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MEASURING AGRICULTURAL LANDSCAPE INDICATORS FOR POLICY APPLICATIONS

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Abstract
Agricultural landscapes consist of physical, biological and cultural elements and reflect the interaction between farming and the environment. Increasing recognition of landscape services and societal demand for the policy response require monitoring and evaluating the stock and state of agricultural landscapes. This study aims to propose indicators for agricultural landscape and their uses in policy design and implementation. The constructed indicators include terraced paddy fields, levees of environment-friendly paddy fields, stone walls, changes in land-use patterns and their diversification. Estimations of the indicators show mixed results over a span of about 40 years. Gains in lengths of the levees for environment-friendly paddy fields and stone walls contrast with the progress of contraction, intensification, concentration and homogenization in land-use patterns. Additional guidelines are identified for ensuring policy relevance of the indicators.

I. Introduction

Developing agri-environmental indicators (AEIs) has evolved in response to growing public concerns in environmental issues and policy interests in

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obtaining information on states and trends of economic and social performance (Bonnen 1997). Efforts to establish environmental indicators were driven by the Brundtland Report in 1987 and the 1992 United Nations' Earth Summit resulting in the set of Sustainable Development Indicators in 2001 (UNESC 2010; UNCSD 2001). The most comprehensive study of AEIs has been carried out by the OECD since the 1980s (OECD 1999; 2001; 2008). On top of the initiatives driven by international agencies, a number of developed countries are increasingly exploring AEIs to monitor and evaluate the linkages between the environment and agricultural policies.

For example, the European Union has developed a set of AEIs for monitoring environmental integration of its agricultural policy (EEA 2005). More than 35 indicators are investigated according to the common criteria: policy relevance, responsiveness, analytical soundness, data availability and measurability, ease of interpretation and cost effectiveness.[1] Canada uses their AEIs to enhance understanding of the interaction between the environment and agriculture and provides decision makers with model-based environmental risk arising from changing agricultural practices and policies (AAFC 2005). AEIs are also used to meet the constitutional and legal requirements of agricultural sustainability and environmental evaluation in Switzerland (Decrausaz 2010).[2] Austria and Norway apply AEIs as a policy tool for supporting multifunctional agriculture (OECD 2010).

Although there is a greater recognition of the overall AEIs and their application in the policy arena, little progress has been made on the development of agricultural landscape indictors. The difficulty in quantifying the quality and composition of agricultural landscape and the lack of comparable and consistent time series or spatial information have proven difficult to establish common indicators. Landscape objectives are also subject to diverse policy measures, varying from site-specific to generic ones. These constraints kept the OECD from further incorporating agricultural landscape indicators into the final set of AEIs in 2008 (OECD 2008). The key landscape elements proposed by the OECD, including landscape structure (e.g. land use, cover, patterns and cul-

[1] The detailed indicators under the IRENA project can be found in the following website: http://www.eea.europa.eu/projects/irena

[2] The OECD workshop on AEIs held in March, 2010, Switzerland provides most recent and detailed information about OECD countries' indicator development and uses in decision-making: http://www.oecd.org/document/9/0,3343,en_2649_33793_43662921_1_1_1_37401,00.html

tural features), functions (e.g. recreation) and values (e.g. monetary value of landscapes) are, therefore, set aside as indicators of regional importance and to be approached by individual countries (OECD 2001; 2008).

Under these backdrops, this paper aims to develop agricultural landscape indicators from a perspective of Korea. It, firstly, attempts to identify some of the significant landscape features in the country and takes account of making use of the indicators in agri-environmental policy schemes.

II. A Framework for Agricultural Landscape Indicators

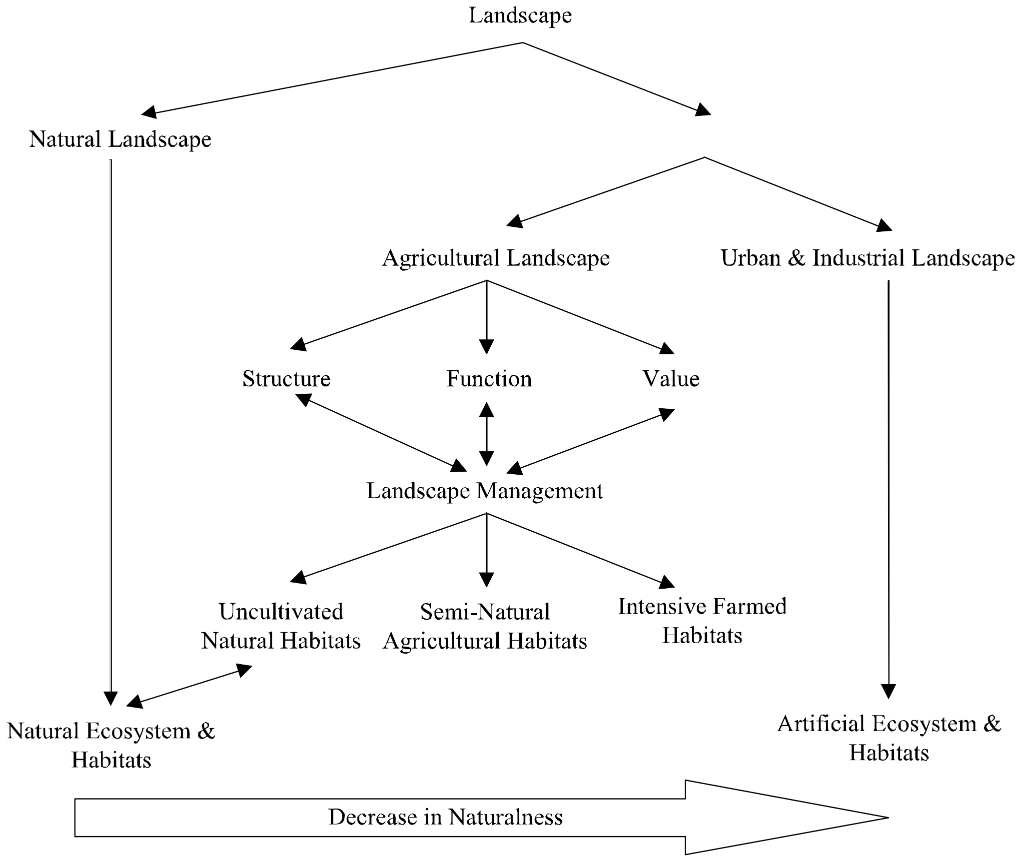
What defines a landscape can be the equivalent of asking what approach one takes in, because a landscape covers various aspects of physical, biological and cultural elements and characteristic products of the interaction between human societies and the environment (Wascher et al. 1999; Porr 2003). Since agricultural landscape is specific to the management processes by man, it is important to recognize that the stock and quality of agricultural landscapes reflect the interaction between farming, managing natural resources and the environment and nourishing societal values such as cultural, aesthetic, and heritage merits.

