ROLE OF TREES IN CROPLANDS

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Summary

Increasing population and decreasing landholding have together put increased pressure on limited cropland resources. Clearing of natural vegetation for timber, fuelwood and farming activities has led to serious resource and environmental degradation. Supply of wood-based products has become difficult from forests in many developing countries while the requirements for wood products are increasing. Planting of trees in croplands has proven a very useful way in supplying wood-based products. The trees planted in croplands can provide not only direct products including timber, fodder, fuelwood, fruits, herbal medicines, etc., but also environmental and ecological benefits. Trees planted in croplands include windbreaks, living barriers, fruit trees, fuelwood trees, fodder trees, timber trees, medicinal trees, and some other cash plants. Trees in croplands provide a large variety of products ranging from timber, food, fuelwood, fodder and fruits, to herbal medicines. Trees planted in croplands are an important source of income for farmers and have to be a form of insurance to farmers. They have many positive impacts on crops growing underneath trees, including improving the physical, chemical and biological properties of soil, and ameliorating microclimate in favor of crop growth. They have negative impacts as well. The negative impacts include mainly competition for light, soil water and soil nutrients. Appropriate management of trees can reduce the negative impacts and improve the positive impacts.

1. Introduction

In the past decades, the most striking changes in development challenges have been fast population increase and environmental degradation. In order to meet the requirements of an increasing population in the developing countries and economic development in the developed countries, natural resources have been exploited at an increasing rate that outstrips the regenerating capacity, causing severe resource and environmental degradation.

Agriculture plays a crucial role in producing sufficient food for the ever-increasing population and in sustaining livelihoods of people in many developing countries. Agriculture provides a substantial proportion of the rural economy and employment opportunities as well. However, due to the ever increasing pressure on natural resources and environmental degradation, agriculture has shown various indicators of unsustainability, including decreasing landholding, declining soil fertility, increasing use of agro-chemicals (chemical fertilizers, plant protecting materials, etc.), increasing

dependence on external inputs, and land degradation. All these result in declining food production and economic support.

Another remarkable change in agriculture, associated with population increase over the past decades, is increasing land loss. Cropland is lost through urbanization, infrastructure development, housing, soil erosion and many other natural hazards. As a result, the per capita cropland has decreased by 50% in many developing countries, which has forced people to adopt intensive agriculture in order to produce more food from the same or less land, or to expand agricultural activities on to the previously non-agricultural land in order to produce more food from the expansion of cultivation. Scientific development and technological innovation have contributed considerably to the production of sufficient food for the increasing population. These include application of high yielding crop varieties, chemical fertilizers and plant protecting materials. However, their extensive and intensive use has brought about various negative impacts. The wide adoption of the high yielding crop varieties leads to loss of agricultural biodiversity, and extensive use of agro-chemicals have resulted in deterioration in soil physical, chemical and biological properties, and pollution of underground water. To reduce these negative impacts, scientists, as well as farmers, have looked for other options, of which adoption of scientifically sound and environmentally friendly practices has been an important aspect.

Trees are of major ecological and economic importance, but they are a diminishing resource. The requirements for wood products have, however, increased considerably with the fast increase in population. But provision of wood products from forests has decreased greatly because most forests have already been cleared. Many of the remaining natural forests are being protected. How to deal with this issue of increasing demand for wood production and declining capacity of provision is crucial for sustainable development of agriculture and forestry.

Attempts to establish tree plantations in less fertile common lands often fail. A more promising option to reduce pressure on the natural vegetation and to meet demands for wood products is to introduce trees on intensively managed and more fertile soils in croplands (called agroforestry). Trees planted in croplands can provide various benefits. In addition to timber, trees planted in croplands can also provide fodder, fuelwood, medicines and other services, such as soil erosion control, soil fertility improvement, shading, etc.

2. Classification of trees in croplands

There are a number of possible classifications of trees in croplands. From the point of view of function, however, trees in croplands can be classified into windbreaks, living barriers, cash plants, shading, etc. The following sections will provide a brief description of each type.

2.1. Windbreaks

Wind has several negative impacts on agriculture, of which two are direct impacts. The first one is direct damage to agricultural crops and the second one is drought. Wind

erosion is severe in many places, which leads to loss of soil and soil fertility. An often-proposed solution to ease the constraint of wind is the use of windbreaks.

