Farm Mechanization Policies in Korea

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Abstract

Korea has achieved successful farm mechanization over the past 45 years. Mechanization for rice production is almost complete and that for horticulture and livestock is well under way. In this regard, the Korean government has instituted a number of policies to promote farm mechanization, including distribution, production, marketing, inspection, after-sales service, and the training of end users of agricultural machines. This paper reviews the progress of Korea’s farm mechanization and the policy directions of the Korean government with respect to the promotion of farm mechanization. Some problems in the implementation of the policies are discussed. The successful actualization of the Korean farm mechanization represents a good benchmark for policy makers in developing countries, particularly for those who preside over rice growing regions in Asia. A country’s farm mechanization policies affect the farmers, machine manufacturers, and agricultural productions of the country; thus, such policies should be implemented on the basis of the country’s local conditions and rural economy. To achieve successful farm mechanization, the rural economy must remain economically viable, and there must be a reduction in rural labor force. Korea’s success has been due to its industrial development.

Keywords: Farm Mechanization, Policy Directions, Korea.

I Introduction

Korea has achieved remarkable progress in farm mechanization over the past 45 years, accomplishing the feat faster than any other country.

The farming population of Korea had peaked at 16 million in 1967, which was 53.4% of the country’s total population. It has steadily decreased since then, reaching 3.2 million in 2008 (6.4% of the total population). More than 12.8 million have left the farm over the last 41 years. On the other hand, rice production has increased from 3.15 to 5.22 metric tons/ha on average over the same period. The number of people required to produce one metric ton of rice has also decreased by 83.9% from 4.1 to 0.66. Similar increases have also been achieved in the production of vegetable, fruit, and livestock over the same period.

High yield varieties, good fertilizers, better disease controls, and improved cultural practices through mechanization have contributed to the increases in rice production. Most of all, farm mechanization has played the most significant role in changing the agricultural production systems of Korea. Farm mechanization has made possible a redistribution of Korea’s labor force, supplying the required labor for Korea’s fast-paced industrial development in the 1970s and 1980s, while producing enough food for the country’s rapidly growing population.

This paper reviews the progress of Korea’s farm mechanization from a policy standpoint and discusses the problems that were encountered during the implementation of the policies. The lessons and experiences from Korea’s farm mechanization may represent a good benchmark for policy makers in developing countries, particularly for those who preside over rice growing regions in Asia and those who wish to implement better mechanization or to plan for such an effort in future.

II Background

1. Decline of the agricultural population

In the 1960s, many Koreans were poor, and they suffered from food shortage. In this regard, Korea had decided to concentrate on developing its export-oriented industries to reduce its poverty and suffering. The country was united behind this idea, which made it possible to launch a series of Five-Year Economic Development Plans (EDPs). The EDPs had started in 1962 and had continued for 35 years through 1996 when the 7th EDP was completed.

The major policy directions with respect to farm mechanization have been detailed in these 5-year EDPs. As the EDPs were successfully implemented, a significant level of labor was required to drive newly developed industrial sectors. Consequently, farmers began an exodus, leaving their
farming jobs behind to work in newly-created jobs in export-oriented industries. The agricultural population in Korea had peaked at 16 million in 1967, which represented 53.4% of the total population. As shown in Figure 1, it has decreased steadily since then, representing 6.4% of the total population in 2008.

In the early 1970's, the government had clearly recognized the need for farm mechanization. The government was concerned for two reasons: First, the projected decline in the agricultural population, due to the shift in labor to export-oriented industries, was seen as a potential threat to stable food supply, especially in the light of the rapidly growing population. Second, there was a perceived need to increase farm production because the achievement of self-sufficiency in the production of rice was seen as a necessity. Increasing labor productivity and improving cultural practices through farm mechanization were regarded as the only way to meet both the required agricultural production and labor force for the new industries.

To promote the mechanization more efficiently, the first 5-year Farm Mechanization Plan (FMP) was initiated in 1972. Under this plan to increase the land productivity, the distribution of farm machines would be accelerated, and paddy field consolidation would be conducted at the same time. The FMPs are still being implemented; the 8th 5-year FMP had started in 2007.

It is widely recognized that farm mechanization should be carried out in parallel with projects that can absorb the excess farm labor from rural areas. In Korea, this has been the industrial development. Korea’s farm mechanization has functioned basically as a means of replenishing the reduction in rural labor arising from newly-created competitive jobs in the non-agricultural sector. Farm mechanization without a corresponding decrease in the agricultural population cannot succeed because the mechanization is not able to compete with the low-cost rural labor. In this regard, Korea’s industrial development has been the key factor in the success of Korea’s farm mechanization.

2. Farm wages and income

One of the most important factors affecting farm mechanization is the wage of farm labor. The wage is particularly critical during peak labor-need periods, which typically occur in spring for rice transplanting and in fall for rice harvesting.

Korea had experienced a 97.7 time increase in the average farm wages from 1962 to 1987. The average annual rate of increase had been more than 20% over the last 20 years and had peaked at 30% during the 4th 5-year EDP period. It has since decreased to less than 5% from 1982. Such a dramatic rise in farm wages had resulted from the rapid decline in the rural labor during that period.

