Resource-Use in Pakistan

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Past-President Weaver is the author of the following article which was the result of his having served with his wife as a Fulbright Lecturer in 1960-61 in Pakistan. They were attached to the East Pakistan Extension Centre at Dacca where they conducted workshops for science teachers. In this article Prof. Weaver describes some of the problems for resource use of Pakistan.

Scientists and resource managers in Pakistan are seeking ways and means to increase the production of food and fiber for the rapidly increasing population of their new country. They have tremendous problems of scarcity of land, limited capital, needed research, and training for personnel, and more effective research interpretation for a largely rural population with a low percentage of literacy.

Despite the discouraging size of these problems, real progress is being made, and our International Agency for Development (AID) has played an important part in providing consultant help in planning, financial aid, training for resource technicians in Pakistan, as well as in the United States, and encouragement to design new programs.

Forestry, fishery, soil, and water resources are the principal renewable resources receiving attention. Hunting and fishing by residents for sport are practically unknown, and wildlife species receive attention only as food or if dangerous. Of course, some American and European visitors and workers hunt for sport. There is no national or provincial department specifically charged with wildlife management work, although fisheries work is independently organized.

Foresters have inherited much of the responsibility for the management of the renewable resources, particularly forests, soils, and water.

Some fisheries biologists are now being trained. There is a great need for providing the technical training necessary for soil and water management programs. Some extension type instruction is being provided for the increasingly important village development workers to assist with educating the land owners and operators.

Forestry

The *distribution* of commercial forests in Pakistan is quite restricted. In West Pakistan, the Muree Forest, northeast of Rawalpindi thirty to forty miles, is of primary importance, since here the former Punjab State of India with British guidance was able to manage some sizeable stands of good timber in an area where water is abundant from heavy snow and rainfalls in the mountains.

In most other areas of West Pakistan trees are sparse because of lack of moisture, but at Chango Mango forty miles south of Lahore there is a well-managed irrigated forest of Shisham and Mulberry which has been managed as a forest since 1920.

In East Pakistan the two national forests areas are in the Sundarbans along the Bay of Bengal and in the Chittagong Hill Tracts bordering on Assam, India, and Burma. An area between Dacca and Mymensingh also has considerable forest cover of inferior quality timber.

Most of the *problems* of forestry in Pakistan grow out of too many people and the need for land to produce enough foodstuffs. Despite severe shortages of wood for lumber and fuel in most of the region it is difficult to get enough trees grown or to keep them growing on the land. Overgrazing by goats, sheep, cows also retard and prevent regeneration.

A regulation or act of many years standing in the Punjab is now hopelessly out of date and cannot be fulfilled although it is still on the books. It authorized each boy when he reached marriageable age to have three mature trees from the forest with which to build his house. When this was promulgated there were fifty people per square mile and this was feasible, but now there are five hundred fifty people plus per square mile and the demands cannot be met. As a result the only timber which can be found around Muree is on lands owned or controlled by the provincial or local govern-

Figure 1. Forest and Farmlands near Murre, West Pakistan. The pine forest is owned by the government and is under great pressure since there are as many as 550 people per square mile trying to live in this area. They are farming all the way to the tops of the mountains which are 8500 feet high. Fuel is scarce and erosion is severe.

ments, and even in these a major problem is that of thefts and deformation of crowns by people seeking firewood.

Growing trees in drier areas is possible with irrigation but in these areas water has a higher priority use for food crops. Some reforestration is being done along canals, roads, and railroads.

An outstanding example of managed versus nonmanaged use of forests can be observed in the Muree area where the Punjab side has numerous stands of excellent long-leaf pines above 3500 feet. Across the valley in the Northwest Frontier Provinces which were once covered with pine and oak have been completely denuded and thousands of people are trying to eke out a living by farming all the way to the top of these 8500 foot mountains. No forest management program had ever been developed in these territories.

One of the most valuable trees in the Muree area is *Pinus longifolia* which produces excellent lumber, and naval stores which are shipped ninety miles southwest to Jallo which is twelve miles north of Lahore, where the largest turpentine-resin plant in Asia is located.

