

CROP-LIVESTOCK FARMING IN THE UPLANDS OF TAIWAN

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ABSTRACT

Taiwan has a very high population density, and there is heavy pressure on its slopeland areas. Geological and climatic conditions make these very vulnerable to erosion. When upland areas are used for agriculture, priority is given to soil and water conservation. This paper describes programs to develop a sustainable system of crop/livestock production in the slopeland areas of Taiwan. The outlook for Taiwan's livestock production in the post-GATT world is discussed.

INTRODUCTION

Taiwan is a mountainous island, with a total land area of 35,980 km², of which 27% is classified as slopeland. The term "slopeland" used in Taiwan refers to areas more than 100 m in elevation or with a slope greater than 5%, excluding national forest.

With Taiwan's rapid economic growth and population increase, the use of slopelands has become very important. Both conservation and utilization of slopeland areas need equal attention, because unfavorable natural conditions can cause rapid soil erosion.

In recent years, livestock production in Taiwan has grown dramatically in response to technical improvements and the increased demand for high-quality foods. There are massive imports of feed grains, and livestock farming has become much less closely connected with locally grown crops. There are also large imports of meat and other animal products. However, certain livestock, such as native beef, native goats, country chickens and dairy cattle, and their products still have a share in the domestic market and give a fairly good profit. Furthermore, livestock manure is often utilized as organic fertilizer that can enrich soil fertility in upland areas. This promotes the further development of crop-livestock farming systems on slopelands.

DEVELOPMENT OF SLOPELANDS IN TAIWAN

Crop-livestock farming systems in slopeland areas are closely related to soil and water conservation and land use planning. There are a number of organizations in Taiwan responsible for slopeland research and development, and most programs are carried out by several of these working in coordination. The Council of Agriculture is responsible for formulating policies and regulations related to soil and water conservation and the use of slopeland resources. Slopeland development is based on the principle of conservation, so as to ensure the proper use of land. Some of the achievements in crop-livestock farming systems for slopelands are as follows:

Slopeland Dairying

The first dairy project was implemented in 1966. Farmers planted pasture grass on slopeland and purchased dairy heifers. The government provided technical services and low-interest loans, and helped with the marketing of milk. At present, there are a total of eleven dairy farming regions on the slopelands of Taiwan. More than 200 upland dairy farms are producing 54 thousand mt of milk each year. Two "youth dairy farming regions" have been

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initiated for selected young farmers who were trained in the United States and New Zealand. Of the eleven dairy farming regions, one has now been converted to a golf links, but the remained ten regions are still operating well. They produce a large part of the total domestic milk production of Taiwan.

Slopeland Pig Farming

It is relatively easy to integrate slopeland pig farming into a crop-manure recycling operation. Under governmental support projects, pig farmers are recommended to use superior breeding pigs and modern housing, and give balanced rations of feed concentrates. In addition to technical advice, the government provides long-term low-interest loans and has set up cooperative marketing channels. Pig farming today is not as closely connected with locally produced crops and agricultural by-products as it was in earlier days, but some farmers still use by-products as feed supplements.

Most hog farms in upland areas are located close to tea plantations and orchards. After the hog manure has been separated into solids and liquids, the solid portion is used as organic fertilizer, helping crop growers to improve the fertility of their arable soils.

Slopeland Beef Farming

From 1966, slopeland farmers were encouraged to raise beef cows in order to propagate calves for sale as a sideline. Dairy beef production was also encouraged by the government in some areas. Unfortunately, imports of cheap beef from Australia have forced most beef farmers to quit beef production. The government spent a large sum of money purchasing their beef cattle so that farmers could repay their loans.

However, some farmers are still continuing to raise water buffalo and cross-bred beef cattle. These animals usually graze on natural pastures under forest trees or on river banks. Agricultural by-products such as bamboo shoot shells, tomato pulp, brewers' grain and discarded vegetables, are used for fattening, thus making it possible to cut down on production costs. Because of its special taste, locally raised water buffalo and cross-bred beef can be marketed at a better price than imported frozen beef. This has enabled some upland beef farms to survive.