Over the same period, the average income per farm household, including both cash and physical asset, had increased by approximately 96.3 times, where 79.6% of the increase was from agriculture in 1962 (61.7% in 1987 and 55.7% in the 2000s). This indicates that, although the total income had increased, the income from agriculture had declined because of the increased income from the non-agriculture sector. The average expenditure of farm households had also increased faster than the income, particularly since 1979. Consequently, the farm household income from agriculture could not absorb the expenditure, even for basic living expenses. The combination of low agricultural income and high expenditure would have made the farm household economy inviable if the farm size had been small. This was partially attributable to the price control of agricultural products by the government and rapid changes in the rural lifestyle. The economy of farm households, thus, had depended largely upon the income from non-agricultural sources such as earnings as part-time workers at nearby industries.

Farm mechanization cannot be promoted without a surplus in the economy of farmers (e.g., the potential power to purchase agricultural machines). To generate a surplus, either the farming size per household or part-time job opportunities must be increased in the rural area, making economically feasible the use of agricultural machines or the employment of expensive labors using non-agricultural income. One of the reasons why the increased wages had not generated additional non-agricultural income in Korea was that employment opportunities in rural areas had been limited.
In sum, the increased farm wages, caused by the shortage of rural labor, had played a positive role for Korea’s farm mechanization, but it had failed to increase the non-agricultural income of farmers because of the limited employment opportunities in rural areas. In addition, the decline in the agricultural population had not adequately increased the farming size enough to make the mechanization economically competitive. In other words, farmers could not carry out farming without using machines because of the labor shortage in the rural area. Nonetheless, they could not afford the machines because of the low surplus afforded by the state of their economy. This had been a serious problem for Korea during the farm mechanization implementation process. Adequate job opportunities must be created in rural areas to achieve success in farm mechanization, particularly in regions where the farming size is relatively small; otherwise, the farming size should be increased to make mechanized farming economically competitive. Increasing the farming size has been a policy direction of Korea in its efforts to reduce the low-income problem in the farm household economy.

III Policy Directions

Before the 1960s, farming in Korea had been generally performed by animal or human powers. Only limited mechanical aids, including hand tools, had been used for cultivation, transplanting, and harvesting.

During the 1st 5-year EDP period (1962-1966), farm mechanization had been concerned mainly with the irrigation and spraying for rice. Mechanization had been intended to minimize crop losses due to bad weather conditions and poor insect and disease controls. Consequently, agricultural machines supplied in this period had been mainly water pumps and sprayers that were imported from foreign countries.

A change had occurred after the successful implementation of the 2nd 5-year EDP. The outflow of rural people to the new industries had begun, and its rate had been increasing; the rural population had reached a turning point in 1967, when the rural population had begun its decline. Thus, the farm mechanization in the 1970’s had been focused on labor-replacing mechanization and had been extended to soil preparation, transplanting, harvesting, and other necessary operations related to labor peak seasons.

An effort was made in the 1970s to integrate government organizations and policies related to farm mechanization. The reason was to accelerate the mechanization and to make the process more efficient. This effort included the promulgation of the Promotion Law for Farm Mechanization in December 1978. This law laid a legal foundation making possible the all-out mechanization of the rice production in the 1980s. The law stated the procedures and measures for the government in its implementation of farm mechanization policies for the production, inspection, supply, after-sales service, and the joint-utilization of agricultural machines.

The continued increase in the outflow rate of rural labor in the late 1970s had resulted in labor shortages not only in rice transplanting and harvesting but also in tilling, pesticide spraying, and threshing operations. In addition, the quality of rural labor had deteriorated as younger male workers moved to the cities and older female workers remained. Under the circumstances, the farm mechanization policy direction had to change from reducing naturally caused damages to substituting the labor shortages. The goals of the farm mechanization from 1977 to 1981 were as follows.

1. The accomplishment of the all-out mechanization for rice production through the distribution of rice transplanters, power sprayers, binders, combines, and grain dryers.

2. The development of small-sized agricultural machines that could be easily operated by older or female farm workers.

3. The promotion of the joint utilization of agricultural machines and the establishment of after-service networks and training facilities throughout the country.

In the 1980s, farm mechanization had placed its priority to the all-out mechanization for rice production. The all-out mechanization was an integrated mechanization model, where all operations, from tillage to harvesting, for crop production would be mechanized. In the case of rice production, soil preparation, growing seedlings, transplanting, chemical applications, harvesting, and drying would all be carried out by using powered machines such as power tillers, tractors, rice transplanter, power sprayers, binders, combines, and grain dryers.

Mechanization for the production of upland crops, fruits, dairies, and horticultural products was the goal of the 1990s. The slope-land farming was also an important area to be mechanized. These mechanization demands were reflected in the 5th 5-year Farm Mechanization Plan initiated in 1992. The all-out mechanization in rice production was still emphasized in the 1990s. At the end of the 1990s, mechanization in rice production was considered as successfully accomplished, even though some operations still needed further mechanization.