Windbreaks are well-designed, properly-planted and appropriately-maintained one to several rows of trees or shrubs. They can reduce wind speed, ameliorate temperature and soil moisture, and decrease the amount of air-blown soil, hence ameliorating micro-climate of croplands, which will improve conditions for crops, and usually lead to increase in crop yield. In addition, they can also protect crops from domestic and wild animals. Apart from the direct protection function, windbreaks can also provide shading, timber, fuelwood and fodder.

Planting trees around croplands to protect crops has a long history. It was reported that trees were planted around croplands in China to prevent wind erosion in as early as 550 BC. Today, establishment of windbreaks has become a common approach in the areas where wind is a problem for agricultural production.

Protection of crops by windbreaks is one of the most important functions that trees can provide in croplands. There are several types of windbreak forests in croplands. Usually windbreaks can be planted in single or several rows in the direction of frequent wind according to wind characters. Evidence indicates that the windbreaks of 2-4 rows of trees in croplands afford significant protection of crops from wind. Up to 10% of land can be planted with windbreaks without reducing agricultural productivity. Research has indicated that planting windbreaks can increase crop yield and improve soil fertility. Windbreaks of cedar and spruce have been planted in southern Ontario, Canada, to prevent wind erosion of the exposed soil. Field windbreaks in the former USSR reduce the wind speed in the protected fields by 30-40%, and were regarded as "the solution to the major task of rational utilization and conservation of natural resources". However, the results from the different regions on crop yields indicated that yield increments of the protected crops were not consistent and assured under all circumstances.

Though the major function of windbreaks is to reduce wind speed and reduce damage of wind to crops, windbreaks can also provide other benefits, such as leaf litter to enrich cropland soil, shading, and hosts for pests and natural insect enemies. In addition, windbreaks also offer long-term solutions to other problems such as the supply of firewood and livestock fodder.

2.2. Living Barriers of Trees or Shrubs

Soil erosion is one of the most severe problems in cultivation of sloping croplands. Soil erosion leads not only to soil loss and nutrient loss, but often permanent loss of croplands. As a conventional approach, bench terrace has contributed considerably to mitigating soil erosion of the sloping croplands. However, due to some constraints, bench terrace cannot be constructed in many places. Consequently, living barriers or hedgerows of trees or shrubs have been advocated to be a possible replacement for bench terrace.

Thick planting of trees or shrubs along contour lines on sloping croplands has been promoted to solve problems of soil erosion and declining soil fertility. This technology

has been under demonstration and research since late 1970s, mainly in the tropics of Africa and South East Asia. Properly managed contour hedgerows of trees and shrubs have proven helpful in reducing surface runoff by 30-70 per cent, and reducing soil loss by 80-99 per cent. The hedgerows are pruned periodically to avoid shading, and to provide green manure to the companion crops. Usually hedgerows consist of nitrogen fixing plants. The nitrogen fixing plants also add a great amount of fresh biomass and improve soil physical and chemical properties. The most widely-used nitrogen-fixing trees and shrubs include *Leucaena leucocephala, Calliandra calothyrsus, Gliricidia sepium, Flemingia macrophylla,* etc.

2.3. Fruit Trees

Planting fruit trees in croplands has been a long tradition in many developing countries and has been encouraged more recently in order to produce more benefits per unit area of croplands. There are several ways of planting fruit trees in croplands, but usually they are planted on land risers or land boundaries, especially in hilly and mountainous areas in order not to occupy valuable croplands. In many places with limited landholdings, planting of fruit trees along land risers or land boundaries has become an important source of income.

Planting of properly selected fruit trees can double or even triple income of the same land area. For example, in Hanyuan County of Sichuan Province, China, planting of fruit trees and spice trees can increase income by two to three times compared to sole cropping of grain crops. Population growth and decreased landholding also means availability of more labor, which make the planting and management of fruit trees in croplands feasible.

In areas where there are no employment opportunities, there is usually emigration, especially male emigration, which not only causes some social problems in the areas to which emigration occurs, but also leaves problems behind. Adoption of cultivation of fruit trees in croplands, especially on land risers and boundaries offers more employment opportunities, thus local people may not need to emigrate.

Many kinds of fruit trees can be planted in croplands. Pears, peaches, cherries, walnut, chestnut, plums, apricot, mulberry, almonds, litchi, mango, and Chinese dates (fruit of *Ziziphus jujuba)* are some examples.

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Biographical Sketch

Dr. Tang Ya is a professor with Department of Environment, Sichuan University, Chengdu, China. His research fields include plant taxonomy, biogeography and applied ecological studies. He has contributed to the studies of the plant order Malvales, gymnosperms, biodiversity conservation and environmental

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