Slopeland Goat and Deer Farming

Native goats are usually kept on slopelands,

steep mountains, or on forested land. Leaving them free to forage at will is a low-cost raising system but not an efficient one. It destroys the plant cover, which, coupled with heavy rainfall, can cause serious soil erosion. The government has followed a policy of not encouraging farmers to go into goat production.

However, there is a rising demand for goat meat in Taiwan, where it is used in expensive dishes such as sukiyaki, especially in winter. There is also a strong demand for goat milk as a health food. Since the prices of goat meat and milk are much higher than those for similar products from other livestock, many farmers have become interested in goat production, and are importing high-performance breeds from abroad.

The same also holds true for deer farming in the uplands. The government has never encouraged farmers to raise deer. However, the velvet and deer blood are consumed as medicines, especially when they are fresh. These products can be sold at very good prices, which encourages farmers to take up deer raising. As of 1993, there were 293.6 thousand goats and 28.7 thousand deer being raised in slopeland areas. Around 150 thousand goats and 5.9 thousand deer were born in the course of that year.

HIGHLIGHTS OF CROP-LIVESTOCK RESEARCH AND DEVELOPMENT

Forage Production and Pasture Development

Napier grass and Pangola grass are the two main pasture species in Taiwan (Huang 1990). Dairy farmers do not usually graze animals on pasture, but keep them penned and feed them on cut grass. However, higher economic benefits can be obtained when animals are able to graze, while their manure is returned to the soil to enrich its fertility.

Cheng *et al.* (1988) conducted a study on pasture development on steep, rolling uplands using a bulldozer and backhoe. It was found that more soil erosion occurred when both bulldozer and backhoe were used together on steeper land, where more earth had to be moved, compared to the plots reformed by bulldozer or backhoe alone. The plot where the bulldozer was used also had some soil erosion when land reformation exposed the topsoil.

Hsu (1990) recommended that Pangola grass is the best species for hay making, although Napier grass gives the highest production of dry matter per hectare. A dwarf line of Napier grass with a high leaf/stem ratio and good feeding quality is

suitable for grazing animals.

Management of Dairy Cattle Grazing

Chang (1990) conducted a study of dairy cattle on upland pastures. The results showed the significant effect temperature had on the diurnal eating activity of dairy cattle, with feed intake higher in cooler weather. Whatever the daily temperature, however, there were two major peaks of intensive eating activity regardless of season. One occurred at around 0800 in the morning, while the other was around 1800 in the afternoon. When the temperature exceeded 32°C on summer mornings, most cows stopped grazing until 1500 hours.

Chen *et al.* (1989) divided a Pangola field on slopeland into four lots. The grass was grazed when it had reached a height of 70, 84, 94 or 112 cm. The interval between grass heights was five days, while the grazing period in each lot was three days. The results indicated that the quality of Pangola grass deteriorated as the grass grew increasingly tall. The protein content decreased, while the acid detergent fiber and acid lignin content increased. In this study, the plot grazed when the grass reached a height of 84 cm had around 30% waste grass, which was the lowest figure of the four different height groups.

Beef Cattle Management

Hsieh (1990) used four tropical grasses (i.e. Pangola grass, Guinea grass, dwarf elephant grass and South African pigeon grass) that were grazed by seven Holstein steers during the first year and 60 Nubian-native goat hybrids during the second year. The results showed that Pangola grass gave the highest rate of average daily gain for cattle,

and Guinea grass the second highest. Pangola grass and dwarf elephant grass gave the highest weight gain in the case of goats (Table 1).

Chen *et al.* (1992) conducted a study of cattle grazing in forest. Mahogany saplings were planted in established forest at a low elevation, and pregnant buffalo cows were grazed in the forest a year after planting. The results indicated that the average carrying capacity over two years for herds practicing heavy grazing was 0.18 animal units (AU)/ha, with 0.10 AU/ha for lightly grazing groups. The cost of weed control during the experimental period was US\$241/ha for the heavy group, and US\$210/ha for the light grazing group, compared to US\$646 for the ungrazed control. The results indicate that cattle grazing reduced the cost of weed control, as well as providing an additional source of income while the mahogany trees matured.