The mechanization for upland crops, fruits, and horticultural and dairy products has continued into the 2000s with special emphasis on the automation of production facilities. Unmanned helicopter spraying has also attracted the attention of many farmers in the 2000s.
IV Implementation of Policies

In the beginning of the mechanization, it had been critically important to make farmers believe that farming can be carried out by using machines without any yield loss and to supply suitable machines which could take the place of the void left by the outflow of farm labor. Farmers were generally conservative and accepted with extreme skepticism the changes that were different from the traditional way of cultural practices. In addition, farmers were not able to afford agricultural machines, which required large initial investments. In addition, the machines had frequently failed due to various reasons. Thus, it was also important to establish an effective after-sales service network throughout the country for successful mechanization.

1. Demonstration of mechanized farming

In the 1960s and early 1970s, agricultural machines that were distributed to farmers had been mainly water pumps, sprayers, and power tillers. The power tillers were multipurpose powered machines that were first manufactured in 1963; the power tillers played a key role in the mechanization until they had been gradually replaced with tractors in the 1990s. In the beginning, the power tillers were used as a means of transporting materials not only in rural areas but also in cities. Later, they were used as agricultural machines for tillage, spraying, water-pumping, and transporting operations.

Farmers had gradually accepted the use of a power tiller as a substitute for animal or human powers. However, the introduction of combine harvesters in 1972 and rice transplanters in 1973 had not been smooth. Many farmers were uncertain about the functions and performances of the machines because the mechanized harvesting and transplanting through the use of these machines would be completely different from the traditional ways of doing the tasks. Thus, it was necessary to demonstrate how the combines and transplanter could be used and why such mechanized operations would not cause any yield losses.

Between 1977 and 1981, an Integrated Farm Mechanization Demonstration Plot (IFMDP), totaling 300 ha in size, was established in each of the eight provinces of the country to demonstrate the all-out mechanized farming for rice production. Although IFMDPs were not economically successful because of large personnel and facility expenditures as well as mismanagement, they had helped change farmers’ prejudices against mechanized farming, particularly against rice transplanting, and helped gain the acceptance of farmers with respect to the new concept of mechanized harvesting and transplanting. Although no demonstration of mechanized farming has been conducted since all of the IFMDPs were closed in 1981, the general agreement today is that farming would have been impossible without the use of the machines. However, in the beginning, the concept of using the machines was ironically one of the factors that retarded the promotion of farm mechanization.

2. Financial aids

Because most farmers were not able to afford agricultural machines, they needed financial aids such as subsidies or loans to purchase the machines. In this regard, subsidy and loan programs have been made available since 1967. Under these programs, farmers and cooperatives would receive subsidies and loans if they were to purchase the machines specified as Supply Models by the government. The amount of an aid would depend on the type of a machine to buy and whether the machine would be used for a joint utilization.

In the 1960s, a subsidy of 60% of the purchase price was made available for sprayers, water pumps, and power tillers. The subsidy was reduced to 40%, and a loan of 25-40% was supplemented, during the end of 1960s and early 1970s. Tractors, rice transplanters, and combines have been supplied to farmer’s cooperatives, which were organized in farm villages for joint machine utilizations, since the mid 1970s. Various types of the farmer’s cooperatives such as Mechanized Farming Centers and the Large and Small Farming Groups had been established at that time. Purchases made through these cooperatives were qualified for 40% subsidies and 60% loans. Individual farmers received only 1% subsidy and 60% loans, which means that the remaining 39% would be paid by the farmer.

This system had changed in the 1990s: 50% subsidies and 40% loans for the cooperatives and only 60-90% loans for an individual purchaser. Small farming companies for contract operations and full-time rice growing farmers had appeared in the 1990s. The farming companies had received the same amounts of subsidies and loans as the cooperatives. The subsidy for the full-time rice growing farmers had increased from 30% in 1993 to 50% in 1996.

In general, the subsidy has reduced as the loans increased. In 1987, 94% of the total financial aid to support the purchase of farming machines was allocated to loans. The subsidy was available only for the machines for joint utilizations and the upland crop mechanizations such as cultivators. In particular, the cooperatives received 50% subsidies and 40% loans to...
purchase the machines for joint utilizations. Only 10% was paid by the cooperatives. However, individual farmers received only 70 to 90% loans.

The subsidy and loan services have been managed by the National Agricultural Cooperative Federation (NACF). The NACF has charged a lower interest rate for their loans than those by commercial banks. The differences in the interest rates between the NACF and commercial banks have been reimbursed by the government. The initial annual interest rate was 10%, and the rate has gradually decreased to 4-5% in the 1990s and 3% in the 2000s. The repayment of the loans was made by 4 to 7 equal installments over 4 to 7 year period (following a one year grace period), depending upon the types of machines.

A policy called “half-price supply” had been implemented for five years from 1993 to 1997. Under this policy, 50% subsidies were given for machines with prices less than two million won (approximately 2,000 USD). For machines over two million won, farmers received one million won in cash as a financial aid. This special aid program was proposed by a presidential candidate (who eventually won) during his election campaign. This “half-price supply” policy had increased the sales of many farm machines during the period, particularly power tillers and cultivators. However, the policy resulted in the excess farm machine supply after it was terminated. The policy was also credited with distorting market-based supply and demand; power tiller and cultivator manufacturers had suffered from sharply decreased sales immediately after the policy termination. This policy had also caused a deep recession in the domestic agricultural machinery market in the early 2000s.