Distinction between natural and cultural landscapes represents the dynamics of human activity in shaping and affecting landscapes. These man-made landscapes also embody the complex interaction of agricultural policy and farm management with various geo-physical forces of nature. The OECD provides a framework in which cultural landscapes within the agricultural context incorporate the three key elements of structure, function and value (Figure 1).

Landscape structure covers man-made objects such as hedges, paths, and farm buildings, environmental features such as flora, fauna and habitat mosaic, and land use patterns such as crop types and cultivation systems. Landscape function includes the provision of various environmental services such as biodiversity and places for living, working and agricultural production. Finally, landscape value refers to monetary values of various amenities and their costs of maintenance and enhancement.

Based on this framework, this study proposes the following guidelines to ensure the practicality of indicator development in the context of Korean agriculture. First, landscape features are viewed as either singular or a mixture

FIGURE 1. The OECD Framework for Agricultural Landscapes



Source: Piorr (2003) and OECD (2001)

of ecological components, spaces, and artificial structure and elements (Suh et al. 2001). Other location-specific, cultural and historic factors such as traditional values of rural people, social systems, customs and farming skills are also relevant (Byun 2004; Palang et al. 2005).

Second, the stock and quality of agricultural landscapes are assumed to be proportional to the extent of environment-friendly farming practices. Even though certain agricultural activities can contribute to creation or maintenance of landscapes, regardless of their impacts on the environment, it is appropriate to presume that environment-friendly farming and farm management improve the agricultural landscapes affiliated especially with the ecosystem of biological diversity, including wildlife species and habitats.

Third, more attention is given to the recognizable agricultural landscapes by the people and the society (Ban et al. 2008). The premise is that agricultural landscapes are visible as well as recognized outcomes taking into account of public perception and evaluation. Internalization of '*who*'–the people and the society –in the process of landscape evaluation is to allow the different societal values and localized preferences. These criteria are, however, by no means complete because some landscape features have spirit or existence values that may not be accurately measurable.

Finally, an indicator needs to be useful for awareness, assessment and action (Gudmundsson 2009). As a parameter, the indicator provides and describes information about the state of the environment and phenomena. It is therefore important for the indicator to require quantification of information and simplification of complex phenomena (Brouwer and Crabtree 1999).

III. State and Comparable Features of Agricultural Landscape

Studies on landscape in Korea use the term 'rural landscape' rather than 'agricultural landscape'. Regarded as a broader concept than agricultural landscape, rural landscape is all inclusive of natural and cultural landscape features in rural areas. Agricultural landscape is often discussed within the context of agricultural production and farming practices. Unless specifically associated with the OECD framework, the term of agricultural landscape is seldom used in the country. Nonetheless, those elements of rural landscapes investigated by various studies are considered here for reviews and comparison.[3]

According to these studies, most common landscape features in the context of Korean agriculture include streams, thatched cottages, hill and mountains, rural residence and other rural landscape patterns (Chae et al. 2008; Lee 2004; Sung and Im 1992; Kim et al. 1999; Suh et al. 2000; Lee and Shim 2000; Kim and Lee 1997). Specific to agricultural landscape indicators, Park et al. (1998) identifies key characteristics of agricultural landscapes and then proposes cultivated areas and vegetation cover rates by agricultural commodity, distribution of landscape objects and perceptions of green fields as landscape

[3] A detailed discussion about the concepts of agricultural or rural landscape and its development and policy implications in Korea can be found in Kang et al. (2009), Jeong (2009), Joo and Im (2008), Lee and Yun (2008), Im et al. (2007), and Lee et al. (2007)

indicators. Lim et al. (2002) provides feature-oriented indicators, including changes in cultivated areas by crops and length of stone walls and windbreak forests around mandarin fields.

Another empirical study identifies particular landscape elements in three rural villages (Kim et al. 2006). These landscape elements are, however, similar to the aforementioned. In addition, the study stipulates a framework for rural landscape as artificial, environmental, and farming components, which are characterized by residence, farming practices, tourism, biodiversity, soil, water supply and crop production. Focusing on stone walls in Jeju Islands Ko et al. (2009) estimates the length of stone walls surrounding upland areas and its economic value with the so-called natural resource assessment system.

The Rural Development Administration (RDA) classifies rural landscape into four categories and provides a list of their landscape features.[4] 'Landscape for agricultural production' refers to the landscape formed through agriculture, which is the closest concept compatible with the OECD definition of agricultural landscape. The total of 28 listed features ranges from rice, barley, and rapeseed fields to the views of stone walls, Korean cows, trees and flowers. 'Natural landscape in rural areas' includes streams, coastal lines and forest. 'Residential landscape in rural areas' covers houses, walls, roads and other rural structures. Finally, 'historic cultural landscape in rural areas' comprises both physical elements, including traditional buildings and cultural properties, and nonphysical elements, including festivals, games and events.

