MULTI-FUNCTIONAL ROLES IN PADDY-FIELDS AND ON-FARM IRRIGATION

Soon-kuk Kwun
President, Korea Society of Agricultural Engineers

ABSTRACT

Despite the unfamiliar term "multifunctionality of agriculture" and the tremendous number of debates made over the past 10 years, multiple benefits from paddy rice farming in the Asian monsoon region are very significance due to the various inherent characteristics of paddy rice in this region. They were identified as rural vitalization, social security, nature and environmental preservations, and social and cultural functions. As studies estimating the monetary value of nature and environmental functions in Korea and Japan revealed, the economic value of multifunctionality from paddy rice farming reached to 70~150% of total annual rice production cost of each country, and would have been even higher, had other functions been included. Therefore, interdisciplinary and international researches within the monsoon Asian countries are necessary to develop counter-measure logics against the Western dry land farming countries, emphasizing the efforts to disseminate worldwide the significance and recognition of the multifunctionality of paddy rice farming under the Asian monsoon climate.

INTRODUCTION

The settlement of the Uruguay Round (UR) agricultural negotiations and the subsequent launching of the World Trade Organization (WTO) System have had significant effects on the world agricultural production, consumption, and trade. Two goals are being pursued under the current WTO system in terms of agricultural production and trade; liberalizing international trade of all commodities and services including agricultural products, and eliminating various domestic production supports distorting world trade. Implementation of the UR agreement is restructuring the agricultural production worldwide, changing the patterns of agricultural production and consumption of individual country as well as specific type of agriculture practiced. More specifically, liberalizing international trade and reducing domestic supports will raise production share of current exporting countries in the world agricultural market, while reducing that of current importing countries.

Should the role of individual country in the agricultural production be limited to only providing commodities that are traded in markets, then the principle of comparative advantage implies that implementation of the UR agreements will enhance the well being of all nations involved. However, it has been consistently asserted by food-importing countries that agricultural production provides more than just marketed commodities to societies, complicating the effect of liberalizing world agricultural trade even more.

Not only does agricultural production provide food, it also maintains rural amenities and preserves natural environment

by contributing to the water resource management, soil conservation, and biological diversity, in addition to achieving rural viability, preserving traditional culture, and food security and safety. Assuming each of these extra functions of agriculture is closely linked with the everyday activities of agricultural production, changes to agricultural production of a country will inevitably result in environmental degradation, food crisis, and damages to the rural viability and cultural heritage.

Because agriculture in the Asian monsoon region is different from the Western countries, it is only natural that these multiple functions are manifested differently from the Western dry land farming. In fact, in Asian monsoon region, agriculture has features quite distinctive including climate, wet paddy rice farming, water management, large number of small family farms, and self-sufficiency for individual farms as well as the nation as a whole.

In this paper, characteristics of paddy rice farming, distinguishable from the Western dry land farming, in the Asian monsoon region will be reviewed in terms of their rural economic and social roles, and multiple benefits other than production from paddy rice fields, on-farm irrigation, and drainage will be examined through scientific and technical viewpoint.

This article would be fulfilling its task if, through the article, the recognition on paddy multifunctionality is disseminate to the people living in Asian monsoon region as well as influences the worldwide public opinion.

CHARACTERISTICS OF PADDY FIELDS AND PADDY RICE CULTIVATION IN ASIAN MONSOON REGION

Definition of monsoon Differential heating and cooling of water and landmasses create large thermal cells in the atmosphere, i.e., air circulation due to temperature differences. Although these thermally driven atmospheric circulation cells, or monsoons, exist in all continents, the best known are those in Southeast Asia and India. Summer winds laden with moisture from the warm Indian Ocean and the southwest Pacific move northwestward over the landmasses of India, Bangladesh, Southeast Asia, southern China and Far East Asia. As the air carried by these winds rises and cools over land, the moisture condenses and falls in the form of monsoon rains, providing rainfall for crop production and human livelihood to over 2 billion people, who live in the vast land area in south and east of the Himalayan Mountains. Winters tend to be dry in monsoon areas because the oceans are warmer than the land. Failure in the development of monsoons, as have occurred several times, results in drought, food shortages, and even dire famines to populations dependent on the rain.

