# SUSTAINABLE FARM DEVELOPMENT IN THE REPUBLIC OF KOREA IN A GLOBAL ECONOMY

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## ABSTRACT

The Republic of Korea will need to alter many of its national economic and agricultural policies to meet the requirements of new global trading agreements. One farm structure that is being encouraged is sustainable farms that use less inorganic fertilizer and pesticide. The main reasons for reducing pesticide and chemical fertilizers on rice, vegetable, and fruit farms are environmental and nutritional: to improve the quality of agricultural products and to protect drinking water supplies for large cities, including Seoul. Other reasons are economic. Korea has to import more than 80% of its food and agricultural products, and the present shortage of foreign currency contributes to a rapidly increasing trend in farm debt on all types of farms: only 20.4% of Korean farms were debt-free in 1997 (MAF 1998). The present goal of Korea`s agricultural policy is to reduce pesticide and chemical fertilizer use on farms by 50%. Koreans consume about $120 million worth of organic food products annually, and this figure is growing by between 30% and 40% per year (UNCTAD).

The number of organic farms is increasing, and the government has promised to compensate farms which convert to organic methods for lower yields of production, one of several government strategies which envisage even greater numbers of organic farms in the future. These structural adjustments to farms and businesses will have a significant impact on the agriculture industry. This study estimates the economic effects on farm household production of altering input levels and adopting sustainable farming techniques.

A Cobb-Douglas production function was applied to derive production elasticities for farm input materials. The data come from a Ministry of Agriculture farm household economy survey of 3,085 farms conducted between 1980 and 1997. The value of farm income was adjusted according to the Consumer Price Index, and the value of input materials was adjusted according to the Farm Input Materials Index.

The results suggest that converting to sustainable organic farming methods would economically benefit most farms. The coefficient estimate for pesticides was -0.9691, and the marginal value of production was 0.57 at the mean. The average farm management unit gains no advantage by applying more pesticide; in fact, it would benefit from reducing pesticide use. A 1% increase in pesticide cost would decrease farm income by 0.57%. The coefficient for chemical fertilizers was 0.28, but was not significant at the 5% level. A 1% increase in the cost of chemical fertilizer would increase the level of farm income by 0.17%. The coefficient for farm machinery was 1.14. A 1% increase in the cost of machinery use would increase farm income by 0.74%. By reducing levels of chemical fertilizer and pesticide application and by adopting sustainable farming techniques, managers of Korean peasant farms could not only contribute to a healthier environment, but could also improve their management systems, reduce farm debt levels, and increase profits.

## INTRODUCTION

The harmony between national economic growth and agricultural development is a seri-

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ous problem in rapidly industrializing nations like the Republic of Korea (hereafter Korea). There are limits to any nation's rate of economic growth, and that rate depends on changes in international economics. Korea's rapid economic growth during the 1970-90 period resulted in a reliance upon outdated farm management strategies, the inefficient use of capital, and rapidly increasing land prices among smaller farms. The resulting high levels of labour input, high wages, and high interest rates on land capital for small farms have contributed to a high per-unit production cost for Korean farms. In recent years, globalization has increased international competition in many Asian countries, including Korea. Under the circumstances, Korean farmers are not motivated to produce enough to feed Korea's growing population, let alone to compete internationally.

Globalization presents Korean agriculture with three basic problems. The first is that foreign agricultural products will have lower import duties, a condition of Korea's admission to the Organization of Economic Cooperation and Development. The second concerns import quotas on, and the price and quality of, those imported products, especially considering Korea's shortage of foreign currency. The third is that Korea will require lower per-unit production costs to compete with other countries. It is clear that a plan to reform the national agricultural policy is required, and effective policy changes demand a clear understanding of the basic situation.

National agricultural policy tries to assist farmers, but, to date, government policies have not been effective in increasing returns. The government spent 32 billion Won on agricultural research in 1988, but used only 18% of the results. A further 32 billion Won was wasted when an agricultural structural fund was spent on inappropriate water applications in agricultural development. Good intentions can go only so far without effective planning.