The olive forest which succeeded the oak and pine original cover is of low value and is used primarily as fuel. Mediterranean olives have been introduced but do not bear usable fruit. Shisham (*Dahlbergia sisso*) and Mulberry are the two more important trees of the drier areas of West Pakistan being used for lumber, athletic goods, furniture, and fuel. These two species grow well in irrigated areas. Therefore, an irrigated forest was established at Chango Mango south of Lahore, covering twelve square miles, in 1920, and it has been operated by the government of India and now Pakistan since 1922. It is a fine example of a well-managed irrigated forest with excellent records of production. The trees mature in twenty-two years so the tract was equally divided into twenty-two plots and one plot is harvested each year. The reproduction of Shesham is by suckering, and the Mulberry reproduces from seeds scattered by the birds. Eighteen Shesham trees are left in each acre for reproduction. Trenches are cut about three feet apart and one foot deep throughout the area and the water allowed to enter. The cut roots of the trees send up the new seedlings for the new forest.

The water needed for this irrigated forest originates in India. The water is available for but six of the twelve months. If Pakistan could obtain sufficient water for year-round irrigation, production could be greatly increased.

Sales of fuel wood are conducted each month, as well as a separate sale for fuel wood. Accurate records of sales and income have been kept. A small amount of charcoal is made for use by the staff and government workers but not sold commercially.

In East Pakistan one of the major commercial species is teak which is grown in plantations in the Chittagong Hill Tracts. It is Burma teak transplanted in Pakistan. However there are at least fifteen or twenty other

Figure 2. Irrigated Forest at Chango Mango, West Pakistan. Eighteen shisham trees left per acre to start the new forest. Small canals through the forest will permit water to "sprout" the cut roots so that new trees will grow from the "suckered seedlings." Mulberry trees will be seeded in by birds. The smallest limbs and twigs are recovered for use as fuel.

varieties of native woods in the Hill Tracts which can produce fine lumber when properly seasoned. Very little real seasoning is done now and most of the wood is used green and therefore warps, cracks, and shrinks. It is sawed into boards by hand, planed by small hand planes, and shaped and drilled with rather primitive type tools.

The East Pakistan Forest Products Laboratory has been established at Chittagong with ninety employees, as an AID project. Many of the scientists have been sent to Madison, Wisconsin for training in the Forest Products Laboratory there. The primary objective is to do the basic research on the numerous woods from the Hill Tracts and East Pakistan to permit these to be seasoned and put to wider uses. One of the more difficult problems, however, is that of getting the potential users of the seasoned wood to pay a higher cost for it, or to buy it in the first place. Changing the cultural pattern is harder than learning the wood technology needed.

At Jallo in West Pakistan the Government processes and sells twelve grades of turpentine and six grades of resin and ships them to all parts of the world. The products have great usefulness and bring in some much-needed foreign exchange.

In the Sundarban Forest of East Pakistan a thriving new paper industry has been developed at Khulna. The Gewa *(Excoecaria agallocha* Linn) tree is a soft aspen-like wood readily available for a continuous operation. In the same forest the Sundri *(Heritiera minor* Roxb.) is also harvested as a lumber species.

This forest is largely inundated each year during the monsoon period but does not have an available fresh water supply to support habitations so the forest can continue to supply lumber and fiber uninterruptedly.

At Peshawar, the new location for the Pakistan Forestry Institute, the foresters are obtaining their advanced education. The staff uses a revised syllabus used in Dehra Dun, India, where most of the older foresters received their training. This Forest College when completed will have one of the most attractive campuses anywhere. Soil conservation and watershed and range management are being added to the curriculum and many foresters have been deputed to work in these new branches of the government.

Current *development schemes* in forestry call for establishing new management areas; more areas for reforestration of teak and other species useful for veneer, lumber, and pulp; and plantings along canals, railroads, highways; and expansion of such food-producing species as bananas, cocoanut, pineapple, and mangoes.

Animals will have to be controlled by fencing if many of the areas are to be reforested.

The Chittagong Hill Tracts on the eastern portion of East Pakistan bordering on Burma is sparsely settled by various hill tribesmen. It is drained by the Karnafuli River, on which a power dam has been constructed at Kapti. Several veneer plants, a paper mill, and various saw mills have relied on logs and bamboo from the Hill Tracts, easily floated downriver for fifty to seventy-five miles.

