TDRI Quarterly Review
Published in *TDRI Quarterly Review*
Vol. 13 No. 2 June 1998, pp. 3-14
Editor: Bruce Anderson and Ryratana Suwanraks

Problems and Outlook of Agriculture in Thailand

Nipon Poapongsakorn[*]
Martin Ruhs[**]
Sumana Tangjitwisuth[***]

INTRODUCTION

Agriculture used to be the engine of Thailand's industrial growth. In the 1960s and 1970s, agriculture facilitated industrialization by supplying cheap food and labor, generating tax revenues and foreign exchange, and providing a market for industrial output (Medhi 1995). Since the 1980s, however, industrial growth has been self-sustained, driving Thai agriculture from "engine of growth" into a declining status. As of 1995, agriculture's share of GDP and total exports was 10 percent and 17 percent, respectively. The corresponding shares of industry were 29 percent and 82 percent, respectively.

The simultaneous decline of agriculture and rise of industry, and the associated shift of comparative advantage from the former to the latter, are well-established stylized facts of economic development. Kuznets (1966) further hypothesized that economic development is characterized by a first increasing and then decreasing level of inter-sectoral inequality, due to an initially widening but eventually narrowing gap between agricultural and industrial labor productivity. However, Thailand's industrialization has always been associated with continuously widening gaps of inter-sectoral productivity and wage levels.[1] While the ratio of industrial value added per laborer over agricultural value added per laborer rose from 5.24 in 1972 to 7.16 in 1996, the ratio of industrial over agricultural nominal wages increased from 6.34 in 1977 to 8.72 in 1990 (Ruhs 1996). As an internal consequence, inequality has increased steadily, with the value of the Gini coefficient climbing from 36.77 in 1975 to 46.96 in 1992 (World Bank 1997). Furthermore, poverty is increasingly concentrated in rural areas. Although trickle-down effects have reduced the country's poverty incidence (as measured using a poverty line) from 42 percent in 1975 to 16 percent in 1992, as of 1992, 94 percent of Thailand's poor lived in rural areas (World Bank 1997). On the other hand, as an external consequence of her low agricultural labor productivity, Thailand now faces considerable difficulties in maintaining the production and export of cheap food, especially rice, to the world market, thereby adding to global concerns about securing worldwide food supplies.

To reverse the described trends of rising inequality, concentration of poverty in rural areas, and decreasing supplies of cheap food to the world market, an increase in agricultural labor productivity and the maintenance of what is left of comparative production advantages are imperative. However, since the early 1990s, the realization of those goals has been increasingly jeopardized by four major factors: a scarcity of water, a shortage of labor, an inefficient utilization of pesticides, and increasing competition on the world market. While acknowledging the gravity of the latter factor, this paper discusses and proposes policy responses to the three internal problems only. While the second section provides evidence of the current problems of Thai agriculture, the third section analyzes the ineffectiveness of past policy responses and suggests new policy directions.

CURRENT PROBLEMS OF THAI AGRICULTURE

Thai agriculture used to be characterized by its strong comparative advantage, which is emphasized when one takes into account the past policy bias against agriculture (Ammar 1996). Until the mid-1980s, the major source of agricultural growth was the expansion of cultivated land at the expense of forest area. After that, productivity growth can be accounted for by yield improvement, capital investment, and a shift from low value to high value crops (TDRI 1995). However, increasing shortages of water and labor, and an inefficient use of pesticides have recently impeded further enhancement of productivity.

Shortage of Water

Water is needed for all types of agricultural production. However, the specific quantities required differ among agricultural subsectors. Apart from the natural water requirement of "fisheries," the crop sector is the most water intensive. As of 1995, Thailand's crop sector still constituted 59 percent of total value added in agriculture. Internally, the production of rice, the most water intensive crop, had a 29 percent share of total crop output, utilizing about 50 percent of total farm land. In addition, some of the fast-growing "new" crops, such as vegetables and flowers, are also relatively water intensive. Hence, despite its gradual diversification and structural change, overall production in Thai agriculture still fails and succeeds with the availability of water.

Until not too long ago, surface water in Thai agriculture was available in abundance, such that farmers could basically increase their water use at will. Water was a free good, available for costless acquisition. However, as with all natural resources, abundance did not last. In recent decades, both an increase in demand and a reduction of supply have gradually driven once abundantly available water resources into scarcity. The water scarcity has become especially prevalent in the Central region, where most of the country's water intensive crops are grown.