These studies manifest that locality and distinctive culture in the country have shaped the unique agricultural landscape. For instance, a thousand-year history of rice farming has contributed to a number of agricultural landscape features such as terraced paddy fields, levees, farm buildings and houses, hedgerows and walls and various other biodiversity. The levees surrounding paddy fields in Korea are comparable with the hedgerows of upland fields in other OECD countries. The terraced paddy fields that can be found in some parts of Asian countries highlight the adaptation of rice farming to geographical disadvantages. The volcanic island Jeju has built a unique landscape of upland boundaries with stone walls and windbreak trees and a peculiar vegetation structure.

Although being comprehensive, these studies largely overlook the in-

[4] The RDA provides a website for those registered landscapes: http://rural.rad.go.kr/.

dicators of agricultural landscape. A very few of them actually attempt to measure or quantify landscape features and encompass dynamic of land-use patterns or landscape management. The next section of this paper will propose specific indicators of agricultural landscape and discuss their significance.

IV. A Proposal for Agricultural Landscape Indicators[5]

As reviewed, the indicators of agricultural landscape portray a variety of landscape features. Table 1 summarizes some of the landscape indicators adopted by the OECD countries. The EU's IRENA indicators especially show strong links between landscape and changes in agricultural land use. Other common indicators include landscape features such as hedgerows, stone walls, small ditches and tracks.

TABLE 1. Agricultural Landscape Indicators for the OECD Countries

Country	Landscape Indicators
United Kingdom	· Length of hedgerows and walls
France	· Occurrence of hedges and trees and permanent pasture on the farm · Area of agricultural land within national and regional parks · Proportion of air photograph squares dominated by agriculture or with some agriculture present · Importance of agriculture in urban fringe areas · Age classes of farm buildings (built heritage on farms) and new construction · Growth in areas of woodland
Norway	· Distribution and size of the isolated cultivated plots · Distribution and size of uncultivated areas with an emphasis on their significance to the natural heritage
European Union (IRENA Project)	· State and changes in the agricultural class and patch density · State and changes in crop distribution · State and changes in total linear landscape features (hedgerows, stonewalls, small ditches and small tracks.)

Source: OECD (1999); EEA (2006; 2005)

[5] An earlier version of these indicators was presented by the corresponding author during the OECD Workshop on Agricultural Landscape Indicators, 7-9 October 2002, Oslo, Norway.

Underlining the framework for agricultural landscape indicators and developments in other OECD countries, this paper identifies potential indicators and discusses their characteristics in the context of the state of the environment and policy relevancy. Nonetheless, these proposed indicators cannot be viewed as an exhaustive list of comprehensive indicators for Korea.

1. Terraced paddy fields

1.1. Definition

The areas of paddy fields in valleys or on higher than a 7% slope

1.2. Background

Known as the earliest form of rice production with traditional farming methods, paddy fields in valley areas or on slopes create unique landscapes (Guh 2009). A famous example is the rice terrace in Namhae, Kyungsangnam-do. The area of 195,428 m^2 is designated as the National Scenic Area in 2005.[6] In rice culture, these landscapes provide the people with peaceful feelings and self-admiration of cultural heritage. They also contribute to various environmental benefits including prevention of soil erosion, landslides and floods, and biodiversity preservation (Eom and Yoon 2000; Oh 1995; Lee and Rhim 1999; Han et al. 2000).

1.3. Method of calculation

Terraced paddy fields have not been formally defined in Korea. So, it needs at least a working definition for them. Several factors appear to be relevant in this regard. One is the case of the direct payment scheme under the less favored areas (LFAs). Since 2006, the government designates and provides support for the LFAs having greater than a 14% slope.[7] Another is a Japanese approach

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[6] The rice terraces of the Philippine Cordilleras, registered as the World Heritage of the UNESCO are well known cases worldwide. Rice terraces exist in other Asian countries including China, Thailand, and Laos (Noh 2009).

[7] The pilot program started in 2002.

that defines rice terraces as either the fields with greater than a 5% slope, or the fields where ears of rice in a lower field do not exceed the height of the levee of the next upper field (Jung 2002). In addition, a comprehensive database on national soil landscapes established by the Rural Development Administration categorizes all paddy fields into six classes by slope (Table 2).[8] Finally, the Rural Maintenance Act defines a marginal farm as having arable fields with greater than a 15% slope.[9]

TABLE 2. National Paddy Fields by Slope

	0~2%	2~7%	7~15%	15~30%	30~60%	60~10%	Total
Area (ha)	550,332	477,677	215,479	44,761	34	1	1,288,249
Share of total area (%)	43	37	17	3	0	0	100

Source: RDA (1992)

Accordingly, a working definition of the rice terrace indicator is postulated as the paddy fields with a 7% slope. This benchmark is acceptable by requiring a half of the level for LFAs or marginal farms, comparable with the case in Japan and feasible for quantification.

1.4. Result and interpretation

According to Table 2, about 20% of paddy fields can be regarded as the rice terraces whose proportion is larger than the estimate of 13% for Japan (Jung 2002; OECD 2001). Figure 2 shows the change in the indicator since 1965. After hitting the peak at 269,000 ha in 1990, the rice terraces are forecasted to reach 183,000 ha in 2010. The declining trend of the indicator since 1990 is a direct result of an incessant decrease in paddy fields.