Goat Management

Chang (1990) conducted a study of the effects of goat grazing pressure on the rate of soil erosion in tropical Pangola grassland. Sixty-four crossbred yearlings (Nubian x native goats) were assigned to two treatments of grazing intensity, namely, heavy grazing (64 animals/ha) and light grazing (32 animals/ha). Ungrazed grassland served as the control. The results showed that there was no significant difference in soil properties, in terms of specific gravity, infiltration rates and erosion rates, between the two treatments ($p > 0.05$). The growth performance of the goats was not influenced by heavy grazing. Since it seems that goat grazing at the relatively high stocking density of 64 animals/ha had no detrimental effect on soil erosion on established Pangola grassland, the recommended carrying capacity in this area is now 60-65 goats/ha.

Another goat grazing experiment was carried out by Chang (1993), who studied the dry matter

Table 1. The performance of cattle and goats grazing on 4 pasture grasses

	ADG		Total weight gain (kg/ha)	
	Cattle	Goats	Cattle	Goats
Pangola grass	0.81	0.046	480	231
Guinea grass	0.61	0.045	375	221
Dwarf elephant grass	0.58	0.046	305	258
South African pigeon grass	0.50	0.031	260	341

ADG: Average daily gain (kg).

(DM) yield per hectare, average daily gain (ADG), total gain (TG) and soil erosion (SE) rates on four species of pasture grass. The results indicated that dwarf Napier grass was found to be the most suitable species for goat grazing of the four pasture species tested, in terms of average daily gain and total weight gain, while Pangola grass gave the poorest results (Table 2). This is in contrast to the findings of Hsieh 1990 (see above), who found in the second year of his experiment that Pangola was the most productive pasture grass for goats.

Farm Extension on Slope lands

Before 1965, soil conservation work was carried out mainly on individual scattered farms. This meant high treatment and maintenance costs, while it was difficult to protect farms from adjacent untreated areas. Integrated conservation programs are now the standard practice. They include proper conservation practices and improved farm facilities such as farm roads and irrigation and drainage systems, as well as providing technical guidance for farmers to help them use land profitably. An area of 50 ha is regarded as the minimum size for implementing a project, which means a group of around 20 - 30 farms.

When an integrated program is being planned, the specific procedure is as follows:

1. Farmers have to specify their requirements and ask their local Soil Conservation Work Station of the Provincial Government's Soil and Water Conservation Bureau to participate in the program.
2. The Soil Conservation Work Station reviews the feasibility of the proposed program. Technicians and farmers discuss the problems which may be encountered during the course of the project.
3. After field technicians have undertaken the initial screening, the location which

has been selected for the new project is jointly reviewed by the Soil and Water Conservation Bureau of the Council of Agriculture, and other official agencies concerned.

4. After final approval of the project, a planning and survey team, which generally consists of a soil conservationist, engineers, agronomists, soil scientists, livestock specialists, horticulturists, etc., will conduct a survey and make a detailed technical proposal.
5. A project committee is normally selected by farmers in each project area, before or during the planning and design stage.
6. When planning is completed, necessary project funds are allocated under a cost-sharing scheme. Participating farmers and local government are requested to contribute part of the project funds, while 60 - 80% of the total budget is subsidized by the government. Long-term low-interest loans are also provided to farmers.

PROBLEMS AND CONSTRAINTS

Management

Early this century, backyard animal production was relatively common in upland areas. Small-scale producers used a wide range of agricultural by-products such as sweet potato vines, peanut vines and banana stems to feed their pigs. Many families owned one or two head of water buffalo or native yellow cattle, which were grazed on unimproved upland pastures.

Native chickens were also raised in backyards, or sometimes in fruit orchards. In the past, most livestock and poultry were raised as part of an integrated crop-livestock production system. In recent decades, with rapid economic development,

Table 2. Performance of goats grazing on different pastures

	Yield ¹ (mt/ha)	Av. daily gain (kg)	Total gain (kg/ha)	Soil erosion (cm)
Dwarf Napier	21.36	0.036	483.0	
South African pigeon grass	16.08	0.022	271.0	0.57 ²
Guinea grass	15.87	0.018	259.0	1.60 ³
Pangola grass	14.40	0.018	217.0	

1: Dry matter basis

2: Lowest erosion

3: Highest erosion

the number of animals raised per farm has expanded, while the number of farms raising livestock has fallen (i. e. livestock farms have become fewer and larger). This has loosened the connection between crops and livestock. However, forage crops and grasses are still used as the main roughage feed for ruminant animals, while various agricultural by-products are used as supplementary feed for beef fattening.

