

## 1. Overview

### (1) Background and features of the practice

“Compound and multi-layered land use” means building a functional resource circulation system by horizontally and vertically combining various land uses to maintain the capacity to supply various ecosystem services that are required in the region. Such practices have been implemented for centuries in many areas around the world as a method to sustainably use and manage natural resources.

In the meantime, with the effects of economic globalization, such practices are quickly being transformed into uniform land uses such as large plantations, pastures, and afforested areas. The balance of the original ecosystem services has collapsed in these areas and negatively affected the productivity of agriculture and forestry and lifestyles of local people.

In addition, some areas where such massive land use transformation has not occurred are also experiencing problems; such as stagnation in agricultural and forestry practices. This has driven people to abandon the management of agricultural land and forests and is producing monotonous land use or vegetation.

Under such circumstances, people are regaining an appreciation of the effects of compound and multi-layered land use on today’s society as a method to restore the sustainable use and management of natural resources. Efforts to reintroduce such practices have started around the world.

### (2) Details of the practices and their applicability

There are roughly two types of multi-layered and compound land uses: vertical, multi-layered land use; and horizontal, compound land use. These two types are combined in some practices.

#### 1) Vertical multi-layered land use (agroforestry and others)

##### i. Details of the practice

- In this practice, trees are planted or wild trees are left in an area where livestock are raised or agricultural crops are cultivated. This is a land use practice that uses one space in a vertical direction in multi-layered ways.
- In addition to the dense use of space, this practice enables an overall increase in productivity by establishing functional material circulations, for example trees in the upper layer providing shade and nutrition to lower layers.
- Major examples include agroforestry (combined agricultural and forestry practices in the tropics) and dehesa (a forest-farming system in the Iberian Peninsula).

##### ii. Range of application

- This practice may be applicable to many types of areas as long as the area can sustain forests. However, natural conditions such as weather and topography significantly affect the complexity of this hierarchy and components of individual layers such as vegetation, animals, agricultural crops, and livestock.
- Multiple hierarchies can be established in the tropics where vegetation productivity is large, but the hierarchy tends to be relatively simple in temperate regions and dry regions (example: vegetation – livestock – feed crops)

- iii. Implementing bodies
- Managers of agriculture and forestry

[Cases]

In Japan No.9: Regional circulation that combines biogas power generation with agriculture and livestock husbandry in Kyotango City, Kyoto Prefecture, Japan

Around the world No.8: Homegardens: sustainable land use systems in Wayanad, Kerala, India

## **2) Horizontal compound land use (home gardens, mosaic land uses, and others)**

i. Details of the practice

- This is a horizontal compound use of a space through the allocation of different land uses, such as agriculture, woody areas, and grasslands, in a mosaic pattern or by combining multiple types of flora, fauna, and their growth phases within one land use.
- This practice enables an improvement in overall productivity by establishing relationships between different land uses, such as using the fallen leaves and bottom grass of forests as fertilizers in agricultural land.
- Representative examples of various mosaic land uses include home gardens in Indonesia, maul in Korea, and the *Satochi-Satoyama* project in Japan.
  - \* *Home gardening is a practice that combines horizontal compound land use and vertical multi-layered land use.*
- Representative examples that combine different flora, fauna, and their various growth phases include nomadic seasonal livestock movement in the dry regions and separated feeding using different types of livestock.

ii. Range of application

- This practice may be applicable to a wide range of regions, however, depending on natural conditions such as weather and topography, the types of land use, animal and plant species, and complexity of horizontal components vary greatly.

iii. Implementing bodies

- Managers of agriculture and forestry

[Cases]

In Japan No.1: Beef cattle farming inheriting traditional "makihata" in Nishinoshima Town, Okinawa Islands, Shimane Prefecture, Japan

Around the world No.2: Use and management of "muyong" in Ifugao province, northern Luzon island in the Philippines

Around the world No.3: The management and use of the natural resources in a mountain village of central Vietnam

Around the world No.7: Creation and management of diverse secondary forest in central Sulawesi, Indonesia

Around the world No.10: Natural resources use and management in Malawi

Around the world No.21: The Ayllu system of the Potato Park (Peru)

Around the world No.22: Land use and biodiversity on Chacras in northeast Argentina

Around the world No.25: Living by utilizing various modified natural resources in the Solomon Islands

## **2. Effects obtained from these Cases regarding the sustainable use and management of natural resources**

Introducing the practices in this category will likely have the following effects on the sustainable use and management of natural resources and maintenance of a healthy secondary nature.