It seems, however, probable that the indicators are underestimated. The high rates of idled and abandoned farmland, especially with 15% or greater slopes, suggest the loss of terraced paddy fields be more than what is proportional to the area of paddy fields (Park and Kim 2005; Kim and Kwon 1992). The key factors contributing to making farmland idle or abandoned are a short-

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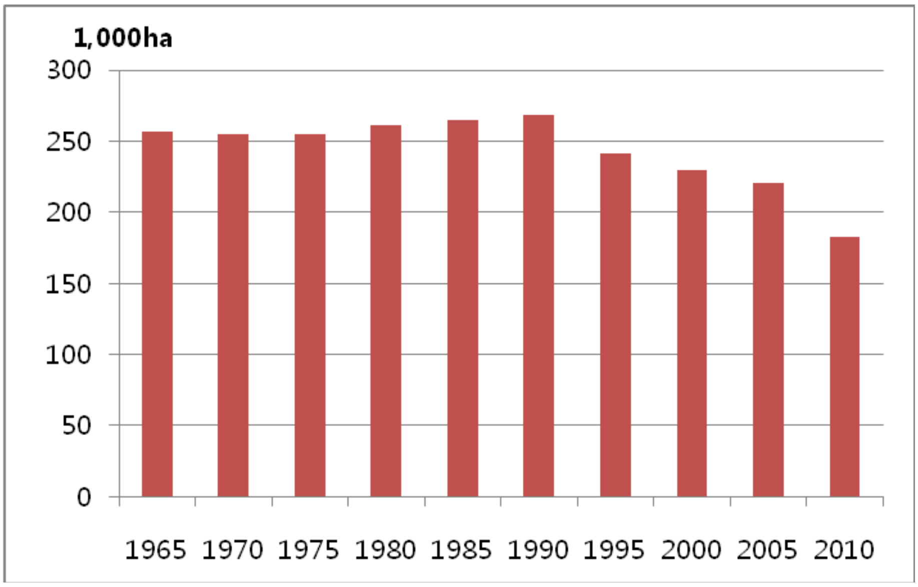
8 RDA (1992) is the most updated and comprehensive research on the national soil landscape.

9 See the following website: http://www.cmcost.or.kr/law/view/id22400.html

age of labor and adverse farming conditions, including inaccessible farm machinery, lack of water and remoteness.

A policy implication is that preservation of terraced paddy fields must be based on their cultural and ecological values. It is also desirable to give an effort to create a market for tourism in eligible places. To make use of them for cultivating feed or growing landscape crops can be an alternative. The invention of a harmonized approach with the existing direct payment scheme for the LFAs could contribute to alleviate the loss of farmland in disadvantaged areas (Park and Kim 2005).

FIGURE 2. The Indicator of Terraced Paddy Field Length: 1965~2010



Note: The forecast estimate for 2010
Source: MIFAFF (2009a)

2. Levees of paddy fields

2.1. Definition

The length of the paddy field levees under the environment-friendly farming scheme

2.2. Background

Levees of paddy fields are one of the common landscape features of rice growing regions. They are comparable to hedgerows or stone walls on upland farms. Averaged at 27cm height, the levees play a vital role in controlling flood, fostering water resources, and preventing soil erosion. On this ground, the direct payment for paddy farming was conditioned to maintain the levees. The people perceive them as a symbol of rural life.

The levees free from pesticide, insecticide or other ago-chemical applications are of particular interest, because expanded ecological functions of paddy fields are generally attributed to environment-friendly farming (Han et al. 2000). Kim and Kang (2006) shows that both rural residents and citizens highly recognize environment-friendly, ‘naturally composed’ levees as an important landscape feature.

Various studies report the prevalence of fauna and flora on the levees. For example, Lim and Park (2009) found 21 species of true bugs in the levees. Sung et al. (2009) observes that the levees are an important habitat for the endangered gold-spotted pond frog. Park and Shim (2004) found 8 different species of butterflies in a conventional levee.

2.3. Method of calculation

According to Kim (2002), a length of a regular square field with plots can be estimated by:

(1) $$L = \frac{(4\sqrt{S} + 2\sqrt{S}(\sqrt{N} - 1}{10},$$

where *L* is the length of the levees of paddy fields in kilometres, *S* is the area in hectares, and *N* is the number of plots per area (*S)*. Since paddy fields or plots are not necessarily regular square forms, an adjustment factor, *f,* is multiplied to the equation:

(2) $$L = \left\{\frac{4\sqrt{S} + 2\sqrt{S}(\sqrt{N} - 1}{10}\right\} \times f.$$

The adjustment factor value of 1.57 is derived from a comparison of the estimated length, L with the actual length obtained by a cadastral map (Kim

2002). So, the final indicator becomes the adjusted length of the levees, L*.

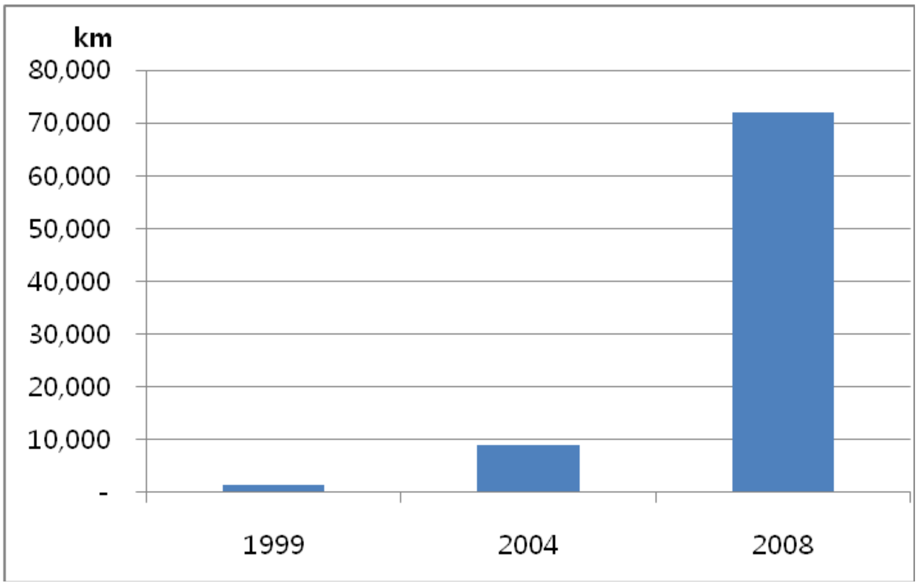
Due to the lack of data for the number of plots for environment-friendly farming paddy fields, a national average of plots for the total paddy fields is calculated and used for the years of 2004 and 2008.