The percentage ratio of the subsidies and the loans were adjusted depending on the government budget, and the subsidy- and loan-based financial aids had been provided until 1999 when all subsidies were suspended; only 70-90% of loan aids have been available since 2000. A total 1,148 billion won (about 1.1 billion USD) in financial aid had been provided for the purchase of agricultural machines over the last 43 years from 1962 to 2006, 18.2% of which was for the subsidies and the rest for the loans.

These aids were funded through loans from the USAID, the KFW(Kreditanstalt Wiederaufbau) of Germany, the Asian Development Bank, and the Oversee Economic Cooperation Fund from Japan

3. Types of machines

The farm mechanization in Korea can be characterized by the types of the machines that were supplied by the financial aids. In the early 1960s, although imported powered machines were introduced, most machines used in agriculture were manually operated. It was only after the mid 1960s that small powered machines such as farm engines, power tillers, power sprayers, power threshers, and power pumps gradually replaced manually operated machines. The distribution of large-sized powered machines such as tractors, combines, binders, and transplanters had started in the mid 1970s. The introduction of such machines reduced the labor constraints arising from peak labor-need periods and also accelerated the speed of mechanization. In particular, rice combines and transplanters made it possible to implement all-out mechanization in rice production.

In addition, machines had been distributed without a proper transition period, during which the machines would have been evaluated and modified to fit local farming conditions. Typically, farmers also need time to adjust to new technologies in the form of new machines. The reason for the rush was due to the fact that the large-sized machines were mostly imported and that there was a need to quickly distribute the machines throughout the country to accommodate the rapidly decreasing farm labor. As a consequence, many farmers had to endure frequent malfunctions, breakdowns, and inadequate performance levels caused by inadequate operations and poor maintenance.

The introduction of binder harvesters is a good example of such a failure; this failure to adapt to local farming conditions had been proven to be costly. The binder was a type of an intermediate machine useful in the transition period between the manual and combine harvesting. However, the binder was supplied without adequate field tests to evaluate its effectiveness with respect to the high-yielding Indica-type rice varieties, which were widely grown in Korea at that time. These varieties have easily shattering characteristics. Unfortunately, the binders were not appropriate for these varieties, resulting in heavy grain losses during cutting and binding operations in paddy fields. As such, farmers were not receptive to the binders, preferring combine harvesters which required more skillful techniques that they were not trained for. The supply of the binder harvesters, without an appropriate adaptation period, had eventually failed, resulting in heavy financial losses and non-smooth transition to combine harvester.

This case suggests that an introduction of any new machine should entail a technology transfer period to allow for appropriate adaptation to take place. Otherwise, the costs may outweigh the benefits.

4. Manufacturers of machines

In the early 1960s, there were few powered machines; most agricultural tools were animal or human powered. It was in 1963 that power tillers were first manufactured in Korea.
Tractors were first produced in 1969. Combines and rice transplanters were introduced in 1972 and 1973, respectively.

In the beginning, power tillers, tractors, combines, and rice transplanters were assembled in Korea with numerous imported parts under technical collaboration agreements with foreign manufactures such as Kubota, Yanmar, and Iseki from Japan, Fiat from Italy, and Ford from the U.S. The imported parts were gradually replaced by locally-made parts. The gradual localization of farm machines was a policy directed by the government to strengthen the agricultural machinery industry.

In order to strengthen the agricultural machinery industry and to increase the quality of locally-made machines, the government had the manufacturers produce farm machines under two different types of licenses: Integrated Farm Machinery Manufacturer (IFMM) and Specialized Small to Medium-sized Machinery Manufacturer (SSSM). The IFMM was licensed to produce farm engines and at least two of the large-sized machines such as power tillers, tractors, transplanters, binders, or combine harvesters. To be eligible for an IFMM license, a company had to meet the facility and employment requirements and had to maintain the required level of quality in the production of products to pass the national inspection. The SSSM license was issued to relatively small manufacturers producing at least two small- or medium-sized machines such as grain dryers, power sprayers, power threshers, and irrigation pumps. This license system was also designed to avoid serious price competition among manufacturers so that they could produce quality products. The machines eligible for the financial aids from the government were limited to those produced by the IFMMs and the SSSMs. However, this policy produced unintended results. Many licensed manufacturers made minimal efforts to strengthen their capabilities with regard to quality of the manufactured products and the development of new technologies; this was due to the minimal competition among the licensed manufacturers within the domestic market.

The license system had continued until 1988 when it was replaced by a new system. The new system was based on a principle that, if qualified, all manufacturers would be permitted to produce any machine that they wanted. In 1987, out of 118 manufacturers, 5 manufacturers were IFMMs and 6 were SSSMs. The remaining produced parts or components as subcontractors to the licensed manufacturers.