Socio-economics

Taiwan is one of the most densely populated countries in the world. The population increased 2.54 times between 1952 and 1991. In 1952, the average farm size was 1.29 ha while each hectare had to support 9.3 persons. By 1991, farm size had fallen to only 1.08 ha, but each hectare had to support 23.3 persons. Consequently, an increasing number of farmers moved onto slopelands and began to cultivate steeper land, especially during the 1960's. This cultivation of marginal lands is the main human factor causing serious and widespread erosion.

The expanded size of livestock farms means that forage crops and pasture supplied by the farm itself are insufficient for animals' needs. Most dairy farmers, for example, have to purchase additional grass from specialized grass producers, or buy imported hay. This helps them to maintain a herd of economical size and make a relatively good profit. With regard to pig farming, agricultural by-products are no longer used as the main feedstuff. However, with the help of convenient farm roads and good transportation, pig farmers in upland areas can easily purchase breeding pigs and concentrates from outside, and take their meat pigs to market. This means that pig farms on slopelands can be as large as those down on the plains.

Technical Issues

Taiwan's various livestock research institutes do not only carry out experiments, but are also responsible for livestock farm extension. Farmers in slopeland areas can obtain as good technical information and assistance as those on the plains. Many local farmers' groups have been organized, to make it easy for members to exchange their farming experiences and to obtain advisory assistance from research institutes. In addition, various technical video tapes and printed materials are available for farmers. Periodic visits by teams of livestock experts provide a good chance for farmers to contact researchers directly, and as a result, their technical farming problems are usually solved.

Environmental Constraints

The average annual rainfall in Taiwan is around 2500 mm, but in high mountain regions it rises to around 3000 mm. However, 78% of the rainfall is concentrated over the summer, from May to October, especially during the typhoon season between July and September. This concentrated, heavy rainfall, plus the fact that much of the parent rock is soft mudstone and shale, causes frequent landslides which damage farmland and block roads.

Nearly all slopeland soils are subject to serious erosion when exposed. In slopeland areas, soil are generally shallow in depth, acid in reaction, low in soil fertility and vulnerable to soil erosion. According to one survey, the average rate of soil erosion in Taiwan was 4.8 mm per year. Soil erosion is not usually found on grass pasture, because the coverage of grass is so good that the soil is not directly exposed.

CONCLUSIONS

Taiwan's area of flat land area is only one third of its total land area. Slopelands are therefore important in its efforts to produce more agricultural products. However, because of the unfavorable geological conditions of mountains and uplands, improper land utilization causes serious soil erosion.

When upland areas are used for agriculture, the control of soil erosion and water run-off must be a major concern. Organizations which plan to initiate crop-livestock projects should comply with conservation needs and regulations. Every project should be conducted in such a way that no soil erosion occurs.

Once Taiwan becomes a member of GATT, the domestic market will be opened to a greater range of imported products. Under competition from imported products, it will not be easy to increase the production of locally produced animal products. From this point of view, there may not be much need for improved livestock farming on slopelands. However, the government must adjust its agriculture policies to help farmers to reduce their production costs and improve the quality of what they produce.

Certain types of livestock farming that yield products with strong competitive potential will continue to develop. In order to strengthen their competition ability, the government must maintain its support for related institutes to conduct projects on both research and extension. Improvements in forage crop production will help maintain a link be-

tween crops and livestock in upland areas.

Slopeland soils are shallow and low in fertility. Animal manure is a good source of organic fertilizer that can enrich soil fertility and help to promote crop production. The combination of animal and plant production forms an ideal integrated crop-livestock farming system in the uplands of Taiwan.

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DISCUSSION

Dr. Chen was asked whether the density of water buffalo under woodland, at a maximum of around 0.18 animal units/ha, was profitable for the farmer. Furthermore, buffalo like to wallow, and he was asked whether there was any negative impact from keeping them in woodland. Dr. Chen pointed out that the main purpose of keeping the water buffalo under forest was to control weeds. Since the carrying capacity was very low, there appeared to be no health problems from this system, even though the buffalo were unable to wallow.