2.4. Result and interpretation

Figure 3 shows the indicator values estimated during last 10 years. The length of paddy field levees jumped from 1,416 km in 1999 to 71,896 km in 2008. A rapid increase in the certified environment-friendly paddy areas from 1,714 ha to 86,678 ha in the same period resulted in such a huge gain. By this, one may conclude the environmental state of paddy fields has improved.

An annual increase of 69% in the marketing amounts of environment-friendly farm products over the 1999-2007 periods sheds light on how farmers are responding to consumers' concern on health and the environment (Kim et al. 2008). Price premiums for environment-friendly farm products are

FIGURE 3. The Indicator of Environment-Friendly Paddy Field Levees



Note: Data for paddy fields is the sum of the certified areas as organic, no-pesticide and low-pesticide farms.

Source: National Agricultural Products Quality Management Service (http://www.enviagro.go.kr/)

up to two times higher than conventional products. It is worth mentioning surging government support, too. In 2002-2008, the direct payment for the environment rose from 2.7 billion won to 28.6 billion won (MIFFAF 2009b).

3. Stone Walls

3.1. Definition

The length of stone walls in uplands and orchards on Jeju Island

3.2. Background

Jeju Island is famous for having volcanic stone or basalt in great abundance. Heaping up basalt around uplands and orchards is a thousand-year-long farming practice aimed to protect plants from animals, prevent soil and wind erosion, provide wildlife habitats and set up boundaries. Stone walls can be built on single or double rows filled with small rocks. The shapes of stone walls depend on their purposes and locations (Ko et al. 2009). Although their unique landscapes and social-cultural values as national heritage are greatly appreciated by tourists and residents, ecological and economic aspects of the stone walls remain to be appropriately explored.

3.3. Method of calculation

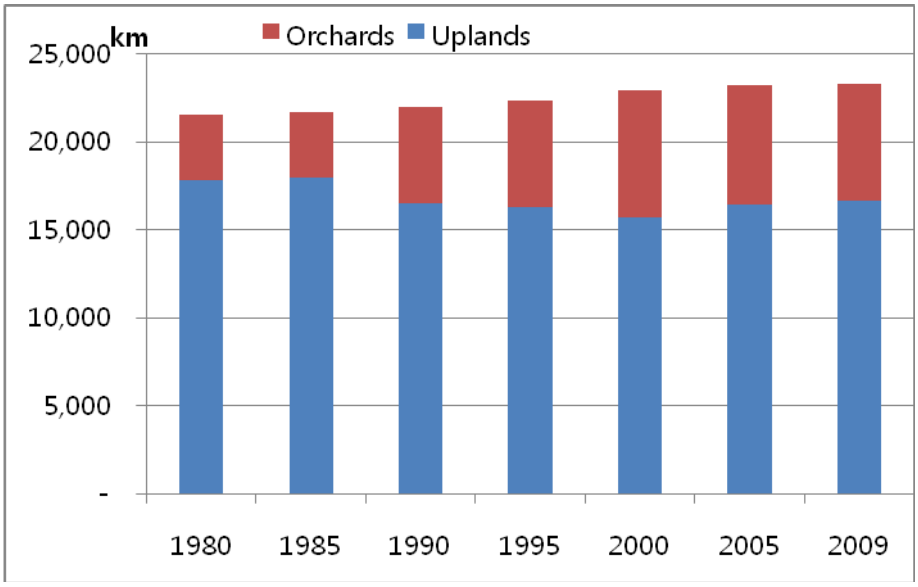
The length of stone walls can be similarly estimated as the length of paddy field levees. Minor modifications are, however, inevitable under the following observations. One is the fact that every plot of uplands and orchards in Jeju may not have stone wall boundaries unlike paddy fields. The other is that there is a reference level of the length of stone walls resulted from a comprehensive research. After investigating 6 study areas, Ko et al. (2009) computed the length of stone walls for uplands and orchards as 22,108 km. It is thus proposed to adopt the above equation (1) (without an adjustment factor) for the calculation of the length.

Data for the areas of uplands and orchards and the number of plots is based on the Jeju's cadastral statistics published by the Ministry of Land, Transport, and Maritime Affairs.

3.4. Result and interpretation

Figure 4 shows the estimated length of stone walls in uplands and orchards for last 30 years. In uplands, the length of stone walls dropped from 17,836 km to 15,689 km during 1980~2000 but it bounced back to 16,624 km by 2009. In contrast, the stone walls in orchards expanded their length from 3,690 km to 7,274 km over the period of 1980~2000. But, it declined to 6,700 in 2009.

FIGURE 4. The Indicator of Stone Wall Lengths



Source: Ministry of Land, Transport, and Maritime Affairs (http://www.mltm.go.kr/)

An improvement of the indicator for orchards during the 1980s and the 1990s was largely due to an expansion of mandarin production. But, the policy initiative to curb the surplus of mandarin resulted in a sharp reduction in the areas of its cultivation over the period of 2003-2005 and made the areas stagnate around 21,000 ha (Chon et al. 2010). Falling profitability is weakening the sector and increasing the risks of losing stone walls continuously. If the unique landscape value of stone walls in Jeju is to be preserved, a greater policy attention must be given to it with recognition of the strong underlying connection between mandarin production and maintenance of stone walls.

4. Agricultural land-use patterns

4.1. Definition

The proportion of arable land areas to total land areas,
The proportion of the cultivated areas under intensive input uses to total arable land areas, and
The proportion of the farms with greater than 3 hectares of arable land to total farms

4.2. Background

The agricultural land-use pattern is a dominant determinant of landscape structure, and it affects the total stock of agricultural landscapes (OECD 2001). The contraction of agricultural land areas or the conversion of agricultural land to non-agricultural uses poses a threat to agricultural environments and landscapes (Jang 2009).