The impounded water will flood the precious rice lands in the limited lowlands but also create a need for motorized equipment so the natives can get their logs to market. Thus, production of power, while needed and helpful, will put severe handicaps on local food production and drains on almost nonexistent capital of the residents in this large region.

At Quetta in West Pakistan a twelve-square mile area of sand dunes has been tied down with trees and shrubs which are doing very well, showing that even in the extremely dry area trees can grow and wind erosion can be stopped.

The foresters in India and Pakistan are well-trained and energetic and have embarked on some far-sighted schemes to produce more lumber and fuel and to conserve soil and water. They work with wide extremes of conditions of temperatures and rainfall and in areas where the demands for their product are ever-increasing.

Fisheries

Fisheries in Asia are of primary value as food and there is little if any interest in them for "sport fishing." The delta rivers, canals, innumerable tanks or ponds, estuaries, and seas surrounding the subcontinent are quite productive and very susceptible to increased use and management.

While various sub-species of carp are used as the primary river and pond fish, they are

Figure 3. Net Making at Karachi Fish Harbor. Nets being made with nylon by fishermen at the New Fish Harbor recently completed at Karachi, with the help of our AID technical assistance program.

of much better quality than the European variety.

Netting, seining, spearing, impounding, or trapping them with bamboo weirs are the standard procedures for capturing fish. Little if any line fishing is done. Various types of deep-water nets are used and many are being helped to make stronger nets by using nylon being supplied through AID. The launches are being motorized, and ice is being provided for refrigeration also with AID help.

Prawns or shrimps are abundant in the brackish waters of East Pakistan and some varieties are as large as our lobsters. A freezing plant has been erected near Khulna and many are shipped to United States and Great Britain.

The major *problems* are centered around: (1) getting marine fishermen to bring fish to market more frequently and to use ice and motorized equipment to reduce spoilage, (2) to improve the marketing and the distribution, (3) to increase production on inland waters and manage the numerous ponds and tanks for fish, and (4) to process the fish more sanitarily for foreign consumption so as to increase sales and foreign exchange and (5) to increase the research and production facilities. Considerable progress has been made on most of these problems in recent years.

The New Fish Harbor and Market in Karachi will be the envy of many ports and countries. With ICA help and advice the Pakistan Government has built a fine modern Fish Market where all of the fish in the Karachi area must be sold, under government supervision, although it operates as a cooperative of the fishermen and the auctioneers.

Auction space, docking facilities, processing sheds, ice and refrigeration, help and advice on nets and boats, and even space for research are all available. A new fish dining establishment complete with dancing girls will soon be added. A similar harbor and market is planned for Chittagong.

A Burmese banker, Mr. Fernandez, is showing how fresh fish can and should be dried using Burmese methods and American ideas for packaging. He could use five to ten times the amount of fish for export to Burma and elsewhere if he could entice more fishermen to market their catch before it is eight hours old. Despite an extra bonus incentive, he is unable to get enough fresh fish. Thousands of pounds of half rotten fish pass through the market salable only at a greatly reduced price and thus a wasted resource for Pakistan.

Various types of hand nets with weights for throwing and encircling the fish, pole dip nets, circular seins operated by ten or twelve men, or small bamboo dip baskets and traps are used in catching fish as well as by spearing. All sizes of mesh are used regardless of needs for future breeding stock.

At Barrackpore, just north of Calcutta, India, the Central Inland Fisheries Research Station for India, the staff is engaged in extensive surveys of waters, fish populations, limnology, as well as basic research on genetics, breeding, and hormone treatment. One of the most useful results to date has been the solution of the problem of breeding carp in captivity through application of hormones. This means the breeding stock can be selected and controlled, and fingerlings produced for distribution. Now fish tanks and ponds are being built along canals for commercial production of the species. Growth studies and distribution studies by means of tagging are also producing some much needed information on the Indian fisheries. Cooperative efforts by both Pakistan and India in the streams running into the Bay of Bengal would produce even greater results.

The Food and Agriculture Organization has developed regional organizations of fishery staff members from various countries through which they can share information,

conduct cooperative studies, and publish their findings. In the conference at Karachi of the Asia Fisheries Commission in January, 1961, representatives of Asia and the Pan Pacific countries met in a two-week conference at the Karachi Fish Harbor. This permitted each country to profit by the work of the others and also to see the operation of the new Fish Market and Harbor. Each delegate was also supplied with a large amount of research papers, management guides, and popular bulletins from participating countries.