The reasons for the reduction of water supply are manifold. First, there has been a long-term decline in annual rainfall. In the Central region, the annual mean rainfall in the 1980s was 55 mm less than the 40-year (1960 to 1990) annual mean of 1,273 mm (Christensen and Areeya 1994). Second, the sideflow into the Chao Phraya basin's tributaries and irrigation canals has been reduced by deforestation, caused by changes in patterns of highland use, and upland cropping on the fringes of the basin. Third, rapid development in the North has tripled its water use of capita within a decade, resulting in a drastic reduction of water available in the Central Plain. The annual flow of water into the Central region's two major dams, the Bhumipol and Sirikit dams, declined from 15,600 million cubic meters in 1953 to 7,400 million cubic meters in 1997 (Mingsarn 1997). Fourth, with the country's industrial development, the sectoral allocation of water has changed in favor of urban and industrial areas. The explosive growth of the Bangkok Metropolitan region near the lower part of the Chao Phraya River required a significant increase in water supply for household consumption, thereby reducing water supply for agriculture. Similarly, rapid industrial development, as exemplified by the creation of the "Eastern Seaboard Industrial Area," has further drawn water resources away from agriculture. Meanwhile, accumulated irrigated area has grown from 10,223,140 rai in 1960, to 18,685,480 rai in 1994 (Office of Agricultural Economics), thereby raising overall demand for water in agriculture considerably. Finally, the water distribution is so inefficient and poorly maintained that an increasing portion of water is lost.

Despite the arisen scarcity of water, surface water continues to be treated as a "free good." Farmers still enjoy free access to scarce natural and irrigated surface water, which has led to its highly inefficient utilization. Direk and Somporn (1990) found that each cubic meter of water in agriculture has a marginal product of 0.57 baht, while the price of urban water supply is about 6.1 baht per cubic meter.

The adverse impact of a persistent water shortage is obvious. As one of the major inputs of agricultural production, the lack of a steady supply of irrigated water results in lower yields and smaller crops. Profit maximizing farmers will subsequently tend to diversify production by partially or totally switching to the cultivation of less water intensive crops. As production and exports of water-intensive crops decline, the income of farmers will be reduced, putting further strain on the already severe problem of social inequality between rural and urban areas. It should be clear that, because of the relatively higher water use in agriculture than in industry, water shortages always hurt rural farmers more than urban workers and industrialists. Clearly, solving Thailand's current water problem very much relates to its attempt to reverse the increasing trend of inequality.

Labor Shortage[2]

Thailand's rapid economic expansion since the 1980s increased aggregate demand for labor in the Thai economy considerably. However, overall labor supply could not keep pace, largely because of continuously declining population growth rates. While the five-year average annual population growth rate was 2.02 percent during 1980-1985, it was 1.6 percent during 1985-1990, and dropped to 1.1 percent during 1990-1995. In addition to declining population growth rates, the share of the labor force in total population decreased from 56.21 percent in 1989 to 55.51 percent in 1995.[3] Consequently, there has been increasing competition for labor among sectors. Especially, the labor market in agriculture has come under pressure.

While its relative share in total employment has always been decreasing, since 1989 agricultural employment has also decreased in absolute terms. The number of employed persons in agriculture dropped from 20.5 million in 1989 to 16.9 million in 1995. As shown in Table 1, the decline in agricultural employment was especially dramatic for the 15-24 years old, whose absolute number decreased from 6.66 million in 1989 to 3.73 million in 1995. In other words, between 1989 and 1995, the agricultural employment of 15-24 years old decreased by 44 percent.

The reasons for the absolute decline in agricultural employment in general, and of 15-24 years old in particular, are three-fold. First, many agricultural workers took up employment in non-agricultural sectors where production growth rates were much higher than in agriculture. During 1989-1995, the average annual real growth rate of agricultural production was 2.1 percent, while that of non-agriculture was 9.5 percent. Accordingly, real wages in industry rose from 108.18 baht/day in 1977 to 206.42 baht/day in 1995, while real wages in agriculture stagnated at 63.99 baht/day until 1993 (see Figure 1). Only recently have real wages in agriculture started to increase. As indicated by Table 1, in the period of 1989-1995, 0.71 million 15-24 years old migrated to industry, while 0.14 million migrated to the service sector. Inter-sectoral migration thus accounted for 29 percent of the reduction 15-24 years old employed in agriculture. In contrast, in the case of 25-34 years old intersectoral migration may be assumed to have accounted for almost 100 percent of their decline in agricultural employment.

The second reason for the decline of the number of 15-24 years old in agriculture has been school. Between, 1989 and 1995, the school enrollment of 15-24 years old increased by 1.51 million, accounting for 51 percent of the reduction of their agricultural employment. Finally, declining population growth rates have reduced the number of 15-24 years old in Thailand by 4 percent since 1989.

In summation, Thailand's labor force, especially the 15-24 years old, is turning away from agriculture at an alarming speed. Unless there is a corresponding increase in productivity or supply of foreign workers, agricultural output is expected to fall with labor, as the elasticity of output with respect to labor is relatively high (close to one). Box 1 illustrates the severity of labor shortage and water scarcity on rice production.

