COMBINED FORESTRY AND LIVESTOCK PRODUCTION IN THE UPLANDS OF KYUSHU, JAPAN

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ABSTRACT

A production system which combines farming, animal husbandry and forestry has long been established in the hilly land of the Kyushu region, where 80% of the land is under forest. To sustain the system, however, has now become difficult because of the problems with forest products. The demand for these is rather low, and supplying them makes a heavy demand in terms of time and labor. Some farmers in Oita prefecture have recently introduced a species of oak trees (Quercus acutissima Carruth.) onto their forested land. The harvested logs are used for the production of mushrooms, which give a good income. Furthermore, the forest itself is used as woodland pasture for beef cattle. This grazing reduces the time and labor required for weed control in the forest, so that farmers can concentrate on the production of mushrooms and vegetables. The mutual benefits derived from the interactions between livestock husbandry and forestry is considered a key factor in improving the agriculture of these hilly lands.

INTRODUCTION

Kyushu is one of the four main islands in the Japanese Archipelago. Its climate is characterized by wide seasonal variation in temperature and high precipitation (over 2500 mm annual rainfall). Farming systems on hilly land must therefore take into account the need for soil and water conservation. On steeper slopes, forest cover is needed to retain the soil.

As Fig. 1 shows, farmers in Kyushu make suitable use of arable land, pasture and forest according to the degree of slope, and have a traditional farming system based on a combination of farming, animal husbandry and forestry.

Utilization of the forested area, however, has declined in recent years, because forest products such as lumber and pulpwood must compete with cheap imports, while forestry operations require much time and labor. To compensate, some farmers prefer to grow short-term crops on steep slopes after the timber has been cut. Such areas have to be abandoned after a few years because of severe soil erosion.

In one area, farmers have developed a more intensive system which combines livestock and forestry. This system is discussed in full in the following Bulletin.

THE SETTING

The village of Souzu is in Oita prefecture in central Kyushu. There is only a small area of arable land: 80% of the land area is under forest, 15% under grass and 5% under crops. The majority of farmers living in the village practice an agricultural system which combines crop farming with animal husbandry and forestry. Most of their income comes from the sale of beef calves, forest products and vegetables. The cereals they grow are mainly consumed by themselves and their families.

Some farmers have recently introduced a species of oak called “Kunugi” (Quercus acutissima Carruth.) into their forest. This species is a deciduous, broad-leaved tree which sometimes forms a native forest in Japan. They use the logs of the Kunugi trees for the cultivation of shiitake mushrooms (Lentinus edodes Sing.). The oak forest itself

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Table 1. Source of farmers' incomes in Souzu village, Japan

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<th>Vegetables</th>
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<td>Farmer C</td>
<td>20</td>
<td>20</td>
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All three farmers are growing Shiitake mushrooms on harvested 'Kunugi' oak trees, and grazing beef cattle under the growing trees.

Fig. 1. Schematic presentation of agricultural land use in the hilly lands of Kyushu, Japan

KUNUGI FORESTRY AND MUSHROOM PRODUCTION

Fig. 2 shows the system of producing Kunugi oak trees. Initially, artificial Kunugi oak forest is established by planting seedlings. The trees are usually cut when they reach a height of about 15 m. The stumps are left in the ground, and regenera-
Fig. 2. Forestry procedures in the production of Kunugi oak (*Quercus acutissima*)

The regeneration of the forest occurs automatically when the coppice grows from the stumps. Thus, kunugi trees can be harvested repeatedly every ten or twenty years, without any need to replant.

Farmers, however, need to harvest fresh Kunugi trees every year, so that a year later they can be used for mushroom production. They thus divide their forest into numerous small sections, each containing trees of the same age, and cut one section each year in rotation. This partial deforestation enables forested land to retain its function of soil and water conservation.

Until the trees are harvested, the most important part of forest management is to control perennial grasses such as *Miscanthus sinensis* Anderss. and *Pleioblastus variegatus* Makino etc., and vines such as *Pueraria hirsuta* Mtsum. and *Akebia quinata* Decne etc. growing on the forest floor, because these weeds grow aggressively and seriously inhibit the growth of Kunugi trees. To control them, farmers have to cut them every year using a scythe or small mower. Farmers find it difficult to find time for this kind of weed control, especially since it is carried out during the warm season when they are busy with other work such as the cultivation of mushrooms and vegetables.