Characteristics of monsoon agriculture The so-called Asian monsoon area is divided into tropical, semi-tropical, and temperate zones. Hot and rainy climates in many areas generally allow cultivation of paddy rice once a year in summer and supplementary irrigation is used mostly to ensure the safe production of this one-time crop. Climate allowing, perennial irrigation could be useful in this area. Up to now, farmers had to deal with excess rainfall at one time, and lack of rainfall at another. Clearly, proper management of irrigation and drainage is critical in this most densely populated area of the world to meet the demands of increasing food production; unfortunately, it has not been practiced actively, probably due to fund shortages, lack of technical support, and/or unstable political situations.

Delta area in the lower parts of rivers provides the most successful paddy cultivation area, with over 1,500 mm of annual rainfall. In this area, drainage is generally more important than irrigation, particularly for controlling the big river floods, making the efficient practice of water management at the on-farm level more urgent.

Uniqueness of paddy rice culture in the Asia monsoon areas The three major crops consumed by humans are rice, wheat, and corn (maize). As revealed by the FAO data of 1992-2000, productions of rough rice, wheat, and corn were 563, 574, and 565 million tons annually worldwide, amounting to 84.5% of total world crop production of 2,013 million tons. Among the three major crops, corns and some parts of the wheat are mainly consumed as feed grains, while rice is mostly consumed directly by humans.

The world rice harvest areas increased from 115.5 million hectares in 1961 to 152.0- 157.2 million hectares during the 1998-2000, with almost 90% concentrated in Asian monsoon region. On the other hand, only 27 and 43%, respectively, of total corn and wheat produced globally are from this area. Thus, rice is sometimes referred as Asian crop. Most of the major rice-producing countries in the world are located in Asia, with China and India being the largest, occupying 36 and 21% of the total world production, respectively, followed by Indonesia, Bangladesh, Vietnam and Thailand. Rice is staple food of most Asian countries. In 1992, Cambodians obtained 80% of food calorie from rice, while over 70% in Bangladesh, Myanmar and Vietnam, 67% in Lao PDR, 56% in Indonesia, and 31-40% in India, China, Korea and Philippines.

Paddy rice culture is the most important agricultural practice in Asia in terms of the monetary value of production, as well

as efficient use of acreage cultivation. Rice, which is closely related to economics, social, political, cultural, and natural environment, is produced and consumed in vast areas by almost 70% of over 3 billion Asian people. Due to its high productivity per unit area compare with other crops, the Asian lands with much paddy field are able to support twice the population as compared with other regions. In addition, because rice is produced by utilizing natural resources such as soil, water, and forest, it is closely related to the maintenance and destruction of the resources. Thus, paddy rice cultivation is the life itself for the Asian people.

Principle of self-sufficiency in paddy rice consumption As mentioned earlier, because over 50% of food calories are supplied from rice as a staple and essential food, rice is also refereed to as wage outputs. Furthermore, unstable supply of rice or sudden rise in the price of rice may directly lead, by all means, to political instability of the country affected. In this situation, rice could be political outputs.

Thus, after World War II, stable supply and price of domestic rice in most Asian monsoon countries have been, without exception, considered as the important policy goals. Through the policy means, domestic rice market was able to de-link from unstable international trade market, and consequently, the policy goals could be achieved by pursuing self-sufficiency in rice production.

On the other hand, rice has a very thin trade market because only 5% of the rice produced annually is traded in the world market compared with 22, 13, and 25% for wheat, corn and soybean, respectively. Accordingly, the world rice market could become highly volatile by variable natural disasters such as drought, floods, typhoon, diseases, insect pest, and abnormal temperatures, which cause shortages and surpluses of rice from one year to the next. Thus, the fragile world rice market system cannot be relied upon; this is the reason that self-sufficiency policy for the rice crop taken in each country would gain much support not only domestically, but also globally.