### **(1) Effects on the sustainable use and management of natural resources (socioeconomic effects)**

- Stabilization and improvement in agricultural, forest, and stockbreeding productivity can be expected through realization of dense use of space or efficient use of space through an optimal layout.
- Improvements in the simultaneous use of multiple provisional services (food, fuel, and materials) and supporting services (soil formation and pest prevention) can be expected through the diversification of species and growth phases within an area.
- Since the timing and place of natural resource collection become diversified, natural resources will no longer be collected in large areas. Therefore, it is expected that regulating services (including the prevention of soil erosion, microclimate modification, storm protection, and water retention) will stabilize.

### **(2) Effects on health of secondary nature (effects on the ecosystem and biodiversity)**

- With the effects described above, it is expected that the health of the secondary nature such as agricultural land and forests will increase through the alleviation of overexploitation or under-exploitation of natural resources by humans.
- By combining various vegetation in vertical and horizontal directions, it is expected that diversified niches and habitats will be established and biodiversity including wildlife will improve.

### 3. Toward the implementation of this practice : Points of planning and examples of action items based on the “Five Perspectives” of the SATOYAMA Initiative

The points for planning the introduction of practices in this category and action items are as follows.

Table: Points of planning and action items based on the “Five Perspectives” of the *Satoyama* Initiative

“Five Perspectives” of the <i>Satoyama</i> Initiative	Points of planning	Action items
(1) Resource use within the carrying capacity and resilience of the environment	<ul style="list-style-type: none"> <li>It is necessary to set a goal to improve the available amount of natural resources and ecosystem services based on the current conditions and issues associated with the use and management of natural resources.</li> </ul>	<ul style="list-style-type: none"> <li>Sort out current conditions and issues associated with the use and management of natural resources.</li> <li>Set a goal for multi-layered and compound land use.</li> </ul>
(2) Circulic use of natural resources	<ul style="list-style-type: none"> <li>It is necessary to determine the composition of crops and livestock that enables the establishment of functional resource circulation based on natural and socioeconomic conditions of the locality.</li> </ul>	<ul style="list-style-type: none"> <li>Determine the composition of crops and livestock.</li> </ul>
(3) Recognition of the value and importance of local traditions and cultures	<ul style="list-style-type: none"> <li>It is necessary to compare traditionally practiced multi-layered and compound land uses with the new plan to make sure that the new plan is in harmony with the local natural conditions.</li> <li>Rather than simply reapplying traditional knowledge, it is necessary to maintain harmony with modern socioeconomic conditions (such as the market needs) by integrating modern scientific technologies.</li> </ul>	<ul style="list-style-type: none"> <li>Reevaluate traditional practices and reflect them in the plan.</li> </ul>
(4) Natural resource management by various participating and cooperating entities	<ul style="list-style-type: none"> <li>It is effective to establish support systems involving public bodies and scientists and community-based cooperating systems when necessary.</li> </ul>	<ul style="list-style-type: none"> <li>Establish support and cooperating systems.</li> </ul>
(5) Contributions to local socio-economics	<ul style="list-style-type: none"> <li>It is necessary to have socioeconomic support toward the establishment of a market for sustainable agriculture, forestry, and fishery.</li> <li>It is important to implement systematic education, human resource development, and capacity development to ensure proper and wide-range promulgation.</li> </ul>	<ul style="list-style-type: none"> <li>Plan socioeconomic support.</li> <li>Plan education, human resource development, and capacity development.</li> </ul>

## (1) Resource use within the carrying capacity and resilience of the environment

<b>Points of planning</b>	<ul style="list-style-type: none"> <li>It is necessary to set a goal to improve the available amount of natural resources and ecosystem services based on the current conditions and issues associated with the use and management of natural resources.</li> </ul>
<b>Action items</b>	<ul style="list-style-type: none"> <li>Sort out current conditions and issues associated with the use and management of natural resources.</li> <li>Set a goal for multi-layered and compound land use.</li> </ul>

Currently, the overuse of natural resources through uniform land use (including large-scale plantation) has led to problems such as a deterioration of ecosystem services, drops in agricultural productivity, and a degraded living environment in some areas. In such areas, it would be effective to shift to multi-layered and compound land use and to expand the use of natural resources within the renewable capacity of the environment.