Another important policy question is how to keep peasant farms sustainable. Farm organizations persistently request higher prices to increase income, but their requests are normally discounted. In 1996, for example, rice farmers requested a price increase of 8%, but obtained only 4%. Even with higher prices, government policy fails to support peasant farms: larger farms (3 hectares or more) benefit from higher prices, but smaller farms (1 hectare or less) do not. With the current farm structure, most rice farmers cannot compensate family members for farm labour, and peasant farms incur ever increasing levels of debt. The Minstry of Agriculture will drop interest rates on policy loans for farmers from the current 6.5% to 5%, but the principal will remain high. The total amount of delayed payment will be 12.7 trillion Won ($9.4 billion), breaking down into 1.7 trillion Won for policy loans and 11 trillion Won for mutual financing loans (Korea Herald, October 15,1998). As peasant farms represent a large proportion of Korean farms, plans to reform national agriculture policy must also ensure their sustainability.

Even with a plan, however, it will be difficult to adjust many types of farms, including rice, vegetable, orchard, dairy, beef, and chicken farms. Most farmers have little information about new management techniques or scientific changes in national and international agricultural situations, and only 5% of farmers use personal computers in farm management. Education will be another important part of sustainable agriculture development planning.

As Korean agriculture enters the arena of international trade, the greatest challenges are to increase profits and productivity while reducing production costs and dependence upon imported agricultural products. Korean farmers are faced with the prospect of developing sustainable farm management techniques, and policy planners need to know how best to assist them. This research will contribute to an understanding of various forms of sustainable farm management systems in Korea, a prerequisite to formulating and implementing effective changes in agricultural policy.

## CURRENT STATE OF RESEARCH

Organic food production is growing all over the world. One estimate projects growth for organic bioproducts at 5% (Bio-Fair), and projects a 10% market share in some developed countries by next year (UNCTAD). World trade in organic products will reach $1 trillion by 2006 (Lohr 1998). Purchasers in both developed and developing countries tend to be urban, well educated, health- and environment-conscious consumers. The health status of urban consumers is one of the most serious problems in urban populations, while conventional farm producers in rural areas also face worsening health.

Consumer behaviour is increasingly driven by factors related to quality, health, and safety in Belgium (Viaene 1998). Consumers want to have better quality of vegetables and they want to know about ideal vegetable production process such as quality of soil, seed, growth, harvest, processing, and preparation. Organic vegetable production has been ideal for Belgian consumers in recent years

There is one research article on the choice of organic produce published in theUnited States (Thomson and Kidwell, 1998). Organic produce did not always display poorer cosmetic quality, and price premiums for organic produce ranged between about 40% and 175% of their conventional counterparts.

Madden and Chaplowe (1997) have produced one of most recent publications on world sustainable agriculture. There are reviews of sustainable agriculture activities in the world and of the recent development of Community Supported Agriculture in the United States. There are presently 600 working CSA projects, engaging at least 100,000 members throughout the United States and Canada. The Organic Farming Research Foundation (1996) undertook a national survey of organic farmers in the United Sates. Organic agriculture in Europe is increasing. "Land under organic management in Europe has increased from about 12,000 hectares in 1986 to 1,300,000 hectares in 1996, representing an annual increase of 15%. The number of organic farmers has increased over the same period from 7,800 to 55,000" (Lampkin 1996). In Germany, the European country with the most organic production, the number of certified organic farms increased from 500 in 1980 to 6,668 in 1996. The number of certified organic farms in Austria has increased from 2,000 in 1991 -- when conversion assistance first became available -- to 15,850 in 1996. Conversion aid is also credited with an increase to 1,500 organic farms in Switzerland in 1996.

Organic foods constitute about 5% of the volume and 2% of the value (US$200 million) of total food consumption in Austria (USDA, 1998). Organic prices are 10% to 20% higher than conventional products, although prices for organic meat products are about 50% higher. Austria's two largest supermarket chains now carry 150 to 200 organic products, and both feature a line of their own brand items. Billa, the larger of the two, stocks its shelves with organic products grown under contract by 1,400 certified organic growers. Organic products are considered prestige items and are sold in separate sections of the store.