MULTIFUNCTIONALITY OF PADDY FIELD AND ON-FARM IRRIGATION

Definition, concept, and classification of Multifunctionality in paddy rice farming

What is multifunctionality? The term "Multifunctional Agriculture" has rapidly emerged from obscurity into common use in environment, agriculture and international trade circles, often placed at the center of heated discussion. Yet, what does it really mean? Proponents of multifunctionality in agriculture generally are pointing to benefits other than food and fibers - benefits, often not rewarded in marketplaces and which vary tremendously depending on farming practices.

OECD Agricultural Committee has been implementing the most comprehensive and analytical study on multifuncyionality of agriculture since 1998. Based on various materials collected and data published by OECD Secretariat, the concept of multifunctionality can be thus described as follows. Firstly, multiple commodity and non-commodity outputs that are jointly produced in conjunction with agricultural production exist; secondly, some portion of non-commodity outputs exhibit characteristics of externalities or public goods, with the result that, at present, markets for these goods neither exist nor function properly. On the other hand, according to Romstad et al. (2000), multifunctionality implies that agriculture entails more than what is traditionally perceived as its main function: producing food and fiber. Lankoski (2000) suggested that multifunctional agriculture could be defined as an economic activity, which, aside from its primary function to food production, contributes to the well being of society by also producing multiple non-food benefits or costs jointly with food production. These benefits include contribution to the vitality of rural communities (through maintenance of family farming, rural employment and cultural heritage), biological diversity, recreation and tourism, soil and water health, bioenergy, landscape, food quality and safety, and animal welfare.

Like all rapidly developing ideas, multifunctionality in agriculture can take on notably different meanings coming out from the mouths of different speakers into the ears of different listeners; therefore, there is no set, definite definition mutually agreed and accepted worldwide.

As pointed out by the OECD (2000), multiple functions are linked to agricultural production activities. One interpretation that could be posited is that most of these functions are linked to farmland. As major portion of farmland in Asian monsoon countries is tilled land with approximately 60% of tillage utilized as rice paddies, it can be concluded that most multiple functions occur through wet rice agriculture. For this reason, multifunctioality in this paper are focused on the paddy rice farming.

Concept Multifunctionality, as a concept, was derived from paddy fields; therefore, rice-producing activities are indirectly enabling these functions to continue to be brought out. One part of rice-producing works involves the responsibility of maintaining suitable conditions under which cultivated land can offer multifunctioality.

Paddy fields are composite commodities of land and irrigation. Various multiple functions have been derived by

utilizing irrigation in paddy fields. Merely increasing the amount of water, however, does not necessarily increase the number of multiple functions; indeed, appropriate changes in the volume of impounded water according to cultivation periods and weather conditions are what create them. Should it be simply that just the impounding of water in paddy fields is required, then only the maintenance of borders and balks would be involved; however, in actuality, how water is controlled and paddy fields maintained throughout the cultivation period decide the level of mutifunctionality. This irrigation control work, which requires daily management, is integrated through a series of rice-producing processes.

Classification For many years, a large number of research institutions in Korea and Japan have been conducting multidisciplinary agricultural technology studies on the existence of multifunctionality. In addition, characteristics and categories of farming practices and areas where the multifunctionality occurs, as well as the conditions of its occurrence, were identified. From technical and agricultural economic viewpoints, items listed in Table 1 are presently agreed upon among the Asian monsoon countries.

Role of paddy fields and on-farm irrigation in creating multifunctionality

Paddy fields must have balanced retention and percolation of water. Paddy rice cannot be grown without water retained

Table 1 Hierarchical structure of the multifunctionality derived by paddy rice farming