Contrasting this, in areas with weakened ecosystem services due to the under-exploitation of natural resources (such as abandoned cultivation and forest management), it is also effective to create new value in using natural resources and improve ecosystem services by converting these areas for multi-layered and compound land use.

In order to take full advantages of these effects, it is necessary to select a suitable goal from various multi-layered and compound land use methods that is in harmony with local natural and socioeconomic conditions, considering current situations and issues on the use and management of local natural resources.

Table: Examples of goals based on problems associated with the use and management of local natural resources

Problems associated with the use and management of natural resources		Examples of setting a goal of multi-layered and compound land use practices	Effects on the improvement of the available amount of natural resources and ecosystem services
Overexploitation	Deterioration of ecosystem services from large-scale agricultural development, and others (such as large-scale plantation and livestock farming)	[Vertical multi-layered land use] <ul style="list-style-type: none"> <li>A possible practice is to convert to shade farming or agroforestry by planting trees in agricultural land.</li> </ul>	<ul style="list-style-type: none"> <li>An increased amount of available natural resources can be expected from introducing plants that can be used as food, fuel, or materials.</li> <li>Through growing forest, improved regulatory and supporting services, and thereby improved agricultural productivity and living conditions in the surrounding areas, can be expected.</li> </ul>
		[Horizontal compound land use] <ul style="list-style-type: none"> <li>A possible practice is to create mosaic land uses by establishing buffer zones such as forests in some parts of agricultural land.</li> </ul>	
Under-exploitation	Deterioration of ecosystem services due to the deterioration of abandoned farmland and fallow fields	[Horizontal compound land use] <ul style="list-style-type: none"> <li>A possible practice is to establish mosaic land use which combines surrounding agricultural land and communities by growing forests in abandoned farmland and fallow fields.</li> </ul>	<ul style="list-style-type: none"> <li>Although the forest stock temporarily decreases, a sustainable collection of agricultural crops and livestock products can be expected.</li> <li>Improved regulatory and supporting services, and thereby increased agricultural productivity and an improved living environment in the surrounding areas, can be expected from the improved health of forests.</li> </ul>
	Deterioration of ecosystem services due to insufficient management of afforested areas and secondary forests	[Vertical multi-layered land use] <ul style="list-style-type: none"> <li>A possible practice is to convert to forest grazing or agroforestry by conducting farming or grazing in the bottom part of forests.</li> </ul>	

## (2) Cyclic use of natural resources

<b>Points of planning</b>	<ul style="list-style-type: none"> <li>It is necessary to determine the composition of crops and livestock that enables the establishment of functional resource circulation based on natural and socioeconomic conditions of the locality.</li> </ul>
<b>Action items</b>	<ul style="list-style-type: none"> <li>Determine the composition of crops and livestock.</li> </ul>

In order to optimize the effect of implementing multi-layered and compound land use, it is necessary to establish an organic, mutual relationship among various elements, in addition to combining these elements. Material circulations in agriculture and forestry are not confined within the area where these practices are conducted; rather, the circulations are connected to the surrounding areas through emission of fertilizers and waste. Thus, it is necessary to maintain a balance with all of the natural resources of the area.

When considering a conversion into compound, multi-layered land use, it is necessary to select crops and livestock that are compatible with the surrounding ecosystem based on the area's natural conditions such as the weather, soil, vegetation, and topography and select a complementary and synergistic combination of crops and livestock.

Since local ecosystems and traditional knowledge often provide important clues for an effective composition of crops and livestock, it is important to examine them.

In addition to harmony with the natural conditions, it is essential that the crops to be harvested and livestock to be raised are a viable means of livelihood. In order to minimize reductions in productivity and income before reaching a stable phase of multi-layered and compound land use, it is effective to employ vegetation that grows quickly, is useful as a food or cash crop, and has soil improvement effects.

