states in part :

"Orderly planning of resource use, based on deliberate weighing of all the values involved, is not only a recognition of our accountability to our children and to society as a whole, but a cardinal requirement of responsible stewardship under God."

Farm owners and tenants alike have a responsibility to society to prevent the deterioration of soil resources which cannot be replaced. Landlords and tenant farmers both too frequently over-emphasise quick returns. The landlords who do this, however, often find their income reduced in later years because of either temporary or permanent damage to their farms. Tenants, too, will find their ability to succeed as farmers and to rent highly productive farms will depend more and more upon their acceptance of systems of farming that insure long-time high production from the land.

*Concluding Remarks*

The success of soil conservation practices and programmes depends on local responsibility and leadership. Good decisions and application of economically sound conservation programmes on individual farms result in progress in soil conservation. Soil conservation districts provide an opportunity for local leadership to be effective in soil and water conservation programmes.

Farmers solve their conservation problem by working together. Erosion does not stop at farm boundaries — nor does the flow of water.

Watershed programmes are a means of using group action to get complete conservation plans applied on the land in combination with waterways, dams and other structures that will help to reduce flood and sediment damages, both on and off the watershed, as well as possibly providing municipal water supplies, recreation areas and other off-farm benefits.

Although they most often have operated in the background, women, individually and through their group efforts, have had much to do with the high level of interest in conservation and sound use of natural resources, particularly in the United States and Canada.

The complexity of the problems associated with natural resources, conservation and management increases greatly as men congregate on small areas of land. If this limited land area is to provide well for the needs of the people living upon it, conservation and improvement must be the joint responsibility of individuals, public groups, and government.

Sound management of land and water resources by farmers not only affects the efficiency of their own agricultural enterprises, but sustains the land and water resources required for urban and industrial development.

The technology of conservation involves an inter-disciplinary approach and involvement of all sciences related to agriculture.

A true conservation programme would not allow the waste of food resources that may be observed in many tropical countries. Proper harvesting, handling, processing, storage and marketing could significantly increase food products available for consumption.

Economics of conservation studies by the U.S. Department of Agriculture and the State Agricultural Experiment Stations demonstrate that money spent on conservation is a sound investment. A conservation plan suited to the capabilities of the land and to the abilities of the farmer increased farm income in most areas studied.

Changes in farm income on the farms studied varied with the condition of the farm when the conservation programme started, the speed at which the programme was applied, the kinds and amounts of fertiliser used, the weather, and the quality of management of the farm owner and operator.

Conservation generally improves production, earnings and farm family living. Erosion and depletion strike a farmer first, and through him it reduces spendable income, the tax base and total area revenue. In short, erosion and depletion affect schools, churches, merchants, the community; hence all have an interest in conservation. Conservation and improvement of soil, water, and other natural resources are a practical means of not only

increasing farm income but also of insuring food, fibre, shelter and other needs for the increasing population.

In the final analysis, both the *economic* and the *social* costs and returns of conservation plans and programmes and alternatives need to be carefully evaluated before determining a course of action for a farm, a watershed, a district, an area, or the country.

## REERENCES


1. **Agricultural Economics Research,** Quarterly publication of the Economic Research Service, U.S. Dept. of Agriculture, 1960-66.

2. **Agricultural Research,** Monthly publication of the Agricultural Research Service, U.S. Dept. of Agriculture, 1960-66.

3. Deatherage, (1966) : J. R. Deatherage, "New Horizons in Research," **The Year-book of Agriculture, 1966,** U. S. Dept. of Agriculture.

4. **Journal of Soil and Water Conservation,** Bi-monthly publication of the Soil Conservation Society of America, 1958-66.

5. Kellogg, (1965) : Charles E. Kellogg, "Fertility and Management of Tropical Soils," **Proceedings of 14th An. Mtg. of Nat. Academy of Sciences** and "Interactions of Agricultural Development," **Vol. III, Agriculture — Science, Technology and Development,** (U.S. papers prepared for the U.N. Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas).

6. **Land and Water Contracting,** Monthly issues, 1960-67.

7. **Research and Development for Economic Growth,** Ohio Agricultural Research and Development Centre, Bulletin 986, 1966.

8. Sauer, (1962) : E. L. Sauer, "Economics of Mined Area Restoration", Annual Mtg. S.C.S.A., 1962.

   Sauer, (1966) : E. L. Sauer, "Community and Area Resource Development in Illinois", Memo., Univ. of Illinois College of Agriculture.

   Sauer, (1964) : E. L. Sauer, "Activities in Developing Community Resources", Univ. of Illinois College of Agriculture Report, **50 Years of Education in Action.**

   Sauer and Case, (1954) : E. L. Sauer and H. C. M. Case, Soil Conservation Pays Off", **Illinois Agr. Exp. Sta. Bul. 575.**

   Sauer, Anderson, Blosser, McNall and Scoville, (1951) : "Conservation Problems and Achievements on Selected Midwest Farms." **Ohio Agr. Exp. Sta. Sp. Circular 86.**

Sauer, Anderson, Heady, Olson and Robertson, (1953): "Economics of Some Soil Conservation Practices," Iowa **Agr. Exp. Sta. Res. Bulletin 403.**

9. **Soil Conservation,** Monthly publication of the Soil Conservation Service, U.S. Dept. of Agriculture, 1960-66.

10. Swanson and Harshbarger, (1964): E. R. Swanson and C. E. Harshbarger, "An Economic Analysis of Effects of Soil Loss on Crop Yields", **Journal of Soil and Water Conservation,** Vol. 19, No. 5, 1964.

11. The Hugh Bennett Lectures — The Agricultural Foundation, Inc., North Carolina State College, 1959.

12. **The Year Book of Agriculture**, U.S. Dept. of Agriculture, 1958-1966.

13. Timmons and Sauer, (1958): J. F. Timmons and E. L. Sauer, "The Wise Use of Our Resources", **1958 Year book of Agriculture** Separate No. 2907.

14. **Tuesday Letter,** National Association of Soil Conserveration Districts, 1960-67.