Group of functions with economic externality - positive multifunctionality					
Rural vitalization	Encouragement of local rice related industries and job creation				
Social security Function	Food security and safety				
	Safety management of local community				
	Natural disaster prevention				
Preservation of nature and environment	Biological preservation	Preservation of biological diversity			
		Preservation of wildlife			
		Preservation of ecosystem			
	Preservation of national land and environment	Land Preservation	Preservation of disaster due to sediment		
			Soil erosion prevention		
			Landslide prevention		
			Soil purification		
		Water Preservation	Water control	Flood control	
				Water retention	
			Stabilization of river flow		
			Water resources Recharge	Surface water recharge	
				Ground water recharge	
		Air Purification	Preservation of atmospheric composition		
			Climate alleviation		
Social and cultural function	Preservation of amenity	Dwelling environment preservation			
		Recreation and relaxation			
		Disaster relief			
		Landscape preservation			
	Local community Viability	Support of local community			
	Local culture preservation	Preservation of traditional cultures			

Remarks: Existence of functions is largely depended on conditions of farming practices.

in paddy fields. On the other hand, if water does not percolate, then the paddy fields will suffer from poor drainage, causing root rots. The ability to control the retention and draining of water according to needs is, therefore, the foundation for successful rice cultivation. Thus, even during intensive rains, paddy fields must function to mitigate rapid discharges by catching and storing rainwater for a while, then discharging it at some later period. Total discharge from paddy fields, excluding evaporated water, consists of (1) surface water removed from drainage system, (2) a portion removed through drainage from underground culverts, and (3) a portion that percolate into the soil.

The first and second discharge volumes affect the floodway levels of relevant drainage basins, and the third affects the groundwater recharge. Of course, water discharged upstream is reused downstream for farming. However, hydraulic analyses of actual outflow and percolation in the basins will be complicated. Evaluation of these discharge volumes involves two approaches: one for evaluation at paddy field level in agricultural engineering, and the other involving the hydraulic evaluation of the whole basin. Discharging appropriate amount of stored water from paddy fields in a timely manner is closely related to the rice production. The contributions of rice cultivation work are, firstly, the promotion of well-maintained field facilities, and secondly, the proper implementation of feeding and distribution of water.

Items of multifunctionality to be discussed

When the outflow of rainwater from paddy fields is properly controlled, various multiple functions could occur. Which of these will happen depends largely on the geography and soil condition. In this paper, attention will paid to the following items shown in Table 1: (1) flood prevention, (2) groundwater recharge, (3) landslide prevention, (4) soil erosion prevention, (5) landscape preservation, (6) biological diversity preservation, and (7) food security..

Flood prevention function Discharge from paddy fields after intensive rain, even if for a very short period, decreases the probability of flood occurrence, particularly in flat lands downstream. This is realized by repeated use of irrigation canals within each area, and can only be done through rice cultivation.

Two scenarios can be drawn up for non-agricultural flood prevention function. One is to construct dams or reservoirs in place of a paddy field and the other is not to use paddy fields for farming but to maintain them for static flooding. Several studies have been conducted by Korea Office of Rural Development (Eom, 1993), Korea Rural Economic Institute (Oh, 2001), Mitsubishi Research Institute (1997) and the Japanese Agricultural Research Institute (1998) on the option of using dams as substitutes for paddy fields in the prevention of floods. Construction cost of a dam with the same water-storing capacity as a paddy field was determined to estimate the monetary value of the flood prevention function.

The second scenario involves self-maintenance and management paddy fields implemented as measures to control rice production. No rice is planted in these paddy fields, which instead are filled with water. So far no studies have been made to estimate the cost of managing these paddy fields as small reservoirs. In general, however, estimation of such costs is extremely difficult.

Soil erosion and landslide prevention Terraced paddy fields in hilly lands have the most ideal configuration from the viewpoint of preventing soil erosion and landslide. Numerous agricultural engineering studies have pointed out that, should such farmland be used for other types of farming under similar geographical conditions, soil erosion would definitely occur.

Even in terraced paddy fields, without proper water control, probabilities of soil erosion and landslide occurrence are high. Technological studies have revealed that probability of farmland degradation is higher in paddy fields and erosion develops where cultivation is abandoned on slopes. When damages brought on by heavy rains, for example, from typhoon and water discharge from tillage in cultivated and non-cultivated paddy fields were comparatively analyzed, results showed that daily management of farmlands was effective for preventing landslides.

