

Sustained Agricultural Growth and Economic Structural Change: Some Reflections on Farmland Consolidation Programmes in Taiwan and Mainland China¹

Minquan Liu

Hopkins-Nanjing Center
Nanjing 210093, China
Email: mliu@nhc.nju.edu.cn

May 2001

Abstract:

This paper reviews farmland consolidation programmes in Taiwan and Mainland China, and studies their role in promoting agricultural growth while the economy underwent (undergoes) rapid structural changes, and in facilitating these changes by raising agricultural incomes and easing the rural-urban migration pressure on cities. A model is developed of a farmer allocating time between three activities, farming, non-farming and urban employment, under the conditions of small family farms. An important feature of the model is that while a farmer can simultaneously engage in rural farming and non-farming activities, he has either to choose urban employment or rural farming and non-farming activities. Although non-farming activities compete with farming for resources, under the conditions of small family farms, farming also critically depends on non-farming activities for survival. Possible conflicts between the “patterns of hours” and “patterns of labour inputs” for farming and non-farming activities may, however, exist and prevent a farmer from effectively utilizing both activities. It is argued that, as well as directly contributing to the labour productivity of farming, FC can play an important role in reconciling these conflicts in patterns of hours and labour inputs, enabling a farmer to better utilize both activities, and thereby helping ease pressures of rural urban migration on cities.

¹ The paper substantially draws on an early work of mine (Liu, 1994) and a collaborative project by myself and Liu Tru-Gin and Wu Ziping (Liu et al. 1998). The latter was funded by the Department for International Development, UK, to which I express my thanks. Thanks also go to Yi Gang and Xu Xiaonian for including me in their investigation team which visited Taiwan in 1993. That visit first acquainted me with Taiwan’s FC programmes.

1. Introduction

While the title of this paper does not lead one immediately to see a connection between the questions to be discussed in the paper and *urbanization*, it is hoped that at the end of reading it, the reader will see an important and crucial connection for the particular economies we look at. Below, I first give a brief background of the kind of farmland consolidation (FC) programmes that have taken place in Taiwan and Mainland China. The question of the role of FC in promoting sustained agricultural growth and, equally importantly, in facilitating economic structural changes by relieving rural-urban migration pressures on cities is then examined in Section 3, where I consider non-farming activities in the agricultural sector and their role in *supporting* the farming sector while competing with it for resources (by definition the agricultural sector shall include both farming and non-farming activities). A model of a farmer's time allocation between three alternative income opportunities (farming, non-farming, and urban employment) is developed. Underlying the model and our discussion is the assumption of the small family tenurial system, which has survived and the rapid economic structural changes in Taiwan and which has arisen and is unlikely to change in the foreseeable future in Mainland China. The desirability and importance of maintaining sustained agricultural growth (a sustained growth of the absolute size of the agricultural sector) in the midst of structural changes is assumed as well.

One characteristic of the model to be developed is that while a farmer can *simultaneously* engage in both farming and non-farming activities in the agricultural or rural sector, he has to choose *either* urban employment *or* rural employment (both farming and non-farming). However, although in principle a farmer can simultaneously engage in both farming and non-farming activities simply because these do not, by and large, take place in geographically distant places (as the choices of urban and rural employment usually are), the undertaking of additional non-farming activities does impose a certain time schedule or "pattern of hours" needed for the non-farming activity, and in the case of rural industries also a certain rigor of work discipline. This can put the "pattern of hours" required by non-farming activities in conflict with that required by farming. This raises the question of how to reconcile the two possibly conflicting "patterns of hours". Further, traditional farming conditions (e.g. land conditions) had given rise to traditional farming practices, which are usually labour intensive and associated with low labour productivity. With the introduction (or accelerated expansion) of non-farming activities, time spent on farming will have to be cut so that the farmer can cope with both activities. In addition, returns from time spent on farming will also have to be competitive enough if the farmer is not to abandon farming altogether. In other words, the labour productivity of farming will have to be raised. If these practical issues are not resolved, the simultaneous engagement by a farmer in both farming and non-farming activities will only be a theoretical possibility.

The issue whether or not a farmer or farm family is able to simultaneously engage in both farming and non-farming activities is important because, if they can, then the introduction of a non-farming activity can boost their income from agriculture, such that they would be less inclined to migrate to cities. We theoretically discuss these and other issues in Section 3. The role FC plays in enabling farmers to better combine farming and non-farming activities, and thereby in affecting their migration decisions, is considered in Section 4, where I draw on the actual cases of FC programmes from Taiwan and Mainland China. The possible dependence of the need for FC on stages of economic development is also looked at. Section 5 concludes the paper with comments on the potential roles of FC for Mainland China and the need for further study of the related issues.