Inefficient Use of Pesticides

Thai farmers' current use of pesticides is highly inefficient. The inefficiency has two aspects. First, the utilization of pesticides inflicts a number of adverse externalities on consumers and the environment, whose costs are not borne by farmers and thus not included in the market price. As recently assessed by Jungbluth (1996), the annual social costs associated with the use of pesticides in 1990 may have been be as high as 5.5 billion baht, in which case the ratio of pesticide sales to externalities would have been almost one to one, implying that for every baht spent on pesticides society incurs costs of about one baht (Pincus et al. 1997). Internalizing those "external" costs into farmers' private costs of using pesticides would lead to a reduction of current utilization to a socially optimal level, thereby reducing pollution and increasing net welfare. Second, the current intensities and practices of pesticide application harm farmers' health and are technologically inefficient, i.e., they do not maximize farmers' expected profits. Improving technological efficiency of pesticide application would increase farmers' profits and competitiveness.[4]

The application of pesticides adversely affects consumers through chemical residues in food. Studies conducted between 1982-1984 by the Food and Drug Administration and the Department of Medical Sciences detected chemical residues in 52 percent of 663 samples, including DDT in 39 percent, and dieldrin in 15 percent of the analyzed samples (Jungbluth 1997). A 1993 survey by the National Environment Board showed little improvement, finding the residues in soil, water, fruits, vegetables and field crops to be 100 percent, 86 percent, 32 percent, 25 percent, and 17 percent, respectively (Thai-German Plant Protection Program 1993). A study published in 1995 by the Division of Toxic Substances found that 37 percent of vegetables were contaminated with insecticide residues. Finally, a recent analysis of residues of monocrothopos in long beans found an average residue of 1.97 ppm. The study further showed that the amount of the chemical residue is positively correlated to pesticide concentration, and negatively correlated to the number of interval days between different spraying rounds (Kwanchai 1997). As Thai farmers generally spray highly concentrated pesticides with little intervals between spraying rounds, chemical residues in food are generally high.

Pesticide-related environmental degradation includes the contamination of groundwater, a reduction of biodiversity, and the destruction of beneficial insects which help control pests. The concentration levels of DDT and dieldrin residues in five Thai rivers (Upper Ping, Lower Ping, Wang, Yom, Nan, Chee) have been shown to well exceed acceptable standard levels of water contamination (Kwanchai 1997). In the late 1980s, the sharp increase of farmers' pesticide use in response to the outbreak of brown plant hopper (BPH) had devastating effects on farmers' production environment, greatly reducing the biodiversity and the number of beneficial insects. In fact, Somluckrat (1992) provided evidence for a clear correlation between the increased use of methyl-parathion, a pesticide used to protect rice crops from infestation with the BPH, and the area infested with BPH in Thailand. Referring to the pests' increasing resistance to pesticides and the resulting futility of a chemical-based protection strategy, Jungbluth (1997) notes that "studies ironically indicate that BPH infestation does not precede pesticide use, but follows it."

Evidence for the harmful effects of using pesticides on farmers' health abounds. Studies of cholinesterase done in

1995 by the Occupational Health Department, Ministry of Public Health, found that 18 percent of farmers tested (85,140 farmers out of 463,142) had unsafe levels of poisons in their blood, an increase from the 16 percent found from similar blood testing of farmers done in 1994. Within the first seven months of 1996, 1,760 people were hospitalized and 16 died due to poisoning. However, as only 2.4 percent of workers with poisoning incidents consult a hospital (Malinee 1985), the figure provided by the Ministry of Public Health is certainly a grave underestimation of the actual extent of pesticide poisoning in Thai agriculture.

One major reason for farmers' chemical poisoning is their misuse of pesticides, which takes on many forms. First, various studies have repeatedly shown that, in order to save labor costs associated with spraying, farmers often mix pesticides, creating a "cocktail" of several chemicals, without considering their combination possibilities (TDRI 1989, 1996). Second, farmers frequently increase the concentration of pesticides, in the belief that increased intensities lead to greater protection (TDRI 1989, Somluckrat 1992). Third, farmers tend to have a strong preference for pesticides which wipe out pests rapidly, thus using the most hazardous chemicals.

Finally, while evidence is yet to be provided, there are good reasons to believe that Thai farmers use pesticides in a technologically inefficient manner. Technological inefficiencies in pesticide use have been reported in many countries. In Sweden, pesticide consumption dropped 47 percent between 1986 and 1990, while yields of the principal treated crops (cereals) increased. Similarly, Denmark appears to be meeting its 50 percent pesticide use reduction goal for 1997, without adversely affecting yields (Matteson 1996). A drastic reduction in pesticide use in Indonesia since 1989 has not affected rice production which has grown continuously (Pincus et al. 1997). Coupled with little knowledge about the actual effectiveness of chemicals, the described misuse of pesticides strongly suggests an overuse, i.e., technologically inefficient utilization of pesticides in Thai agriculture.

The reported inefficiencies in pesticide use may be assumed to have existed since the very beginning of chemical pesticide-based crop protection in Thailand. However, a surge in pesticide use over the past 20 years has greatly aggravated the problem. The estimated consumption of pesticides in 1996 was 90,000 tons, which is about 10 times that of 1974 (Ruhs et al. 1997). The crops with the greatest usage shares in the total consumption of active ingredients (a.i.) were rice (25%), fruits (24%), sugarcane (16%), rubber (14%), and vegetables (4%). On the other hand, the crop treated most intensively with pesticides was vegetables (6.4 kg a.i./ha), while the least pesticide-intensive crop was rice (1.1 kg a.i./ha).