Changes in farming intensity are also proposed to determine landscape changes. In particular, input uses beyond a certain benchmark can negatively affect specific biodiversity and wildlife habitats. An increasing trend of greenhouse areas may worsen landscape quality, too.

In response to further market opening and rising demand for structural adjustment, various policy drives have been made to raise the economies of scales for farm operation and farm concentration since 1988 (KRCC 2010). For example, the government plans to secure 70,000 specialized rice farms equipped with more than 6 hectares and make them to take up 50% of rice production by 2013.[10] But the other side of the coin in these policy initiatives is that enlarged farm operation may facilitate monotonic farming structure that could degrade overall agricultural landscapes. The average size of a farm is recorded at 1.45 hectare in 2008 (MIFAFF 2009a).

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[10] See the following website for the government's plans and achievements: http://www.index.go.kr/egams/stts/jsp/potal/stts/PO_STTS_IdxMain.jsp?idx_cd=2704

4.3. Method of calculation

Three indicators are proposed to measure agricultural land-use patterns. The first indicator is the proportion of arable land areas to total land areas. As an expansion-contraction measure, it provides an overall picture of land-use patterns.

The second indicator is the proportion of arable land areas under intensive input uses. As an intensification-extensification measure, this indicator shows the interaction between intensive farming practices and landscape changes. The input intensity is defined based on the level of pesticide use per hectare and cultivated areas of greenhouses. A 10 kg per hectare on an active ingredient basis is chosen as a benchmark of intensive pesticide uses because it is greater than the application level in rice cultivation and includes most fruit farming (Table 3).[11]

TABLE 3. Pesticide Uses by Crop

Crop (Year)	Red Pepper ('05)	Cucumber ('05)	Mandarin ('06)	Apple ('06)	Pear ('06)	Persimmon ('06)	Grape ('06)	Peach ('06)	Rice ('07)
Pesticide use (kg/ha)	12.5	7.4	45.6	22.9	17.9	12.0	7.9	5.7	6.4

Source: Kim et al. (2009a); Kim et al. (2009b)

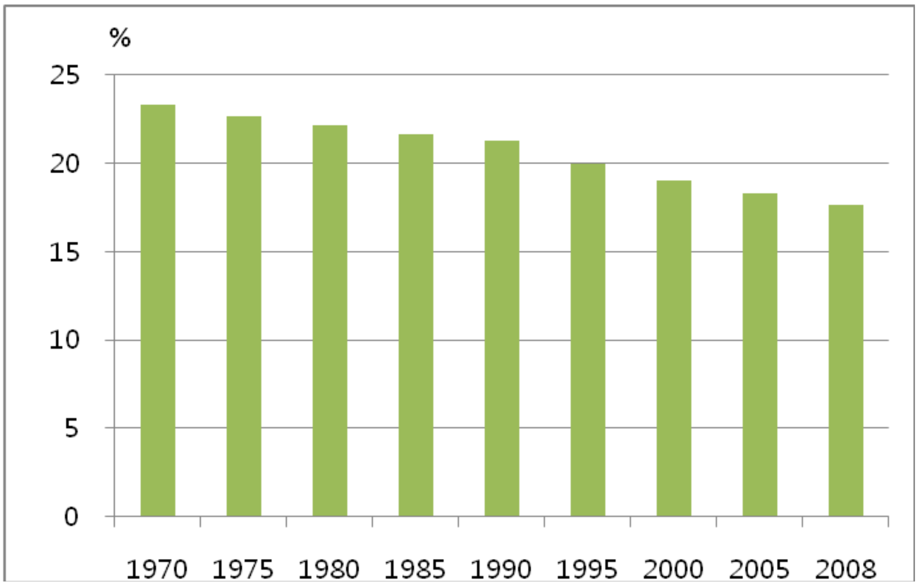
The third indicator is the proportion of farms with larger than 3 hectares of arable land. As a concentration-marginalization measure, this indicator captures potential degradation of traditional landscapes, which have been developed from small-scaled farming environments to a large extent. The threshold of 3 hectares is proposed because it is often cited as a basis classifying large-scaled farms and statistical data is available.

[11] Pesticide uses can be different across time horizon. For example, the levels of pesticide uses for fruit and rice faming in 1999 were slightly larger than the levels shown in Table 3 (Ihm et al. 2003; Kwon et al. 2000). But these differences are not considered here for simplicity.

4.4 Result and interpretation

Figure 5 shows a steady decline in the indicator of arable land. Starting from 23% in 1970, the proportion of arable land to total land declined to 18% in 2008. While total land has expanded by 1.4% over the period, arable land has contracted by 24%. More specifically, agricultural sectors lost their arable land to non-agricultural sectors by 212,247 hectares since 1995 (MIFAFF 2009a).

FIGURE 5. The Indicator of Arable Land Contraction

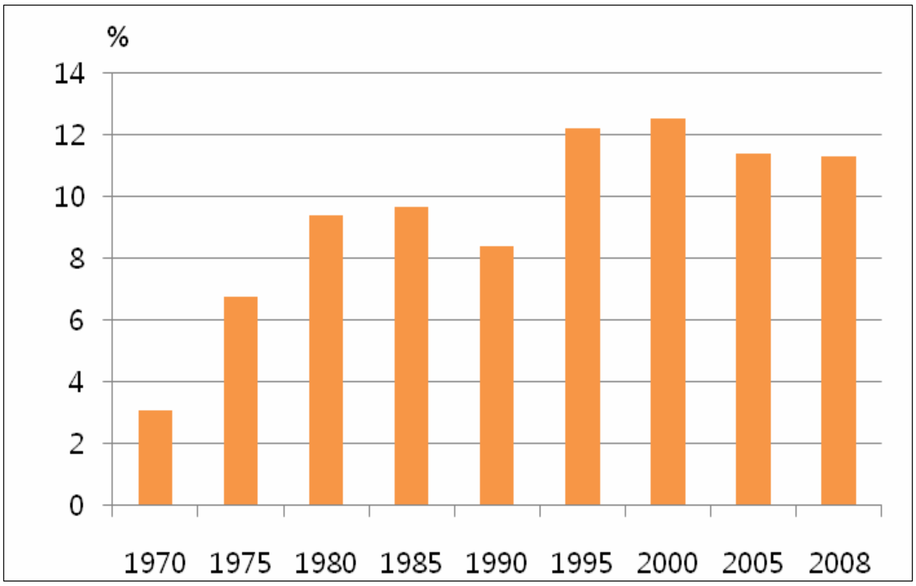


Source: MIFAFF, Food, Agriculture, Forestry and Fisheries Statistical Yearbook, various years