Another problem associated with the old license system was that it had caused the licensed manufacturers to expand their production facilities to meet the seasonal peak demand. However, the off-season demand had decreased such that many licensed manufacturers had experienced excess capacities in their production facilities in the late 1980s, particularly for power tillers, tractors, transplanters, and binders.

Starting with just 50 manufacturing firms in 1963, the farm machinery manufacturing industry has grown into one of the key manufacturing industries of Korea, comprising more than 450 firms. The industry generates approximately 1.1 billion USD annually. The industry produces 34,000 units of tractors, 5,000 units of combines, and 12,000 units of rice transplanters. However, most manufacturers are relatively small, employing less than 50 workers.

5. Marketing of machines
Agricultural machines have been sold through two marketing channels in Korea: manufacturers’ dealers and the NACF. These organizations compete with each other, but they complement each other as well.

Between 1962 and 1971, farmers could buy agricultural machines only through the NACF. This was because the NACF had a well-established network throughout the country, while the dealership network of manufacturers was in its infancy. The NACF had also wanted to prevent the potential formation of a cartel among manufacturers.

The NACF channel had changed in 1972 to the dealership channel so that farm machines could be purchased only through manufacturers’ dealers. The NACF provided farmers with only subsidy and loan services. However, two years later, the dealership channel had switched back to the NACF channel. Thus, the NACF had resumed its marketing services and continued to provide them for two years. The dealers performed only repair and maintenance services during this period.

Between 1977 and 1980, both the NACF and dealers had engaged in marketing activities, each selling a different set of machines. Combines, binders, and transplanters were sold by the dealers, and other machines, including tractors and sprayers, by the NACF. However, such differentiation in the selling of the machines was terminated in 1981; both the NACF and the dealers could sell all agricultural machines without any differentiation. Although one more attempt was made for the dealership channel from 1982 to 1983, the dual channel system had resumed again in 1984 and has since continued.

The alternation of the two marketing channels was simply because of disagreements on the roles of the NACF and manufacturer’s dealerships in terms of their functions and efficiencies for the execution of the planned farm mechanization. The well-established network of the NACF made possible easy access to sales information on machines.
The farmers found convenient the financial aid services of the NACF for the subsidy and loan applications. The NACF had also insisted that, as a farmer’s association, its participation in the marketing would help farmers in purchasing higher quality machines at lower prices. A price control on agricultural machines against the manufacturer’s cartel also made the NACF’s position justifiable. However, the after-sales services of the NACF were not adequate; the NACF lacked well-trained mechanics and it suffered from bureaucratic rigidity. The bureaucratic rigidity also made the procurement process slow, generating many complaints from farmers. The subsidy and loan services by the NACF were frequently used as a means of attracting buyers. The NACF’s marketing activities were inconsequential to the enhancement of domestic and international competitiveness (in both price and technology) of manufacturers. The manufacturers had competed only in the bidding for the NACF’s procurement.

The manufacturer’s dealerships were more flexible and responsive in providing farmers with necessary services. Through the dealership channel, the manufacturers took on additional responsibilities to improve the quality of their products and to provide the farmers with better after-sales services. On the other hand, the dealerships also experienced acute marketing competition with each other. Many dealers sold machines on credit to increase their sales volumes. However, their generally insufficient capital and thin profit margins were not adequate to cover large volumes of credit sales. Large stocks of spare parts also became a financial burden to many dealers. In addition, the application process for subsidies and loans through the dealerships was inconvenient to farmers because the NACF was inflexible in interpreting the related regulations in processing the dealership-originated applications.

The dual channel was designed to solve the problems associated with the two marketing channels. At one point in time, the annual sales of the NACF were limited to 40% of the total procurement through the government’s financial aids. However, the dual channel system has survived fairly well to this day; there is no restriction on sales volumes and types of machines sold. Nonetheless, there has been no clear consensus to date on which of the two channels better reflects Korea’s circumstances.

6. Prices of agricultural machines

Before 1988, prices of agricultural machines were controlled by the government. The objective of the price control was to prevent manufacturers from forming a price cartel or increasing their prices to unreasonably high levels. To determine list prices of agricultural machines, the NACF first estimated the costs required to manufacture the machines. The list prices based on the estimated costs were proposed by the NACF and approved by the government. The upper limits of the list prices were also proposed by the NACF; manufacturers were allowed to compete within the pre-set price ranges. The price control was applied only to the machines eligible for the subsidies and loans.

However, the price control had resulted in problems for manufacturers, including increasing financial difficulties, decreasing machine quality, and stagnating technology development. The government controlled list prices were not able to reflect the fluctuations in the material and labor costs on a timely basis. Farmers also found the price control not much helpful to them. Although the government kept the prices as low as possible, the income of farmers was still inadequate to purchase the machines they needed. The price control, therefore, did not promote farm mechanization; it simply weakened the farm machinery industry.

In recognition of these problems, the government had abolished the price control in 1988 and allowed the manufacturers determine their own prices on a free competition basis. In sum, the price control policy did not yield the intended results with respect to the interests of both manufacturers and farmers. The manufacturers had insisted that the controlled prices could not reflect the reality (with respect to fluctuating costs in the manufacturing of agricultural machines) on a timely basis. Nonetheless, many farmers had thought that the prices of agricultural machines were kept unreasonably high. This was because the farmers’ increased incomes were still inadequate to afford the increasing machine prices.