Groundwater recharge Filtrated water in soil causing damages to slopes fulfils the function of replenishing groundwater in low flatlands. What is important about groundwater recharged from paddy fields is that replenishes areas that natural rainfall cannot reach, because canals for agricultural water artificially transfer water in large quantities to areas where natural flow is not possible.

It is well known that percolation into soil is promoted through root holes, when rice roots of the previous year decompose. Undoubtedly, this formation, which is a biochemical process, cannot occur without rice farming. Percolation helps raise the groundwater level when plowing and irrigating fields, proving the significant effect of groundwater recharge by rainfall. Cultivation through direct-seeding and non-tilled cropping is more effective than through transplantation in terms of retaining root holes, but all three methods exert greater draining effect compared to when cultivation is altogether abandoned.

Preservation of biological diversity Paddy fields offer homes

to entomofauna, which comprises some hundreds species including the terrestrial insects and aquatic insects, both resident and migratory. Characteristics of such habitat depend on the attributes of rice farming, and cannot be observed in other farmlands. Paddy fields and irrigation canals are dwelling places for insects, including both species that reside or lay eggs there.

Many types of fish and amphibians also live in paddy fields and irrigation canals, and quite a few of them are rare species. This diversity is possible because rivers and paddy fields are regularly linked. If rice is not grown in these paddy fields, however, the waterways linking rivers and paddy fields which fish can come and go, will disappear.

For water birds including migratory birds, paddy fields serve as both feeding and dwelling places. The loss of feeding ground due to decreasing paddy field areas, along with indiscriminate hunting, has been pointed out as factors leading to the extinction of rare birds. Cranes are under the risk of extinction worldwide. In Korea, their major habitats are found in mid and southern Korean peninsular. Preservation of cranes not only requires safe habitat but also abundant food source. Urbanization of great magnitude has been occurring in East Asian countries, which constitute the largest habitat of cranes globally, making it extremely difficult for birds to find foods during the winter season in these areas. Lee and Rhim (1999) found that the remaining grains in paddy fields after harvest are wonderful sources of food for cranes. They also revealed a close correlation between the number of the two different types of cranes in three regions of Cholwon and the average number of grains per 30 cm^2 of paddy fields (Table 2). Protection of valuable cranes is only one example of the contributions of paddy rice production to biological diversity.

Table 2 Correlation between cranes and rice grains remaining after harvest in paddy fields

	Region1	Region2	Region3
Number of grains (mean ± s.e)	28±4.98	5±3.78	37±7.25
No. of red-crowned crane	84	21	173
No. of white-nape crane	197	57	239

Rice farm works such as plowing and irrigating of fields and the subsequent transplanting of rice seedlings also promote habitat segregation of spices living in paddy fields, further enhancing the biological diversity.

Landscape preservation Since landscape of rice cultivation fields requires the actual growth of rice, it is practically impossible to detach them from agricultural production. Rice is annual crop, which does not continually vegetate in the soil. Therefore, landscapes change notably between summer and winter. Typical landscapes of paddy fields are green fields in summer and yellow before harvest in fall. Moreover, study through a contingent valuation method (CVM) has shown that even winter fields, if they contain leftover hays, whether they be piled high or bound and hung for drying, are highly valued by local people as part of the landscape.

Food security Since most of Asian monsoon paddy fields have a solid history of continued production, some that stretches over a thousand years, and their sustainability has been proven by cultivation and soil sciences, paddy rice framing is a dependable means of future food security. Continued rice production not only supplies present foods, but also enhances the future food supplies. General activities of rice cultivation and production have been playing roles in accumulating human resources, as well as proper maintenance and improvement of the land foundation for paddy fields. As described in the previous chapter, due to the uniqueness of paddy rice culture in the Asian monsoon areas, most governments in the Asian monsoon countries have to declared that food security will be improved by raising the self-sufficiency rate of rice, although national consensus on this should have been reached prior to implementing the policy.