The rapid increase of pesticide use may be accounted for in several ways. First, Thailand's most pesticide-intensive crops, vegetables and fruits, are also its highest value added crops. As farmers have gradually switched from low value added to high value added crop production, the overall consumption of pesticides has naturally increased. Second, in order to raise yield, farmers have intensified pesticide use in the production of all crops, as reflected by increasing shares of pesticide costs in total production costs. Third, with 96 registered producers in 1996, Thailand's pesticide market is highly competitive. A survey of the retail prices of 18 pesticides showed that, between 1986 and 1996, the average nominal retail price of pesticides remained virtually constant, implying that the average real price of pesticides actually fell by 45 percent. The real price of the highly hazardous methyl-parathion fell by 23 percent (Ruhs et al. 1997). Fourth, the great gap between registered trade-names and generic names (3,058 trade-names and 247 generic names as of 1996), some pesticide producers' deceptive advertising, and widespread product adulteration (Kwanchai 1997) have considerably increased farmers' uncertainty regarding the effectiveness of pesticides, which is widely agreed to be a major factor inducing pesticide use. Finally, a number of public policies have encouraged pesticide use.

First, as a result of the government's reduction of the import duty on formulated pesticides from 5 percent to nil in 1992, the total effective tax on pesticides is 7 percent, while that on agricultural machinery and active ingredients for fertilizers is 8.05 percent and 17.7 percent, respectively. Clearly, the existing tax differentials among agricultural inputs encourage pesticide use.

Second, the Department of Agricultural Extension (DOAE) provides farmers with free pesticides in case of a pest outbreak. The required funds for the government's purchase of pesticides are drawn from a permanent outbreak budget, which amounted to a cumulative 100 billion baht over the past 10 years. To obtain free pesticides, farmers need to make a request with the local extension officer, stating that there has been a pest outbreak. In most cases, extension officers do not inspect the farmers' fields to confirm the actual occurrence of a pest outbreak. Consequently, when asked about the frequency of pest outbreaks on their fields, farmers have tended to overstate the actual level and frequency of pest infestation. In fact, a few farmers have claimed that there is a pest outbreak every day! As may be expected, this relatively uncomplicated procedure of requesting and obtaining free pesticides has led to severe overutilization. However, it should be noted that farmers are not to be held responsible for the overuse. Clearly, where

the marginal cost of obtaining pesticides is almost nil, basic economic theory justifies an increase of pesticide application until the benefit derived from further increases in the quantity of used pesticides is close to zero.

Furthermore, in case the extension officer actually inspects the farmers' fields, he has a clear incentive to overestimate the crop loss because his performance is usually measured by the amount of budget obtained and spent. The reported overestimated crop loss will induce the central officer to further raise the supply of pesticides.

Finally, as one of its main responsibilities, the DOAE provides farmers with information about feasible protection methods. However, since the inception of its involvement in pest protection, the DOAE has advocated the intensive use of pesticides, with methods of integrated pest management (IPM) receiving little attention. As formally documented in the annual report of its activities in 1995, the DOAE promoted IPM in an area of 747,750 rai, the use of biological control methods in an area of 161,886 rai, and the use of chemical pesticides in an area of 9,255,762 rai (Vitoon 1997). Clearly, the bias in the government's provision of information about pest control methods has been a major factor inducing increased use of chemical pesticides.

THE POLICIES

Agricultural Policies

Since the early 1980s, the simultaneous occurrence of the end of the land frontier, the fall in agricultural prices, and the industrial boom have confronted Thai farmers with a cost-price squeeze. Concerned about the maintenance of agricultural competitiveness, the government has subsequently launched a number of agricultural policies whose scopes go far beyond those of "traditional government intervention" as justified by economic theory. The most recent policy, falling in this category of extensive and, as we argue, unjustified intervention in agriculture, is the late-1993 formulated and approved three-year plan on "Restructuring Agricultural Production Systems" (RAPS), which aims to reduce and replace the production of rice, cassava, coffee, and pepper, with the production of higher value products, such as vegetables, flowers, fruit trees, bamboo (for human consumption), fast-growing trees, cattle, and milk cows (TDRI 1995). Having picked winners and losers among agricultural commodities, the government attempts to implement its restructuring plan by encouraging cattle production and the replacement of selected crops through the extension of subsidized credits and inputs.