V Number of Farm Machines

Since the farm mechanization was initiated in the early 1960s, the numbers of power tillers, tractors, combines, and rice transplanteers have steadily increased as shown in Figure 2, reaching to a peak of 959,976 units of power tillers in 1998 and 342,648 units of rice transplanter in 2001. Since then, the numbers of power tillers and rice transplanter have slowly declined. Power tillers have been replaced by tractors, and the 3- or 4-row walking-type transplanter, by the 6-row riding-type transplanter. In the 2000s, there were strong indications that power sizes and working capacities of machines were increasing with the increased farming size and contract works. In this regard, the number of power tiller has declined continuously, and tractors have assumed the role of power tillers. The numbers of combines and rice transplanter are also expected to reach their peaks and remain constant or slightly decline in the 2010s.
Table 1 shows the numbers of power tillers, tractors, cultivators, transplanters, combines, and grain dryers owned by 100 farm households over the last 40 years. Noteworthy is that the numbers had increased at a faster rate, particularly over the 10 years from 1985 to 1995. This reflects the fact that the subsidies and loans to purchase machines were more widely available during this period than at any other period. Since 2000, when the subsidy was terminated, the rate increase had declined.

The mechanization has increased naturally with the number of farm machines. By the end of 1996, on average, 96% of the soil reparation, transplanting, spraying, and harvesting operations for rice production had been performed using powered machines throughout the country.

Table 1  Numbers of major farm machines owned by 100 farm households

<table>
<thead>
<tr>
<th>Year</th>
<th>Power tiller</th>
<th>Tractor</th>
<th>Cultivator</th>
<th>Rice transplanter</th>
<th>Combine</th>
<th>Grain dryer</th>
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<td>1965</td>
<td>0.0</td>
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<td>0.0</td>
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<td>0.5</td>
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<td>0.0</td>
<td>0.5</td>
<td>0.1</td>
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<td>1985</td>
<td>30.6</td>
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<td>0.6</td>
<td>0.2</td>
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<td>42.5</td>
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<td>2.9</td>
<td>7.8</td>
<td>2.5</td>
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<td>16.5</td>
<td>4.8</td>
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<td>27.4</td>
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<td>26.1</td>
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<td>34.2</td>
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One of the key factors affecting the number of agricultural machines was the financial aids program. The financial aids were given as a subsidy, a loan, or a combination of both. The subsidies were possible before the Korean government joined the WTO. As a WTO member, the subsidy was no longer an option for the Korean government, as this was against the WTO charter. The loans can still be provided either by the government or by machinery manufacturers. However, no loan program has been available through the manufacturers to date.

To manage the financial aid services more effectively, the subsidy and the loan must be properly combined, taking into account the types of machines purchased and the direction of the mechanization policy. An inappropriate combination can result in excess machine supply. There has been frequent concerns with respect to the potential oversupply of agricultural machines, particularly power tillers, combines, and rice transplanters. These concerns have negatively affected the propagation of farm mechanization and made difficult the security of the necessary government budget to implement financial aid programs.

The farm mechanization had successfully attained its intended objectives with respect to rice production by the end of 1990s. However, upland crops, horticulture, and livestock farming still need further mechanization. Although the mechanization in rice production can be regarded as successful from a standpoint that machines had replaced the traditional forms of farming techniques and freed farmers from drudgery, there are still areas for improvement. The mechanization process should continue, focusing on achieving energy efficiencies, human comforts, and cost reductions.

VI  Inspection of agricultural machinery

Agricultural machines were inspected by the government to determine their eligibility for the financial aids. The machines were evaluated against the minimum performance requirement set by the government; the machine would need to pass the evaluation prior to its release to the market. Supplying farmers with good quality machines and encouraging the agricultural machinery industry to develop new technologies were the other objectives of the national inspection.

The first national inspection was conducted in 1952 for hand tools such as hoes, shovels, and sickles. Powered machines have been included as of 1962; the machines have been required to be inspected according to the official test procedures by the Ministry of Agriculture and Fishery (MAF).
In the beginning, the inspection was conducted by two institutes: The Institute of Agricultural Engineering and Utilization (IAEU) and the NACF. The IAEU conducted basic inspections to confirm the machines against the specifications submitted by the manufacturers. The NACF conducted pre-shipment inspections of machines at manufacturing plants prior to their release; the inspections ascertained the performance level of the machines against the manufacturer specifications. These inspections had continued until the National Agricultural Material Inspection Office (NAMIO) was established in 1966 and the NAMIO had taken over the inspections conducted by the two institutes.