In Italy, where a new survey covers both certified producers and those in conversion, the number increased from 4,927 in 1997 to 7,219 in 1995. The development of ecological farms in the European Union has also been studied (Kim 1996).

In Korea, the Paldang organic vegetable farm project permits no pesticides or chemical fertilizers on crops grown in the area in order to improve the quality of water in the Paldang Dam. The water quality continues to decline, however, because of nearby construction, poorly treated municipal waste water, and runoff of livestock waste. The water in Paldang Dam contained 1 ppm of Biological Oxygen Demand in 1990, and this increased to 1.6 ppm in 1997 (Chosun Ilbo, October 10, 1997). There has been no new waste water treat-

ment construction since 1995, but the quantity of waste has increased to 15,000 tons per day. Organic farming in the Paldang Dam area may contribute to improved water quality, but other factors that contribute to declining drinking water quality for larger cities, such as Seoul, need to be addressed.

Linear programming models have been used to study organic farming systems (Kim, 1997). Organic production can have an economic advantage in comparison with conventional agricultural products, especially when the higher value of organic products is considered. At the farm level, an additional unit increase of organic production can result in a higher level of income from organic products than from conventional products. At an aggregate level, increased production of organic products will lower their price premium.

Supply and demand in wholesale markets for organic broccoli, carrots, and lettuce have been analysed in the United States (Park and Lohr 1996). The value of organic production increased 20% per year, and annual sales were more than $US2 billion in 1994.

Organic growers sometimes receive prices up to 250% more for organic products than for nonorganic products. At the same time, consumers pay average premiums of 25% to 30% for organic produce.

Lampkin and Padal (1994) review the economics of organic and sustainable farming in England. The economic situation of organic farming was also considered for Britain, Germany, Denmark, Switzerland, Canada, the United States, and Australia. There are also some other aspects such as conversion to organic farming and government policy assistance to promote organic farming. Most European countries have increased numbers and area of ecological farms in recent years.

There are increasing trends of sustainable farms in the southern part of Korea. The motive is often to improve drinking water quality. Therefore, the Korean government is compensating farmers who reduce quantities of pesticide and chemical fertilizers. The number of sustainable farms in 1996 was 6,700, or 0.5 % of all farms (MAF,1996). Korea has increased research activities in soil conservation, water management, waste management, cropping patterns, integrated pest management, and genetic conservation (KASA 1995). Other countries have similar interests in organic farming (RDA 1994).

The National Agricultural Inspection Office has a program to control the quality of organic and conventional agricultural products. The NAIO's four cultivation categories are:

organic cultivation (12%),

non application of pesticide (22%),

lower level of pesticide (66%), and

conventional cultivation (0%).

MAF is planning to finance up to 40,000,000 Won (US$44,415 as of October 13, 1997) per farm household in Kyunggi Province for farms which reduce the application of pesticide and chemical fertilizer. There are 2,500 sustainable farms receiving long term credit at an annual interest rate of 5% to be paid back after two years, during the next five years (MAF 1996). At present, there is no economic analysis of sustainable farms and the impact of reforming government policy. There are marketing difficulties for sustainable agricultural products, and most of these products are marketed through the national agricultural cooperative federation.

The ministry of agriculture is going to finance 8300 million Won to sustainable farms in Korea during the next decade. Therefore, the number of sustainable farms will probably increase.

**MODEL** In order to derive elasticities of production of farm input materials, the Cobb-

Douglas form of production function was applied. The general form of Cobb-Douglas production function is:

$$Y = aX_1^{b}X_2^{c}X_3^{d} \quad (1)$$

where: Y = farm income (1000 Won/household), X1 = pesticide (1000 Won), X2 = chemical fertilizers (1000 Won), X3 = farm machinery (1000 Won), and a0, a, b, and c are estimated parameters.