EVALUATION OF ECONOMIC VALUE ON MULTIFUNCTIONALITY

Many estimates are available on the value of multifunctionality as assessed by beneficiaries. Most, related to environmental beneficiaries, have been conducted using a substitutive cost method (SCM) and CVM for evaluation of food security, landscape preservation, and rural revitalization.

Few studies have also been made in Korea and Japan estimating the multifunctionality for the paddy rice fields at a national level by designing a nationwide SCM and CVM surveys. Mitsubishi Research Institute (1997) estimated expanses by using alternative means that provide similar level of effects for each major function, rather than directly measuring demands for these multiple functions. The Japanese Agricultural Research Institute (1998), through the same method used by Mitsubishi Research Institute (1997), estimated the value at about 38.4 billion $US. In Korea, however, Office of Rural Development (Eom, 1993) and Korea Rural Economic Institute (Oh, 2001) have evaluated the multifunctionality for the paddy farming as, respectively, 8.7

Table 3 Estimated multifunctional value from paddy fields according to substitutive cost method as an example (100 Million $US2))

Multiunctionality	Korea		Japan	
	ORD[3] (1993)	KREI[3] (2001)	MRI[3] (1997)	ARI[3] (1998)
Flood prevention	13.19	11.09	162.72	239.91
Water resources recharge	NA	9.52	61.65	107.39
Water purification	49.68	9.96	NA	NA
Soil erosion and landslide prevention	0.56~1.72	3.78	3.93	35.66
Soil purification	NA	0.74	0.38	0.53
Landscape preservation[1]	NA	9.35	142.63	NA
Air purification	23.32~47.39	18.43	14.31	0.83
Total externalities	86.75~111.98	62.87	385.62	384.32

1) evaluated only by the CVM method, 2) 1 $US=1,200 Won=120 Yen, 3) ORD=Office of Rural Development, KERI=Korea Rural Economic Institute, MRI= Mitsubishi Research Institute, ARI= Agricultural Research Institute

~ 11.2 billion and 6.3 billion US$, excluding the North Korea portion. Table 3 shows the economic values of multifunctionality from paddy farming in both Korea and Japan.

It is likely that comparison of economic values between the two countries will have no significant value due to their economic, social, and cultural differences; however, its structure of multifunctionality from paddy rice farming can be grasped through such comparison research. Nevertheless, paddy fields do provide various environmental, and social non-commodity outputs, accounting for 70~ 150% of the total annual rice production cost.

AN OUTLOOK TO DIRECTION OF THE FUTURE

As was pointed out, multifunctionality inevitably leads to controversy on how one measures optimal non-market outputs, such that they are not under- or over- estimated as a pretext for agricultural protectionism and the legitimate policy that should be implemented. A universally accepted and agreed upon logic of count-measure requires verified analysis backing it. However, only a limited number are available for rural vitalization and food security, which are difficult to express in terms of monetary values. Joint and interdisciplinary research projects between economists and natural scientists on domestic as well as international level should be developed, and the cooperative research system should be established for the development of counter-measure logic through actual proofed analysis. In addition, it should be further verified that not only are many beneficiaries linked in the paddy rice production, but also, within the beneficiaries, one beneficial function is linked to another function.

For the development of counter-measure logics, interdisciplinary and international researches focused on the following points are required.

1. Differences between maintaining paddy fields without cultivation, and cultivating paddy rice for recharging of water resources, prevention of floods, and landslide and soil erosion of paddy rice fields

2. Assessing the net effect of environment preservation of paddy fields by comparing the effects of environmental pollution caused and preservation achieved through paddy rice farming.

3. Differences in costs between those achieved through rice production and resulting environmental preservation by paddy rice cultivation to those accrued by importing rice and achieving environmental preservation through means other than paddy rice cultivation.

4. Establishing the direction of future research, which contribute to multifunctionality of paddy rice cultivation by estimating demand and supply of water resource in an era of worldwide water shortage.

5. Estimating the capability of worldwide demand and supply of rice in standpoints of science and technology, taking into consideration the effects of economic variables.

6. Measurement of social loss due to declining living standards in rural areas caused by rural exodus phenomenon and development of concrete examples.