Figure 6 shows that the indicator for farm intensification has stabilized around 11%. Except for greenhouse whose areas expanded by more than 200% since 1985, intensive farming areas have been lowered from the late 1990s or the early 2000s. A moderate reduction in fruit farming is forecasted in a medium run (chon et al. 2010).

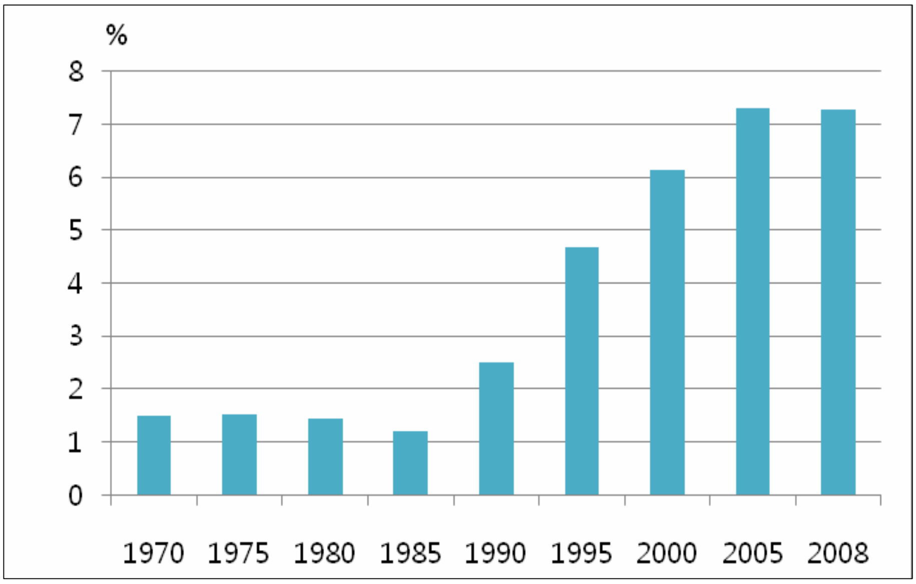
Figure 7 indicates that farm concentration has been rapidly increased over the period of 1985 to 2005. On top of competitive market conditions, the ongoing concentration is attributable to extensive policy efforts to facilitate re-adjustment of farmland and rear the so-called rice specific farmers (Song 2006). In 2008, about 7% of all farms are large-scaled farms.

FIGURE 6. The Indicator of Farm Intensification



Source: MIFAFF, Food, Agriculture, Forestry and Fisheries Statistical Yearbook, various years

FIGURE 7. The Indicator of Farm Concentration



Source: MIFAFF (2009a)

Overall, the indicators associated with the changes in agricultural land-use patterns are characterized by contraction of arable land, intensification of input uses and concentration of farms. Those changes are putting a great deal of stress on biodiversity and wildlife habitats and thus agricultural landscapes. The rise of concern about agricultural landscapes is especially real in the face of great demands for farmland conversion and intensive production through greenhouse farming. On the contrary, the steady expansion of environment-friendly farming and the government support will offset the mounting threats.

5. Diversification in land-use patterns

5.1. Definition

A diversification index of farmland for major agricultural products

5.2. Background

The more land-use patterns diversify, the more landscape features become intricate. Diversification in land-use patterns adds complexity, heterogeneity and seasonality to landscapes. It provides wildlife habitats and increases the wealth of biodiversity. For example, different vegetation cover and species bring about multifarious landscapes (Lindenmayer and Fischer 2006).

It is important for diversified land-use patterns to be in harmony with specific and localized environments. Locality and harmonization augment landscape values arising from diversification. Use of location-specific exploration is, however, limited due to its complexity, the lack of comparability and high costs in measuring diversification.

5.3. Method of calculation

As a tool to measure a diversification index, this study adopts the Herfindahl index (Capello and Nijkamp 2009; Tauer and Seleka 1994). The Herfindahl index (H) is defined:

(3) $$H = \Sigma_{i=1}^{N} S_i^2 ,$$

where S_i is the share of the i^{th} item. The index ranges from 1/N to 1. A normalized Herfindahl index (H*) makes the index interval between 0 and 1.

(4) $$H^* = \frac{\left(H - \frac{1}{N}\right)}{1 - \frac{1}{N}}.$$

If the index approaches closer to 1, the concentration rate in land-use patterns is deemed to be high. For the merit of simplicity and accessibility the index is built on national statistics of land-use patterns for major 28 agricultural products.[12].

5.4. Result and interpretation

Figure 8 shows the estimated Herfindahl index from 1965 to 2008. The index rose from 0.18 to 0.41 over the period. An increasing trend of the index underlines the ongoing process of farming concentration. Huge losses in farmland for grains such as barley, wheat, corn and beans, and other traditional crops such as sweet potatoes, sesame seed, peanuts, rapeseed and mulberry leaves have all contributed to the current concentrated land-use patterns. The stock of the farming areas for those crops dropped by a half during the same period. In the middle of declining arable land, a slower reduction in paddy field areas resulted in a high rice concentration rate. The share of paddy fields in the farmland continues to increase up to 65% in 2008.