When Kunugi trees are harvested for mushroom production, the felled trees are immediately sawn into logs 1 m long. Chips of hardened material containing Shiitake mushroom spore and various plant nutrients are inserted into each log. The logs are then left for one year, cleaned and then set up in the shade, often in a net house. Shiitake mushrooms germinate on the log after a week and grow by consuming nutrients in the log. When the mushrooms have reached the size of an egg they are harvested, and marketed either dried or fresh.

### BENEFITS OF THE WOODLAND PASTURE

In conventional forestry, grasses and vines growing in the forest were controlled by cutting them. However, when beef cattle were grazed in woodland pasture, weed growth was so weakened that farmers no longer had to carry out weed control operations. The time and labor this saved could be used for other work such as the cultivation of mushrooms and vegetables.

It was also found that the manure from grazing cattle accelerated the growth of the Kunugi trees, so that the intervals between harvests became several years shorter.

### GRAZING RESOURCES IN THE WOODLAND PASTURE

Beef cattle were grazed from April to November in the woodland pasture, and in winter were kept in sheds and fed on rice straw, hay, and various fodder crops. Fig. 3 shows yearly changes in the height of Kunugi trees in the woodland pasture, and the effect of tree height on light intensity and forage mass. As the Kunugi oak trees grow, the forest floor becomes darker. By the end of the cycle, when trees...
were ready to harvest, light intensity was only 9% of the level recorded during the first year. As a general rule, the productivity of forage species declines sharply under heavy shade, but this was not seen in the Kenugi forest. The reason is probably the photosynthetic characteristics of *Pleioblastus variegatus*, which has the ability to carry out photosynthesis under shadier conditions than most other grasses (Fig. 4).

The fact that the woodland pasture had been divided into many small sections, each with trees of the same age, also helped. This meant that the average light conditions over all the sections was at a relatively high level (about 30% of the relative maximum light intensity). These factors enabled the herbage mass in the woodland-pasture to maintain itself at a stable level year by year. It was estimated to be about 250
gDM/m² at its maximum at the height of the growing season, although the range of the herbage mass in each section was extremely wide (171 - 553 gDM/m²). The carrying capacity of the woodland pasture is considered to be one-third that of improved pasture.

PROBLEMS IN THE WOODLAND PASTURE

Over-grazing is generally recognized to be a major cause of soil erosion. Kunugi woodland pasture has higher resistance to soil erosion than pasture, because the canopy and root systems of the trees protect the soil. However, forest floor covered with grasses will become bare ground if over-grazing occurs. When this happens, grazing cattle often browse on the young branches of Kunugi oak trees. The growth of trees used as browse is seriously delayed. It is very important to avoid heavy grazing when the trees are in leaf.

On the other hand, the quality of forage growing on the forest floor during the cold season of the year was insufficient to meet the nutrient requirements of the beef cattle. In order to improve their feed supply, there has been an attempt to introduce improved grasses into the forest. While this program succeeded in establishing improved grasses, their growth fell year by year due to light deficiency. There is a need for research on the selection of grass species adapted to shady conditions.

CONCLUSION

Most of the hilly land of Japan, including that of the Kyushu region, is covered in forest vegetation. There is a national consensus on the need for soil and water conservation in such areas. However, the amount of arable land and pasture is not sufficient for the farmers who live there. Thus, the best strategy for the agricultural use of hilly land is believed to be a system which combines forestry with farming and animal husbandry. The bottle-neck in such a system in Kyushu is the low value and marketability of forestry products, and the time and labor it takes to produce them.

The first step must be to raise the value of forest products. This is accomplished by making a processed good from the raw material. The production of mushrooms using the logs harvested from Kunugi forest, as found in Souzu village, can be considered a good example of this. Second, the utilization of forest as a woodland pasture should be developed, because the grasses growing on the forest floor are suitable as a livestock feed. Furthermore, in the case of Kunugi woodland pasture in Souzu village, the grazing by beef cattle saved time and labor required for weed control operations, while their manure stimulated the growth of the trees. The mutual benefits derived from interactions between forestry and animal husbandry are a key factor in improving a combined system on hilly land.

For such improvements to occur, it is clear that long-term support by national and the local programs for slopeland farmers is essential. Their resources are too small to fund reforestation, unless they can earn some source of income while they are waiting for their first harvest of trees.