7. Analysis of consumer' propensity for food safety and their

willingness to pay higher prices for safer foods.

8. Providing fundamental materials and data necessary for estimating various social costs due to the cityward preference.

CONCLUSIONS

1. Wet rice farming in the Asian monsoon region is unique compared to dry land farming of Western countries in terms of climate, farming practices, water use, self-sufficiency principle, and agricultural structures of small family farms. These characteristics are the evidence, which have a strong jointness to the multiple benefits from paddy rice farming, other than producing rice.

2. Even though many debates were made in the WTO agricultural negotiations, the definition of multifunctionality for agriculture (paddy rice) is still open to discussions, with different positions held by various nations with different needs. However, if we accept the viewpoints of the proponent's side, the definition of multifunctionality would be that agriculture entails more than what is traditionally perceived as its main function: producing food and fiber.

3. Multiple functions in the monsoon Asian countries, where the paddy rice farming is predominates, were identified as rural vitalization, social security, nature and environment preservations, and finally social and cultural functions. Paddy rice farming also contributes to flood prevention, groundwater recharge, landslide and soil erosion prevention, landscape preservation, biological diversity preservation, and food security.

4. Studies from Korea and Japan revealed that the nature and environmental functions of paddy fields provide the economic value of 6.3 billion $US in Korea and 38.4 billion US$ in Japan, approximately 70~150% of total price of annual rice production of each country.

5. The interdisciplinary and international researches within the monsoon Asian countries for the multifunctionality of paddy rice farming are necessary to develop counter-measures against the logistics of the Western dry land and commercial farming countries. Furthermore, efforts to disseminate the significance and recognition of the multifunctionality of paddy rice farming under the Asian monsoon climate to the local people as well as societies worldwide become more critical.

REFERENCES

1. Eom, K.C., S.H. Yun, S.U. Hwang, S.K. Yoon, and D.S. Kim, (1993): Public benefits from paddy soil, *Journal of Korean Society of Soil Science and Fertilizers,* **26(4)**, 314-333.
2. Kim, E.S., (2000): A Delphi forecast of the future changes in public benefits of rural development, *Rural Life Science* **21(2)**, 11-16.
3. Kwon, Oh Sang, (2001): *Empirical Work on Multifunctionality: The Case of Korea,* Report to OECD Directorate for Food, Agriculture and Fisheries, Suwon, Korea.
4. Kwun, Soon-kuk(ed.), (2001): *Rice culture in Asia,* Korean National Committee of ICID, Ansan Korea.
5. Lankoski, J., (2000): *Multifunctional character of agriculture,* Agricultural Economics Research Institute, Finland.
6. Lee, W.S. and S.J. Rhim, (1999): *Current status and management of cranes in Korea,* Proceedings of IUCN/WCPA-3 Seoul Conference, 185-195.
7. Mitsubishi Research Institute, (1997): *A study on the measurement of social cost of environment deterioration.*
8. National Agricultural Research Institute, (1998): *Evaluation of multifunctionality of agriculture and rural community by the substitutive cost method.*
9. OECD, (2000): *Multifunctionality: Towards an analytical framework,* COM/AGR/APM/TD /WP(2000)3/FINAL.
10. Oh, S.I., C.Y. Kang and S.S. Kim, (2001): *Research on value evaluation of multifunctionality of agriculture,* Research Report of Korea Rural Economic Institute C2001-31, Seoul, Korea.
11. Romstad, E.A., A. Vatn, P.K. Rorstad and V. Soyland, (2000): *Multifunctional Agriculture - Implications for policy design,* Agricultural University of Norway.

편집자주: 이 논문은 2002년 3월 20일 일본 시가현 오쯔시에서 개최된 세계 물포럼3 프레-심포지엄(WWF3 Pre-symposium)에서 발표한 본학회 권순국 회장의 기조연설입니다. 이 글에서 아시아 몬순지역 논농사의 다원적 기능에 대한 유래, 내용, 평가, 향후 발전방향 등이 제시되어 있으므로 더 많은 학회회원이 읽어 볼 수 있도록 게재합니다.