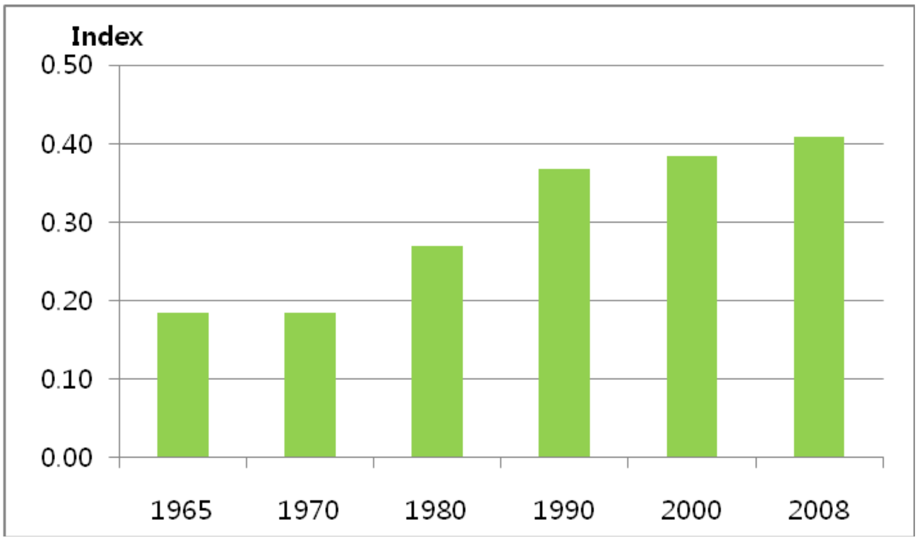
Less diversified or more concentrated agricultural land use is largely due to changing market situations and policy initiatives. Integration of domestic agriculture to the world economy and greater market opening have depressed the production of coarse grains, wheat and beans. Weakening market demands for barley, roots and tubers and mulberry leaves resulted in production shrinks. Policy drives for farm modernization and structural adjustment have stimulated the expansion of commercial production and monotonic farmland use for economies of scales. Policy bias in favor of rice production and a series of rice sub-

12 These agricultural products are rice, naked barley, hulled barley, malted barley, wheat, rye, potatoes, sweet potatoes, beans, corn, cabbage, radish, red pepper, garlic, onion, apple, pear, grapes, peach, mandarin, sesame seed, peanuts, rapeseed, ginseng, horticulture, mulberry leaves, mushroom, and tea.

sidies made the sector to maintain the highest share in farmland use.

The increased concentration in farmland use can be a threat to landscapes at the national level. The agricultural production system which tilted toward rice farming tends to erode the overall diversity of landscape features. A typical example is a vanishing double cropping farming of rice and barley in paddy fields that risks a valuable landscape element during the winter and next spring. Nonetheless, one can't ignore the possibility that farming concentration in harmony with local conditions may improve landscape quality from a regional perspective.

FIGURE 8. The Normalized Herfindahl Index for Land-Use Diversification



Source: MIFAFF, *Food, Agriculture, Forestry and Fisheries Statistical Yearbook*, various years

V. Discussion and Policy Implications

Although the proposed agricultural landscape indicators are mostly rooted in a mixture of macro- or national level data and feature- or site-specific landscapes, their potential use will not be limited to gauge the change in landscape elements. Not only can the developed indicators be a basic tool to monitor and evaluate changes in landscape features in the country or regions over time, but they can be an integral part in designing and implementing the agri-environmental measures (AEMs).

An example is the Landscape Direct Payment Scheme (LDPS), the first AEMs squarely addressing landscape preservation.[13] The objective of the program is to vitalize rural areas by promoting local festivals, rural tourism and rural-urban exchanges (MIFAFF 2009b; Song and Park 2005). Simply focusing on income compensation for landscape crop cultivation, the LDPS aims mostly at incomplete features of landscapes (Kim and Kim 2009). In addition, the LDPS does not explicitly consider any landscape indicator in evaluating the jointness between landscapes and farming, monitoring the contract implementation and determining payment amounts (Seong and Park 2010; Joo and Im 2008; Ban et al. 2008).

The indicators for agricultural landscapes that this study proposes cannot be regarded as an exhaustive list of relevant indicators for the country. Furthermore, they are subject to the following additional guidelines for policy use, especially in supporting landscape preservation.

First, the indicators must be used with the discernment of production jointness between agriculture and landscapes. For instance, a holistic farm support can be more desirable under which strong joint relationships or externalities and market failure exist between the levees of environment-friendly paddy fields or stone walls surrounding uplands and farming activities. Because of the production jointness, independent and separated support for landscape features will not guarantee the provision of landscape services when agriculture fails.

Second, the government policy targeting regional and location-specific landscape provision requires further refined or disaggregated indictors. To be policy relevant, these indicators must technically feasible and economically efficient. Once operational targets for landscapes are pertinently established, achievement of goals and compliance of participants must be timely monitored and accurately evaluated by the indicators.

Finally, the agricultural landscape indicators must comply with the necessary condition that legitimizes government subsidies for the agricultural provision of landscapes. Only when it exceeds good farming practices or reference

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[13] Various survey results show that Korean people recognize agricultural landscapes as one of the leading elements of agricultural multifunctionality (Oh et al. 1995; Lee 1996; Kim 2000).

levels, or it meets societal demands, the government compensates farmers for their landscape provision under the so called provider-gets-principle.

In a nutshell, it is increasingly important to develop a common, measurable, comparable and policy-relevant set of indicators in order to monitor and evaluate the targeted measures for agricultural landscape. As a stepping stone to elaborate plans, systems and procedures, these proposed indicators could contribute to refinement of existing policies, development of new policy instruments and coping with tightened international scrutiny into market and trade distortion of domestic agricultural policies.

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