With the use of times-series data, values can change over time, due to changing quantities and price levels. When dealing with time-series data, it is necessary to work with a constant price so that inflationary or other price changes do not affect results. This problem will not occur in analyzing cross-section data. The model of Cobb-Douglas form of production function is explained in detail elsewhere (Judge et al., 1982).

**DATA**

The MAF and the RDA surveyed a total of 6,720 sustainable farms between July 1 and August 31, 1996. Table 1 shows the five different types of farms and the number of farms in each category. The categories are:

I. organic farms (no pesticides or chemical fertilizers for the last three years);

II. half organic farms (no current application of pesticides or chemical fertilizers, but for less than three years);

III. no pesticide application or chemical fertilizers (these farms may not apply pesticides, but may apply organic manure and minimal levels of chemical fertilizers);

IV. pesticide, but no application of chemical fertilizers (these farms apply no chemical fertilizers, but may apply minimal levels of growth promotants, herbicides, and hormones); and

V. control farms (these farms may apply minimal levels of pesticides and chemical fertilizers).

The MAF classifies all of these farms as sustainable. Table 2 shows the numbers of farms and areas by sustainablility classification and type of agricultural product.

The first year of the sustainable farm survey was 1996. The 6,720 farms were only 0.45% of the total numbers of farms (1,480,000 in 1996 [MAF p. 40]). Of the surveyed farms, 35.21% were rice farms, 44.93% were vegetable farms, 12.46% were orchards, and 7.4% were other farms. The number of sustainable vegetable farms is increasing the most. Organic farms account for only 11.98% of all sustainable farms. All agricultural products from sustainable farms are certified and labeled with the name of the producing farm. The NAIO also performs regular -- at least once a week -- soil and water control checks on sustainable farms in different regions.

There are five types of special sustainable farms in Korea:

I. Traditional (use traditional farming methods like planting black beans or brown potatoes);

II. Duck (rice farming with ducks to control weeds and pests);

III. Clean water (the water quality must be clean, and the farm must produce crops like water celery);

IV. Mud snails (rice farming with mud snails to control weeds);

V. Mud fish (rice farming with mud fish to control weeds);

Forty-six percent of the farms using these practices grew rice, covering 47% of the total area. Vegetable farms were 32% of the total farms, using 27% of the area. Orchards and other crops were small users of these techniques.

There is more statistical information on the numbers and area of farms by type and product (Table 2). Of the total number of farms, 32.39% were rice farms, 48.40% were vegetable farms, 11.34% were orchards, and 9.88%were other farms. Organic farms made up 10.71% of rice farms, 12.55% of vegetable farms, 6.96% of orchard farms, and 7.86% of other farms. It is true that most sustainable farms are rice and vegetable farms, and organic farms still account for less than 11% and 13% of rice and vegetable farms respectively. At present, there is less economic analysis of different types of sustainable farming systems and kinds of agricultural products.

Table 2 lists the number of sustainable farms by special farming method. Of these, 47.28% were clean water farms, while 22.49% were duck farms. Together, farms which use these methods outnumber farms which use other methods. Vegetable farming has priority over special farming methods.

**RESULTS**

The estimated results of the production function are presented in Table 3. The coefficient for pesticide was -0.97, and the marginal product was -0.57 at the mean. There is no economic advantage to applying additional pesticide. A 1% increase in chemical fertilizers will increase the level of farm income by 0.28%. The coefficient of farm machinery showed 1.14. The variables of farm machinery are statistically significant at the 0.05 level. The coefficient of determination (R2) is 0.9827. The F-value is significant at the 0.05 level. It is found that an increasing application of pesticide cannot increase level of farm income. At the same time, there are also some other possibilities of keeping a healthy rural quality of life, better food quality, better health status of farmers and consumers in urban areas.

At present, the main goal of agricultural policy is to reduce pesticide and chemical fertilizer use by about 50%. The other main reason why reducing pesticide and chemical fertilizers in vegetable and fruit farms is to maintain drinking water quality near larger cities and near Seoul.