A recent assessment of the costs and benefits of the "restructuring policy" concluded that, if price changes, increasing water scarcity, adverse externalities associated with crop production, and non-efficiency objectives, such as poverty alleviation and employment creation for the rural poor, are taken into account, "government intervention in production restructuring may not be as undesirable as it is generally argued" (Yao 1997). However, we argue that restructuring policies are bound to be ineffective for at least four reasons. First, the government's attempt to successfully pick winners and losers crucially depends on its knowledge and ability to forecast markets and prices better than farmers. However, the government's record in forecasting prices has been poor. In fact, all four commodities which the government had targeted for an acreage reduction in 1993 saw an upswing in prices in 1994. Second, the promotion of the production of "new" high value added products requires the government to provide farmers with adequate technology. However, the technology available to the government has shown to be insufficient, with the private sector's role in the provision of technology being much smaller than originally hoped for (TDRI 1995). Third, the program of planted area reduction of four main crops was incapable of shoring up their prices. Most farmers who participated in the program were those who had already made plans to restructure their production. They only joined the program in order to appropriate the economic rent. Finally, with the exception of rice, the domestic prices of all major crops are determined by prices on the world market which Thailand is too small to influence in any significant way.

The lessons to be learned from Thailand's experience with restructuring policies are well-known principles of public economics. The government should refrain from intervention, unless it is justified by well-identified incidents of market failure and/or a lack of adequate infrastructure. Problems of agriculture may all be attributed to varying degrees of market failure. In the following sections, proposed policy responses are examples of required and justified policy intervention.

Water Policies

There is no lack of water policies in Thailand. In fact, the country has about 30 water-related laws, administered by at least 30 departments overseeing water issues in six ministries (Mingsarn 1997). Despite their great number and dispersion, Thailand's past water policies have all been characterized by a common, distinguishing feature: they are all

concerned with the provision of water, rather than its allocation. In other words, the solution to the arisen water constraints was simply sought in the development of untapped resources, the enlargement and improvement of irrigation systems, and the promotion of increased pumping of groundwater (Christensen and Areeya 1994). The latest policy addition, the announcement of Water Resources Policy under the long-term Natural Resources and Environment Policy and Plan (1997-2016) in late 1996, was no exception and shows that Thailand's water policy makers continue to be supply siders.

Any attempt to increase supply in response to water scarcity is both a very short-sighted and seriously flawed approach to the problem. In addition to quickly disappearing untapped resources, most of the more suitable sites for dams and reservoirs have already been used up. Furthermore, future expansion of these facilities faces a steeply rising supply curve caused by higher financial, environmental, social, and political costs. As the dry season problem worsens, officials have responded with the apparently only means currently at their disposal: limit the flow of water into the Central Plain's irrigation canals, and encourage dry season paddy farmers to switch to less water intensive crops (Christensen and Areeya 1994). However, although the water scarcity provides a strong justification for diversification, the existing irrigation structure is not suitable for upland crop and tree crop production (Nipon 1994). Hence, the government's attempts to both increase the supply of water and to restructure agriculture to less water intensive cultivation are ineffective and should be de-emphasized in the new water management policy.

A more efficient management of Thailand's scarce water resources requires demand rather than supply policies. In principle, there are two policy options, namely, water pricing and the establishment of property rights. However, as charging farmers for water use is a politically sensitive issue, the latter approach is to be preferred.

Basic welfare economics teaches that competitive markets allocate scarce goods efficiently. As traditionally abundant water has recently become a scarce resource, its efficient allocation requires the development of a market. The absence of such a water market in Thai agriculture clearly qualifies as a case of market failure, requiring and justifying government intervention. The basic policy recommendation is based on the simple principle "no market without endowments." Hence, an effective water policy needs to assign tradable water rights to water users in agriculture, aimed at facilitating the development of a water market. One transaction cost minimizing and, from an administrative point of view, conceivable procedure of establishing and allocating water rights is a distribution according to the historical record of water utilization of each water user. In other words, farmers living on riverbanks and shores are given riparian rights, i.e., property rights to the water running through their fields. Riparian farmers may then, if they wish, sell water to other farmers by trading water rights. In line with economic theory,[5] the assignment and trading of water rights will ensure efficiency in water allocation.

However, the initial development of a water market will require three further steps. First, at the beginning of the dry season, information needs to be provided about the size of the available water stock. Second, institutions in which farmers can organize themselves and negotiate with potential users need to be created. Importantly, locations for water markets should be identified, such that farmers can actually meet and trade water rights. Transaction costs need to be minimized. Finally, the irrigation system needs to be improved such that water transfers are facilitated. After the successful establishment of a market, the government should reduce its interference to a minimum.

The assignment of property rights to water is imperative to the sustainability of agricultural production. Although the depletion of water resources is not yet an imminent danger, its highly inefficient use which has resulted in the current water shortage should be clear warning signals of the severity of the problem and the fatal consequences of policy apathy.

Labor Policies

As is well-known from basic economic theory, decreasing population growth rates and a reallocation of labor from low into high productivity sectors both favor the growth of the overall per capita income and are thus signs of advanced economic development. As such, the recently arisen absolute decrease of Thailand's agricultural labor force had to be expected and should, for the above-mentioned reasons, be beneficial to the country's overall development. On the other hand, unless countered by appropriate policies, the arisen labor shortage in agriculture clearly threatens the sustainability of current levels of agricultural output. Hence, in order not to impede the country's overall development but, at the same time, help sustain agricultural output, public labor policies should not directly aim at preventing laborers to migrate from agriculture into industry, but on either importing more foreign workers and utilize them for agricultural production or raising the productivity of the remaining labor force in agriculture.