Table: Examples of combining crops in vertical, compound land uses  
(Agroforestry in the Amazon area of Brazil)

Level	Required conditions (example)	Crops (example)
Tree layer	<ul style="list-style-type: none"> <li>Creates large amounts of shade</li> <li>Useful in various ways such as clothing, food, and housing</li> </ul>	Nuts Large palms
Sub-tree layer	<ul style="list-style-type: none"> <li>Grows well in the sun.</li> <li>Useful for food and cash crops</li> </ul>	Citrus Palms
Shrub layer	<ul style="list-style-type: none"> <li>Grows well in shades</li> <li>Useful for food and cash crops</li> <li>Grows fast and allows continuous harvesting</li> </ul>	Coffee Cacao
Herb layer	<ul style="list-style-type: none"> <li>Grows in infertile soil</li> <li>Covers the soil and provides nutrients to the soil</li> <li>Useful as a staple food</li> </ul>	Potatoes Peas

### (3) Recognition of the value and importance of local traditions and cultures

<b>Points of planning</b>	<ul style="list-style-type: none"><li>• It is necessary to compare traditionally practiced multi-layered and compound land uses with the new plan to make sure that the new plan is in harmony with the local natural conditions.</li><li>• Rather than simply reapplying traditional knowledge, it is necessary to maintain harmony with modern socioeconomic conditions (such as the market needs) by integrating modern scientific technologies.</li></ul>
<b>Action items</b>	<ul style="list-style-type: none"><li>• Reevaluate traditional practices and reflect them in the plan.</li></ul>

Some forms of traditional multi-layered and compound land use have been practiced in areas around the world where people have been living for centuries. The wisdom of functional material circulations and selecting crops and livestock that suit natural conditions, as well as the knowledge of useful organisms that have been accumulated in these practices often provide valuable clues to verify the compatibility of a new plan with local natural conditions.

Meanwhile, since the socioeconomic conditions that surround the area have drastically changed, it is possible that a simple reapplication of traditional knowledge will not result in sufficient effects.

Thus, when introducing new practices, it is necessary to verify that the plan is in harmony with local natural conditions by comparing it with traditional knowledge and at the same time maintaining harmony with current socioeconomic conditions (such as market needs) through the use of modern technologies.

For example, agroforestry in the Amazon area of Brazil refers to knowledge of multi-layered structures that indigenous people created. In the meantime, in order to be in harmony with current market needs, crops obtained through agroforestry are processed into products such as the materials used in automobile interiors and paper.

### (4) Natural resource management by various participating and cooperating entities

<b>Points of planning</b>	<ul style="list-style-type: none"><li>• It is necessary to establish support systems involving public body and scientists as well as community-based cooperative systems when necessary.</li></ul>
<b>Action items</b>	<ul style="list-style-type: none"><li>• Establish support and cooperating systems.</li></ul>

If land owners who wish to employ multi-layered and compound land use do not have sufficient knowledge, information, or skills, then support from government organizations, international organizations, NPO/NGO, researchers, or other people who do have them will be effective.

Rather than introducing this practice to each individual land owner, it is more effective to facilitate synergy effects and consensus building by creating a community-based effort in which multiple land owners and residents cooperate and work on this practice as they share their knowledge and experience.

## (5) Contributions to local socio-economies

<b>Points of planning</b>	<ul style="list-style-type: none"><li>• It is necessary to have socioeconomic support toward the establishment of a market for sustainable agriculture, forestry, and fishery.</li><li>• It is important to implement systematic education, human resource development, and capacity building to ensure proper and wide-range promulgation.</li></ul>
<b>Action items</b>	<ul style="list-style-type: none"><li>• Plan socioeconomic support.</li><li>• Plan education, human resource development, and capacity building.</li></ul>

Agricultural, forestry, and fishery products obtained through sustainable production methods require more labor and incur more costs than conventional products; thus, their sales prices in the market tend to be higher than conventional product prices.

In order to alleviate such economic barriers, it is effective to regard the increased price as the value of social benefits of ecosystem services and biodiversity and seek social understanding or acceptance of the burdens associated with these benefits. Specific examples of such efforts include the certification of farmers, foresters, and fishermen or their products (certificates of organic products in individual countries, FSC certification, and MSC fishery certification) to promote selective purchasing by consumers.

In order to ensure proper promulgation of the practice, it is effective that public entities such as government organizations, international organizations, NPO/NGO implement systematic education, human resources training, and capacity building programs targeting local residents.