Cabbage production is important in Korea. The RDA conducted a spring cabbage management and income survey between 1980 and 1997 (RDA, 1998). Table 4 shows the results of the Cobb-Douglas form of production function for spring cabbage production. The dependent variable is income per 10a ( 0.1 ha ) and independent variables are pesticide cost, chemical fertilizers, farm machinery depreciation, and family labor. The elasticities of pesticide and farm machinery depreciation are negative, while chemical fertilizers and family labor are positive. The additional application of chemical fertilizers may increase the level of farm income in spring cabbage production. The additional application of family labor can also increase the level of farm income. The additional application of pesticide cannot increase the level of farm income. In vegetable production, the application of pesticide and chemical fertilizers are very common.

The price difference between organic and conventoanl carrots appears in Table 6.The price of organic carrots was 57% higher than the price of conventional carrots in March 1999. There is greater economic advantage in producing organic carrots than conventional carrot. Although the prices of agricultural products vary from enterprise to enterprise in Korea, organic agricultural products consistently have much higher prices than their conventional counterparts.

## SUMMARY AND DISCUSSION

At present, there is no systematic survey of organic farmers each year in Korea, and economic analyses of organic farms are not available. Korean agricultural policy should be based on scientific research results in future. The ministry of agriculture can promote the future expansion of organic farms. The national agricultural cooperative federation and the city of Seoul are striving to produce organic products near Seoul. There are rapidly increasing numbers of organic farmers and products. There is financing to convert to organic production. There is more labor input in organic farming method and less yield of production. There is none of organic agricultural markets and systematic economic research. In order to improve quality of food, drinking water, status of health both for consumers and producers, the organic farming method should be improved in future.

It is found that an additional application of pesticide cannot increase level of farm income in bookkeeping farms in real and nominal value. The additional application of chemical fertilizers may increase level of farm income in real value, but not nominal value. An additional application of farm machinery may increase level of farm income in book-keeping farms.

There is economic advantage of organic farmers to compensate lower yield of yield during conversion period, therefore the number of organic farms can be increased in future. The economic situation of organic farms should be better than conventional farms by having higher level of prices of organic products. At the same time, the urban consumers can buy better quality of food to keep better status of health in urban families.

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## TABLES

**Table 1. Numbers and area of sustainable farms (area in ha)**

| | Total | | Sustainable Farm Classification | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | | 2 | | 3 | | 4 | | 5 | |
| | farms | area | farms | area | farms | area | farms | area | farms | area | farms | area |
| Total | 6,720 | 7,265 | 814 | 781 | 367 | 344 | 1,038 | 1,131 | 577 | 577 | 3,908 | 4,431 |
| % | 100 | 100 | 12 | 11 | 6 | 4 | 16 | 16 | 8 | 8 | 58 | 61 |
| Rice | 2,366 | 2,654 | 256 | 285 | 112 | 114 | 520 | 518 | 108 | 104 | 1,365 | 1,634 |
| Veg. | 3,019 | 3,003 | 388 | 367 | 180 | 164 | 440 | 446 | 284 | 282 | 1,727 | 1,754 |
| Orch. | 837 | 1,086 | 52 | 62 | 31 | 34 | 62 | 89 | 138 | 153 | 564 | 699 |
| Other | 518 | 571 | 109 | 77 | 44 | 325 | 61 | 78 | 32 | 39 | 262 | 345 |

Source: MAF (1996): Status of Sustainable Farms (August, 1996): 269.

Note: 1=organic farms, 2=half organic farms, 3= no pesticide application, 4= pesticide, 5=control farms; area is in hectares; Veg.=vegetables, Orch.=orchards.