The government may allow more foreign workers to take up employment in agriculture, in order to make up for the

current shortage of domestic labor. However, while helping to maintain production levels, such a strategy is only a second-best solution. As it is, there are already a great number of legal and illegal migrants working in agriculture. Their wages are generally much lower than those of Thai workers. Hence, if agricultural employment were further promoted among foreign migrants, there would be additional downward pressure on Thai farmers' income which would put further strain on inequality. Hence, while foreign laborers certainly helped Thai agriculture to sustain high output growth in the past, solving Thailand's problems of agricultural labor shortage and inequality simultaneously requires policies aiming at improvements in productivity rather than increasing labor supply through importation of more foreign labor.

In the past, the government relied on the private sector to provide farmers with new technology through contract farming. However, as reviewed by TDRI (1996), the experiences with contract farming have often been disappointing. In other words, the private market has failed to provide farmers adequate technology, needed to mechanize farm production and raise productivity. Hence, there is clear scope for government intervention. The suggested policy is twofold. First, the government should create incentives, such as subsidies or tax exemptions, for private machine producers to step up research and promote a more rapid mechanization. Second, the public sector itself should engage in more research and development of agricultural technology. Initial priority should be given to the mechanization of transplanting in rice production. Importantly, farmers need to be trained to use the new technology. One way of doing so would be to take a group of diligent farmers to neighboring countries, such as Korea, where mechanization of transplanting has already been successfully implemented. The farmers could observe the advanced production method and introduce it to their own and their neighbors' fields in Thailand. Furthermore, public research is needed in the design of new varieties which should be compatible with and able to withstand machine operations (Ammar 1996).

Pesticide Policies

In order to reduce pollution and enhance the competitiveness of Thai agriculture, the current inefficiencies in the use of pesticides must be eliminated. There are essentially two policy approaches: "command-and-control policies," referring to pesticide laws and regulations concerning the availability and utilization of pesticides, and "market-based" policies, referring to taxes and other financial incentives aimed at inducing farmers to utilize pesticides in an efficient manner. As enacted by the Hazardous Substance Act (1992), which revised the Toxic Substance Act (1967) and its Amendment (1973), Thailand's past pesticide policies have all been of the command-and-control type. Although the existing regulations may be described as quite advanced, including most aspects[6] of American and European laws (even product liability!), they have yet been ineffective in reducing pesticide use in Thailand. The well-known problem, of course, lies with law enforcement which has been notoriously low. The lack of quality control of pesticides as reflected by widespread product adulteration and the commonly observed sale of already banned pesticides are cases in point. The latter practice is also documented by the fact that, once an import ban has been announced, imports of that pesticide typically surge right before the imposition of the ban (Ruhs et al. 1997). This clearly indicates that companies generally know about the imposition of import bans in advance and, consequently, greatly increase imports, accumulating stocks of the hazardous pesticides for later sale (after the chemical has been banned from import).[7] As a result of the lack of law enforcement, Thailand has become an international dumping ground for highly hazardous pesticides. In a nutshell, given the well-known problems with law enforcement, effective pesticide policies should be "market based" rather than of the command-and-control type.

The existence of pollution externalities is a well-known cause of market failure, calling for the imposition of (Pigouvian) excise taxes on pesticides. The purpose of such a tax is two-fold. First, it aims to internalize the social costs associated with the use of pesticides into the polluter's privately perceived costs, thereby reducing pesticide use to a socially optimal/efficient level. Second, government revenues are raised. Clearly, increased revenues enable the government to implement a number of facilitory policies which induce farmers to take up less pesticide intensive production methods.

While a correct Pigouvian pesticide tax should be levied on the consumption of pesticides, for practical reasons, the tax is likely to be collected at the producer, rather than retailer level. Assuming that the increase of producer prices, as caused by the imposition of an excise tax, is fully passed down to the retail price of pesticides, the extent of farmers' reduction of pesticide consumption in response to the imposition of an excise tax depends on the price elasticity of demand for pesticides. Considering the relatively low share of pesticide costs in farmers' total production costs, the absence of readily available substitutes, and the relative inelasticity of many crops whose production requires pesticides, it is certainly safe to say that the price elasticity of overall pesticide demand in Thailand is quite low. In his study of Thai orange production, Nat (1997) derived a 0.21 percent price elasticity of pesticide demand. This conclusion is consistent with most research estimates of prices elasticity of pesticide demand in other countries, which usually range between 0.1 and 0.5 percent (Pease et al. 1996).

In 1996, the total consumption of pesticides was estimated at 90,000 tons, with a nominal sales value of about 8 billion baht. Table 2 contains the reductions of pesticide use and the creation of revenues in response to the imposition of a uniform[8] excise tax (ad valorem).