Soil and Water Conservation

Pakistan is a land of contrasts with many arid lands in West Pakistan which have to be irrigated, and which become easily waterlogged and poisoned by salts, whereas in East Pakistan the delta soils are deep and rich with much clay and silt added each year during the monsoon period by the overflowing rivers. Even here much acreage becomes too dry to use during the dry season.

In the area around Rawalpindi the soil was deposited by monsoon winds hundreds of thousands of years ago to a depth of two hundred feet in some places. Unfortunately it erodes easily and the silt fills stream channels, clogs reservoirs, dams, and canals. In fact siltation of power dams, harbors, and canals is a problem throughout the subcontinent.

Near Rawalpindi the recently-created Soil Conservation Department has established several demonstration areas to try to work out inexpensive and effective methods for controlling erosion and conserving water.

Figure 4. Soil Conservation Demonstration Area Near Rawalpuidi. Dr. Md. Raffique, Director of Research for the Soil Conservation Department, shows the author some rat damage to the water retaining ridges which separate the fields and ownerships.

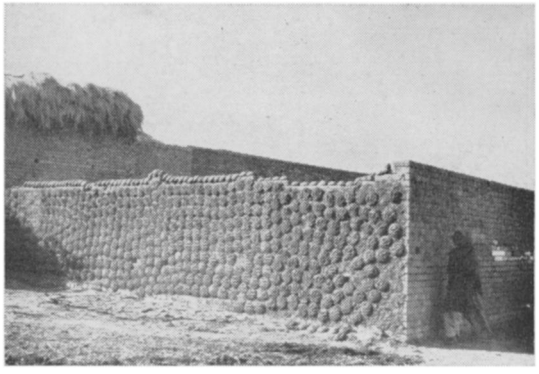

Figure 5. Animal Manures Being Dried for Fuel. Fuel is so scarce that animal manure must be burned instead of being used as fertilizer.

Several major *problems* are involved. One is that of the multiplicity of land owners, as there are twenty-three owners on one area consisting of twenty-six acres, half of them absentee landlords. Getting agreement for cooperative undertakings involving the whole area becomes more of a problem of human relations and education than of soil technology. The second problem revolves around the abundance of water during a relatively short period followed by a long dry season. An abundance of rats which eat the seed and dig holes through the water retaining walls also creates a real problem, requiring inexpensive poisons which will not harm other animals. A fourth problem is that of getting some vegetation on the heavily eroded areas to help in erosion control but also to provide some much needed fuel, so that the animal manures can be used for fertilizer instead of fuel.

By utilization of better methods of plowing, cultivation, fertilization, the demonstration areas are producing three to four times as much as the control plots and the surrounding farms. Catchment basins are being prepared to collect the excess runoff and hold it for later use as irrigation water in the dry season.

In the area southeast of Rawalpindi where the dam on the Jellum River will be built, the Watershed Management Department is also trying out methods for slowing down runoff and conserving water and soil, so that when the dam is built silting will be minimized. Likewise the wells in the area around Karot have gone dry and the ground water needs to be raised.

Figure 6. Catchment Basins to conserve water. Most of the rainfall is concentrated during the monsoon summer months, so the excess runoff is collected in such basins, and can be used to irrigate the fields during the dry season.

The Rawal Dam near the site of the new Capitol–Islamabad, will form a new lake which will be a domestic source of water for the city and also Rawalpindi, as well as to provide recreational facilities for the region and a beautiful setting for the new Capitol. It has been built entirely with hand labor and without foreign assistance.

Much of West Pakistan and of India can only be farmed by irrigation and so millions of acres of land have been irrigated, and the strength of agriculture lies in the continuous use and expansion of production on the acres, and in finding new lands which can be irrigated. However, the most serious problem of all is the tremendous loss each year of thousands of acres going out of production because of waterlogging and salinity. The loss is irreparable and costly at a time when the populations are soaring beyond the capacity of the countries to feed their people adequately. The solution, unfortunately, is not an easy one and certainly not an inexpensive one, so a great amount of research and attention is being given to it. Some large new schemes have been found unworkable because there was no way to prevent these evil effects, and so much money has been wasted. The only possible solution to increased food production on dwindling acres is to increase the yields on usable acres through better management, seed selection, fertilization, and cultivation.