The Agricultural Mechanization Promotion Law was enacted in 1978. This intensified the systematic inspections. All agricultural machines entitled as the Supply Models under this law were subjected to the inspections. The law specified three inspections: the type approval, pre-shipment, and after-delivery inspections. The type approval inspection replaced the previous basic inspection and tested the machines for durability, performance, and the ease of operation to identify their performance specifications. The minimum performance requirements set by the NAMIO had to be satisfied to pass the type approval inspection. The pre-shipment and after-delivery inspections were to ascertain, prior to the shipment or the after-delivery, respectively, whether the machines could perform as well as they had when they passed the type approval inspection. The result of the type approval inspection was valid for 3 to 5 years depending on the machine type. If serious defects had been found on the machines with respect to the performance or safety factors through the after-delivery inspection, the type approval could have been cancelled. The manufacturers with appropriate testing personnel and facilities as specified by the NAMIO were later allowed to conduct the pre-shipment inspection by themselves. Table 2 shows the agricultural machines that were designated as Supply Models in 1987, which subjected the machines to the mandatory national inspections.

In addition to the mandatory national inspections for the Supply Models, the NAMIO also conducted consignment inspections for non-Supply Models when requested by manufacturers or government offices. Machines such as dusters, mist blowers, powered cutters, farm engines, and seedling boxes were subjected to the consignment inspections.

The national inspections conducted by the NAMIO have greatly contributed to the improvements in the quality of agricultural machines produced in Korea. However, the inspections had negative effects as well. Rigid applications of the test procedures often limited a manufacturer’s ability to develop modified or new machines. Moreover, the inspections were sometimes considered as an obstacle to the improvement of machine performance because of the material or dimensional constraints imposed by the test procedures.

Recognizing these negative effects, the role of the national inspections had been reviewed and changed to adapt to the changes in the agricultural machinery industry. It was suggested that the national inspections should be conducted only for the machines of poor quality, and the manufacturers were encouraged to conduct self inspections to take more responsibility for their products. The pass-or-fail type inspections were changed to an evaluative test so that farmers could utilize the test results as third-party, objective information when purchasing machines.

In 1995, the national inspections were changed from mandatory to voluntary. Many agricultural machines were subjected to self inspections, and government inspections were conducted only when necessary. However, the safety inspections were intensified. Machines such as tractors, combines, transplanters, and speed sprayers were required to be furnished with safety features that passed the safety inspections. Although inspections, except for the safety inspections, had become voluntary, machines were still subjected to government inspections with respect to financial aid eligibility.

Types of machines have increased since 1985; accordingly, testing equipment and inspection facilities also increased and became more modernized. In 1994, the National Institute of Farm Mechanization (NIFM) was officially designated as an OECD tractor test station.

The proper roles of the national inspections are still under discussion. If the intent is to change the inspection system, the role and effects of the inspections must be evaluated from the
standpoint of the promotion of farm mechanization and the development of industrial technologies.

VII After-sales services

A farm machine may fail during field operations. The failure may be caused by bad work conditions or inappropriate operations resulting from the operator’s inadequate training on the use of the machine. Thus, training end-users for the safe, proper operation of machine and making available responsible repair services are essential in maximizing the utility of farm machines.

From the onset of farm mechanization, efforts were made to establish an efficient after-sales service network throughout the country. The types of service organizations, the optimum number of service organizations, their locations, equipment, and the facilities to be furnished by the service organizations were determined, depending on the degree of repair and maintenance services.

The policy direction regarding to the after-sale services was developed on a premise that the services would be provided by the machine suppliers. Consequently, manufacturers’ dealers and the NACF have taken the responsibilities of repair and maintenance services for the machines they sold.

The after-sales service network has been comprised of five different types of service organizations: parts centers and service factories in provinces, service centers and manufacturers’ dealers in counties or cities, and repair shops in towns. The parts centers and the service factories have been operated by manufacturers. The parts centers have supplied other service organizations with spare parts. The service factories have performed maintenance checks, including overhauls. The parts centers and the service centers have been required to stock all spare parts so that the parts could be delivered without a delay. Ordinary repair and maintenance services have been provided by dealers and the NACF-operated service centers located in counties or cities. The manufacturers producing the Supply Models have been required to maintain a dealer in every county throughout the country, and the dealers have been required to keep more than 45% of all consumable parts in stock. The repair shops have been the smallest service organization conducting simple repairs. However, this has been important because most repair works have been performed in the repair shops. The repair shops have been required to keep more than 20% of all consumable parts in stock. All service organizations have been required to be furnished with equipment, facilities, and the number of mechanics as specified by the government. As of the mid 2000s, there were more than 700 dealers and 2,500 other service organizations, including the NACF-operated service centers, in operation throughout the country.

Although the after-sales service network was well established, farmers have still suffered from delayed repair services and difficulties in acquiring spare parts. The repair and maintenance services have not been provided on a timely basis because of the increased demand, especially for tractors, combines, and rice-transplanters during the planting and harvesting seasons. From the perspective of the farmers, the dealers and the repair shops have been the two most easily accessible service organizations. However, their performances have been less than expected. The dealers have been more concerned with sales than providing reliable after-sales services. Consequently, unless the dealers made a reasonable level of profit from their sales, their service functions would not be adequate. In fact, a case to this effect can be found in the years between 1984 and 1986. Due to severe sales competition among the dealers during this period, 84 of the 650 dealers went bankrupt. A low sales margin (4%) during this period had also contributed to the bankruptcy (the margin had increased to 7% by 1987). As a result, the repair and maintenance services had been seriously jeopardized by the sales competition. A similar competition had also existed between the repair shops and the local forge shops during this period.