**Table 2. Numbers and area of special sustainable farming methods (area in ha)**

| | Total | | Crops | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Rice | | Vegetable | | Orchard | | Other | |
| | farms | area | farms | area | farms | area | farms | area | farms | area |
| Total | 1,654 | 1,111 | 758 | 528 | 534 | 297 | 105 | 111 | 257 | 176 |
| % | 100 | 100 | 46 | 47 | 32 | 27 | 6 | 10 | 16 | 16 |
| Traditional | 308 | 309 | 51 | 58 | 125 | 111 | 54 | 68 | 78 | 72 |
| Ducks | 372 | 250 | 372 | 250 | | | | | | |
| Clean water | 782 | 452 | 143 | 119 | 409 | 185 | 51 | 44 | 179 | 103 |
| Mud snail | 191 | 100 | 191 | 100 | | | | | | |
| Mud fish | 1 | 0.4 | 1 | 0.4 | | | | | | |

Source: MAF: ibid, p. 271

**Table 3. Result of production function analysis in real value (1980-97)**

| | Coefficient | t-value | Marginal Product |
|---|---|---|---|
| constant | 5.6087 | 14.6525 | N/A |
| pesticide | -0.9691 | -3.209 | 0.57 |
| chemical fertilizers | 0.2807 | 2.224 | 0.17 |
| machinery | 1.1443 | 5.628* | 0.74 |
| R2 | 0.9827 | | |
| F-value | 265.5214* | | |

* Indicates significant estimates (P< 0.05).
+ Marginal vales are computed at the mean.

**Table 4. Result of production function analysis for spring cabbage in nominal value (1980-97)**

| | Coefficient | | |
|---|---|---|---|
| constant | 2.4634 | 3.102 | N/A |
| pesticide | -0.1378 | -1.002 | -0.34 |
| chemical fertilizers | 0.7129 | 1.734 | 1.34 |
| machinery | -0.2619 | -1.740 | 0.65 |
| own labor | 0.2883 | 1.836 | 0.34 |
| R2 | 0.6527 | | |
| F-value | 5.6384* | | |

* Indicates significant estimates (P< 0.05).
+ Marginal values are computed at the means.

**Table 5. Organic produce markets worldwide**

| Country | Approx. retail value (US$) | Year | Share of imports | Share of sales | Average retail price premium | Sources |
|---|---|---|---|---|---|---|
| Germany | 1.6 billion | 1997 | 1.5% | 60% | 30% | PSC; Achilles |
| China | 1.2 billion | 1995 | 6.0% | 0% | 30% | CICED, Wang et al. |
| France | 508 million | 1996 | 0.4% | 10% | 25-35% | GIRA; EuroConsulting |
| Japan | 500 million | 1994 | 1.0% | | 13-40% | JETRO |
| United K'dom | 445 million | 1997 | 2.0% | 70% | 0-30% | PSC; McCrea |
| Austria | 270 million | 1997 | 2.5% | 30% | 20-30% | PSC; Krucsay |
| Netherlands | 230 million | 1997 | 1.5% | 60% | 15-20% | PSC; Harst-Collaris |
| Sweden | 200 million | 1997 | 2.0% | 30% | 15-50% | PSC; U.S.Embassy |
| Switzerland | 190 million | 1996 | 5.0% | n.a. | n.a. | Wyler |
| Denmark | 190 million | 1997 | <3.0% | 25% | 15-40% | PSC; Bio-Fair |
| Belgium | 75 million | 1997 | 1.0% | 50% | 29% | PSC; Bio-Fair |
| Canada | 68 million | 1995 | 1.0% | 80% | 30% | Myles; Bio-Fair, Christie |
| Australia | 59 million | 1995 | <0.5% | n.a. | 10-20% | Hudson; Conacher & Conacher |
| Hong Kong | n.a. | 1996 | 0.5% | n.a. | 50-300% | Yuen |
| Taiwan | n.a. | 1998 | 1-3% | n.a. | 200-300% | Peng |

Source: Lohr (1998)

**Table 6: Price difference between organic and conventional carrots (March, 1999)**

| unit | conventional (A) | organic (B) | B/A |
|---|---|---|---|
| Won/kg | 1460 | 2300 | 1.57 |
| US$/kg | 1.21 | 1.91 | 1.58 |

Source: National Agricultural Cooperative Federation, March, 1999
Note: the basic exchange rate was 1200 Won per US$ on March 12, 1999