In Nepal where the valley around Kathmundu is filled with a very deep soil which was likely deposited at the bottom of a large lake, there is little difference between the top soil and the sub soil. The top soil is used until the minerals have been exhausted, and is then converted into brick, and the next layer used for farming. This is also very wasteful and eventually all the soil will be used up and converted into brick. Manure is used for fuel instead of fertilizer, as in so many other areas of Asia where wood and coal are in short supply or too expensive.

Soil and water conservation in Asia is a relatively new field of endeavor, at least as far as training technicians to cope with the problems. But as has been discovered at Taxila, Mohenjodaro, Haripa, and other sites of ancient civilizations much was known

about water use, irrigation, distillation, etc. In fact, around Karot some Hindu stone terraces in the field no doubt date back hundreds of years. But practical training in the colleges and universities is very limited and very often theoretical. At Peshawar the staff of the Forestry Institute has begun to teach soil and water conservation and range management to the forestry students. Many men have been sent to the United States through AID to help prepare them for this important work. The type of training as now given in the Soils Department of the Universities will have to be revamped so as to give the men more actual work in the field on real problems to help train them to cope with these tremendous problems which are retarding the progress of these newly developing countries.

Biology Teachers Needed

The Peace Corps estimates a need of 5000 teachers for 1964 of which 20% will be in science. Some of the countries involved are Bolivia, Ethiopia, Ghana, India, Liberia, Malaysia, Nigeria, Philippines, Sierra Leone, and Turkey. Applications may be made to the Division of Recruiting, Peace Corps, Washington, D. C. 20525.

Significant Bioluminescence Studies

The glow of the lightning bug, and other living organisms, has long fascinated mankind. Cooperative efforts by an American and two Japanese scientists in analyzing and explaining the luminescence of certain marine organisms now indicates that an understanding of this little glow may hold the key to knowledge of general energy transfer within living creatures.

Through the mechanism provided by the U.S.-Japan Committee on Scientific Cooperation, and with the aid of a $46,984 grant from the National Science Foundation, these scientists, Dr. Frank Johnson of Princeton University, Dr. Yata Haneda of the Yokosuka City Museum, and Dr. Osamu Shimomura of Nagoya University, will be enabled to continue their investigations on the biological and chemical nature of reactions that permit certain animals in the sea to create their own light.

Much of the work that has been carried on already, and is to be continued, involves a tiny crustacean known as *Cypridina*. Dr. Shimomura has just returned to Japan from a year at Princeton where he for the first time isolated and crystallized *Cypridina* luciferin, the light-emitting substance that reacts with the enzyme, luciferase, to produce light.

Cypridina was well known to many Japanese soldiers during World War II for its light-producing qualities. In lieu of flashlights, they would crush and dry quantities of the small creature, then carry the powder with them at night. When water was added to a small amount of the powder in a soldier's palm, enough low intensity light was produced to enable him to read maps or messages.

Noteworthy scientific advances have already resulted from the cooperation between Drs. Johnson, Haneda, and Shimomura, working under an earlier NSF grant of $38,000. Among these have been the following:

1. The first authentic demonstration of an extractable luciferin-luciferase system in a luminescent fish.

2. Determination of major properties of a new type of luminescence system in a jellyfish, involving a single organic compound.

3. Determination of the quantum efficiency of light emission (ratio of photons of light emitted to number of molecules of luciferin decomposed and to number of molecules of oxygen consumed) in the *Cypridina* system.

4. Production of the first example of a light-emitting "cross reaction" between the luciferin and luciferase components of organisms related only very indirectly, *Cypridina* on the one hand, and certain fish on the other.

In addition to the intrinsic interest of bioluminescence to many investigators, basic research in this phenomenon may lead to important knowledge about other biological processes. As a result of the development of very sensitive devices for measuring the emission of light, this enzyme-catalyzed reaction may be used as a very sensitive indicator of the effect of various drugs or chemical inhibitors of cell respiration.

A current hypothesis holds that bioluminescence is a side branch of the general process by which the cell extracts energy from food. It is through investigations of this aspect of bioluminescence that more may be learned about energy transfer in living organisms.