In order to eliminate inefficient pesticide use, the prime goal of an excise tax should be the reduction of overall pesticide use, rather than the maximization of government revenue. However, as seen from Table 2, assuming an elasticity of 0.2 or 0.3 and the imposition of a relatively low (politically feasible) excise tax, significant amounts of government revenue may be raised, while overall pesticide use is reduced at low rates only. Clearly, substantial reductions in pesticide use may only be brought about by imposing high taxes or increasing price elasticity of demand. As the former approach is argued to be politically infeasible in the short run, efforts should be made to enhance elasticity. This may be achieved by using the revenue created by the tax to enhance public research and information about IPM (thereby offering farmers a substitute for pesticides which makes pesticide demand more elastic) and implement a number of facilitory policies which offer farmers financial incentives to switch from a chemical-based protection strategy to IPM.

In principle, the development of and dissemination of information about IPM may be carried out by the government, private sector or both. However, the experiences of the US, European countries and Thailand show that the private sector generally lacks incentives to undertake research into IPM. Naturally, pesticide companies have little interest in promoting less pesticide intensive protection methods. Therefore, there is clear scope for the government to counter the market's promotion of pesticide-intensive methods with public investment in IPM-related R & D and dissemination of information among farmers. Importantly, the DOAE should concentrate its research efforts exclusively on the development and dissemination of information about IPM, and stop advocating pesticides. In particular, farmers need to be more adequately informed about the actual effectiveness of specific pesticides. This may be achieved through on-farm demonstration plots or the development of an information market, on which private pest consultants sell their services and information about pesticide use and IPM to farmers.

Feasible policies creating financial incentives include cost share programs, tax credits, low interest loans, and the provision of insurance to farmers practicing IPM (Stabinsky et al. 1994). The justification of all four is the need of financial assistance to farmers who voluntarily switch from pesticide intensive crop protection to IPM, whose initial setup and regular practice are associated with high management costs. Issues related to their implementation in Thailand are discussed in Ruhs et al.(1997).

In order to enhance the effectiveness of the implementation of an excise tax and the discussed facilitory policies, it is imperative that the previously discussed policies which work at cross purposes, i.e., which actually encourage rather than reduce pesticide use, are eliminated. First, the total effective tax rates of agricultural inputs must be equalized through either the abolishment of all import tariffs on agricultural inputs or raising the import tariff on pesticides. Second, the DOAE must stop distributing free pesticides to farmers. The outbreak budget should be eliminated or greatly reduced, with the remaining funds being allocated to research in IPM.

Finally, in order to facilitate and promote the implementation of the proposed policies, the current institutional framework for the operation and regulation of pesticide policies needs to be restructured. First of all, there must be clear division of labor among government offices. Currently, the DOAE is acting both as the regulator as well as the operator, resulting in a conflict of interest. The Office of Agricultural Economics should be given the task of formulating new pesticide policies, with the aim to reduce pesticide use, maintain agricultural yield, and reduce environmental and health risks. The regulatory agency, currently resided in the DOAE, should be an independent agency which consists of officials representatives from the Food and Drug Office, the Department of Agriculture (DOA), the DOAE and Consumer Protection Office. The regulatory agency, under the Office of Permanent Secretary of the Ministry of Agriculture and Cooperatives (MOAE), will be also responsible for monitoring activities and making recommendations on budget allocation. Second, the budget allocation should be based upon the joint projects of the executing agencies, the DOAE and the DOA, whose work should be closely linked and coordinated. Finally, in developing and implementing their new approach to a less pesticide intensive pest outbreak control, the DOAE and the DOA should be encouraged to work closely with farmers, if the research results and extension work are to be successfully disseminated and adopted. Such an approach will be feasible only if new criteria of budget allocation are established.

CONCLUSION AND OUTLOOK

The discussed problems of the scarcity of water, shortage of labor, and inefficient utilization of pesticides pose serious threats to the maintenance of comparative advantage and productivity of Thai agriculture. Even the production and

export of Thailand's most traditional crop, rice, has already been adversely affected. To be sure, as the country's industrialization continues, Thai agriculture will eventually be subject to increasing comparative disadvantage. However, in order to reverse the current trends of increasing inter-sectoral inequality, concentration of poverty in rural areas, and a reduction of Thailand's supply of cheap food to international markets, it is imperative that the productivity of the remaining labor force in agriculture be raised. To this end, government is justified, as all discussed problems may be attributed to varying degrees of market failure. In response to the increasing scarcity of water, property rights to still freely available surface water need to be assigned, thus facilitating the development of a water market. In order to counter the current flow of labor from agriculture into non-agricultural sectors and school, agricultural production, especially rice production, must be mechanized. Third, the elimination of the current inefficient utilization of pesticides requires the imposition of an excise tax on pesticides, the creation of financial incentives for farmers taking up IPM, the promotion of the development and dissemination of information about IPM, and the elimination of all existing policies, which work at cross purposes, i.e., which encourage, rather than reduce pesticide use. Finally, the government should redefine its general agricultural policy approach such that intervention takes place where it is required and justified by the absence of adequate infrastructure or the presence of market failure only.