In general, service organizations have been financially weak. They have not been able to finance a large stock of spare parts. Theoretically, spare parts should be delivered to repair shops within one day from dealers or service centers and within two days from provincial part centers. However, the reality has not reflected this ideal. Farmers have often been forced to make trips to the manufacturing factory to obtain necessary spare parts. Another problem has been the lack of qualified mechanics, a situation commonly shared by most service organizations. This has been due mainly to the typically bad working conditions for mechanics and the low wages the mechanics have been receiving (often lower than wages paid to auto-repair shop employees).

To solve these problems, a number of measures have been taken, including loans and subsidies for purchasing spare parts, the modernization of service equipment and facilities, the standardization of spare parts, and the computerization of service management. Mobile service teams consisting of manufacturers, dealers, and government personnel have been operating semi-annually during peak machine-use periods. Despite of such efforts, service organizations still suffer from a poor level of performance, particularly in the delivery of spare parts.
In this regard, not only the equipment and facilities but also the inventory system of spare parts must be computerized to improve the quality of after-sales services. Further, the wages of mechanics should be raised to the levels comparable to those of technicians who work at auto-repair shops.

**VIII Training**

Farmers must be well trained before they use their machines; this would result in the efficient use of the machines and would minimize machine-related accidents. Farm machines should be properly maintained before they are put to use. A survey of farm machinery accidents in Korea showed that 77.3% of the accidents were related to the mishandling and carelessness of operators.

As such, end-users of machines should be properly trained in the areas of operation, maintenance, and repair prior to the delivery of the machines. Training should also be required for instructors who train end-users and service mechanics. The training programs should be developed in accordance to the roles that would be played by the trainees.

In the early phases of training implementation in Korea, training could not be properly conducted simply because budget limitations; personnel, equipment, and facilities were also not sufficient and inadequate. Manufacturers trained end-users in a series of 3-day classes on operation, maintenance, and repair prior to the delivery of machines. With the establishment of the Central Training Center at the Office of Rural Development in 1969, owners and end-users had the opportunity to be trained through various programs developed by the government. In the beginning, the training program offered an eight-week session to 4-H members and farmers who were more than 19 years old. The program consisted of four weeks for tractor and another four weeks for power tiller, farm engine, and spraying equipment. In addition, the 4H Training Farms, later renamed as the Farmer's School, were established in provinces and provided farmers with four to six-week sessions of training. In 1972, approximately 100 local farmer's training centers were also established in cities and counties. These centers provided training programs mainly for end-users. Between 1992 and 1996, the centers were expanded, and their facilities were modernized to improve the quality of the program.

At present, three levels of training courses are offered. The highest level offered is through the Rural Administrative Agency for instructors and mechanics to teach the lower level courses. The intermediary level is offered by provincial government authorities for village leaders and operators working at Mechanized Farming Groups. The end-users are trained by Agricultural Technical Centers in cities or counties throughout the country. The training programs include operation, maintenance, and repair, but the training period and the content differ, depending upon the types of courses. It has become even more important to educate farmers on the operation of machines because this will help in reducing fuel consumption.

**IX Conclusions**

This paper reviews the progress of farm mechanization and associated policies in Korea over the last 45 years with an emphasis on rice production.

Farm mechanization in Korea has been carried out in parallel with the national economic development. It has fulfilled two major functions: providing newly developed industries with required labor forces and producing food for the rapidly-growing population despite decreased farm labor.

Korea has implemented various polices to promote farm mechanization. Mechanized farming has demonstrated its ability to change farmers’ belief with respect to traditional cultural practices in rice production. Powered farm machines have been distributed with financial aids. A proper combination of subsidies and loans is necessary to avoid excess machine supply. Farm machinery manufacturers have started to produce powered machines through technical collaborations with foreign manufacturers and have successfully carried out the localization of parts and components. To strengthen the agricultural machinery industry and to improve the quality of its products, national inspections have been inevitable. The creation of a viable agricultural machinery market has also been important for the agricultural machinery industry as well as for farm mechanization. After-sales service networks must be properly established to provide after-service organizations with spare parts without delay. Training end-users and farmers has been necessary to increase the efficient use of machines and to prevent machinery-related accidents. There are many factors beyond those already mentioned that mechanization policy makers should consider in contemplating meaningful farm mechanization policies; such efforts would improve the agricultural production and the rural economy of the country.

Although this paper represents only a basic framework of the mechanization policies carried out in Korea, it will be a helpful reference to policy makers who are planning or promoting farm mechanization in developing countries, particularly those presiding over rice growing regions in Asia. Because farm mechanization policies affect the farmers, machine manufacturers, and even agricultural productions of a country, they should be properly implemented with care and in the context of the local farming and rural economic circumstances. To achieve successful farm mechanization, the rural economy must remain economically viable, and there
must be a reduction in rural labor. Korea’s success has been due to its industrial development.

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