REFERENCES

Abler, D., and J. Shortle. 1995. "Technology as an Agricultural Pollution Control Policy." *American Journal of Agricultural Economics* 77 (1): 20-32.

Ammar Siamwalla. 1996. "Thai Agriculture: From Engine of Growth to Sunset Status." *TDRI Quarterly Review* 11 (4): 3-10.

Christensen, S., and Areeya Boon-Long. 1994. *Institutional Problems in Thai Water Management.* Bangkok: Thailand Development Research Institute.

Direk Patmasiriwat, and Somporn Isvilanonda. 1990. "Measurement of Production Efficiency of Thai Farmers: A Case of Six Villages." *Thammasat Economic Journal* 8 (3).

Jungbluth, Frauke. 1996. *Crop Protection Policy in Thailand*. Pesticide Policy Project Hannover, Publication Series No.5.

_____. 1997. "Pesticide Facts in Thailand." *Pesticide News* 35.

Kuznets, S. 1966. *Modern Economic Growth: Rate, Structure, and Spread*. New Haven: Yale University Press.

Kwanchai Sombatsiri. 1997. Policy and Strategic Measures to Regulate the Import and Utilization of Toxic Substance Insecticide in Agriculture. Presentation at the Conference on Approaches to Pesticide Policy Reform Building Consensus for Future Action, Hua Hin, July 3-5.

Malinee Wongphanich et al. 1985. *Pesticide Poisoning among Agricultural Workers: A Research Report*. Bangkok: Mahidol University.

Matteson, Patricia. 1996. "Cutting Pesticide Use, Keeping Agriculture Strong—Lessons from Northern Europe." *Global Pesticide Campaigner* 6 (1).

Medhi Krongkaew, ed. 1995. *Thailand's Industrialization and its Consequences.* London: St. Martin's.

Mingsarn Kaosa-ard. 1997. *Formulation of the Chao Phraya Basin Water Resources Management Strategy.* Bangkok: Thailand Development Research Institute.

Nat Rattanadilok. 1997. "Demand for Pesticides in Orange Production." Master's thesis, Faculty of Economics, Thammasat University.

Nipon Poapongsakorn. 1994. Implications of Modernization on the Agricultural Resource Base in Thailand. Paper prepared for a workshop on Social Science Methods in Agricultural Systems Research, organized by IRRI in cooperation with Chiang Mai University, Chiang Mai, Thailand.

_____. 1996. Will Thailand Have to Import Rice in the Coming Decades? Paper prepared for the Asia

International Rice Conference 1996, Singapore.

Office of Agricultural Economics. Various crop years. *Agricultural Statistics of Thailand.* Bangkok.

Pease, William et al. 1996. "Taxing Pesticides to Fund Environmental Protection and Integrated Pest Management." *California Policy Seminar* 8 (1).

Pincus, J. et al. 1997. Pesticide Policy: An International Perspective. Paper prepared for the Conference on Pesticide Use and Policy in Thailand, Hua Hin, July 4 – 6.

Ruhs, Martin. 1996. "Economic Dualism: Theory and an Application to Thailand." Master's thesis, Karl Franzens University Graz (Austria) and Thammasat University (Thailand).

Ruhs. Martin et al. 1997. Pesticide Use in Thailand: Problems and Policies. Paper prepared for the Conference on Pesticide Use and Policy in Thailand, Hua Hin, July 4 - 6

Somluckrat Grandstaff. 1992. *Pesticide Policy in Thailand*. Bangkok: Thailand Development Research Institute.

Stabinsky, Doreen et al. 1994. *Financial Incentives and their Potential to Reduce Pesticide Use in Three Crops: Cotton, Oranges, and Strawberries*. Pesticide Use Reduction Series. Pesticide Action Network North America (PANNA).

Thai-German Plant Protection Program. 1993. *Project Presentation*. Bangkok: Department of Agricultural Extension.

Thailand Development Research Institute (TDRI). 1989. *Agricultural Information and Technological Change in Northern Thailand*. TDRI Research Monograph No. 1. Bangkok: TDRI.

_____. 1992. *Food Situation Outlook in Asia: Case Study of Thailand*. Bangkok: TDRI.

_____. 1995. Agricultural Diversification/Restructuring of Agricultural Production Systems in Thailand. Paper prepared for the Food and Agriculture Organization of the United Nations.

_____. 1996. The Potential of the Development of Contract Farming: The Case of Cotton Production in Thailand. Unpublished research report.

Vitoon Lienjamroon. 1997. Agricultural Extension and Pesticide Policy. Paper prepared for the Conference on Pesticide Use and Policy in Thailand, Hua Hin, July 4 – 6.

World Bank. 1997. *Everyone's Miracle.* Washington, D.C.

Yao, Shujie. 1997. "Comparative Advantages and Crop Diversification: A Policy Analysis Matrix for Thai Agriculture." *Journal of Agricultural Economics* 48 (2).