2. FC Programmes in Taiwan and Mainland China

The various FC programmes that have taken place in Taiwan and Mainland China have by and large included at least some or all of the following measures aimed to improve the basic farming conditions of a rural community: (1) expanding the irrigated area and improving irrigation and drainage conditions by making plots directly irrigatable and drainable (directly linked to irrigation and drainage ditches); (2) improving farm plot conditions such as the plots' size, shape and configuration by suitably consolidating small and irregular shaped plots into larger ones of a regular size and shape; (3) improving farm road systems to provide better road access to plots for both workers and machinery; (4) reducing land fragmentation (of a farmer's land into many non-contiguous plots scattered at several locations). An aim of FC was to reduce such fragmentation by consolidating (merging) and relocating a farmer's plots to fewer places. Figures 1-2 provide a graphical illustration of samples of FC in Taiwan and Mainland China, respectively.

2.1 FC Programmes in Taiwan

In Taiwan, a series of government-initiated and to a large extent government-funded FC programmes started in the early 1960s, beginning with the first ten-year programme (1962-71). The idea of a government-sponsored and -organized, large-scale FC programme, however, dates back to the early 1950s.²

To establish the desirability and feasibility of FC programmes in Taiwan, in 1958 two "experimental" sites covering an area of 525 ha were first set up. A third site was later added. These experiments encountered no major problems, and the "experimental stage" of the policy was over in 1960. There followed a "demonstration stage" in 1961, when nine "demonstration" sites from eight counties were set up. The total area of FC covered was 3,225 ha.

In 1961 an island-wide farmland survey was conducted to establish the need for and feasibility of FC in all Taiwan. Land suited to FC was identified and designated. Criteria for being designated as land suitable for FC included: (1) having a suitable topography, (2) being technically feasible, and (3) having an economic return. In general the selected areas were those that had had particularly poor farming conditions (poor irrigation, poor roads, and serious land fragmentation), and where it was considered that "standard family farms" could be formed after FC and plot consolidation.³ The island-wide survey designated 369,003 ha of farmland as suited to FC, about 40% of Taiwan's total cultivated land at the time.

The island-wide survey resulted in the first Ten-Year Programme (1962-71). The initial target of the programme was to consolidate 300,000 ha of land, accounting for 80% of the total FC area designated by the survey. Annual targets were set, and precise guidelines and standards were laid down as to the dimension (size and shape) and configuration of the new consolidated plots, new road systems, new irrigation and drainage systems, and road and ditch dimensions. Detailed

² Japan's FC experience appears to have had an important influence on Taiwan's official thinking at the time. Two government officials were dispatched to Japan on a fact-finding mission in 1953. They later became main proponents of the FC programmes in Taiwan. When the present author visited Taiwan's Agricultural Commission in 1993, he obtained a complete set of a Chinese translation of the Japanese laws and regulations on land use and FC.

³ It is important to stress that FC programmes in Taiwan involved only consolidations of a farm household's plots, and not its holdings, that is, there was no redistribution of land between farm households as a result. Such redistribution had been the central aspect of a prior "trio" land reform programme taking place in Taiwan in the late 1940s and early 1950s. A "standard family farm" is one that had a given area of land, with a given number of standard-sized and -shaped plots, operated by a typical farm household. See *Jishi* (1989).

schemes of cost sharing were also devised between the government and farm households. Formal procedures of application, review and approval of an FC site were stipulated. Methods of reallocating post-FC land to participating households were designed, and the authorities, offices and personnel to oversee, organize and execute FC at various sites were set up and appointed.

At the end of the Ten-Year Programme, the actually consolidated land area was 249,000 ha, accounting for 28% of the total cultivated land in Taiwan at the time, which is by any standard a colossal achievement. Particularly noteworthy is the fact the cost was principally borne by farmers themselves. Farmers paid, although often in arrears and with subsidized loans from the government, the full engineering cost and provided the labour input; the government paid two thirds of the estimated administration and professional assistance costs.

While the precise economic benefits of the programme have been difficult to estimate, some reported figures indicate an enormous change of the basic farming conditions in the affected areas. According to Hsieh (1993), based on land consolidated in 1962-1967, the total number of farm plots in the consolidated area fell from 1,260,200 to 465,050, a reduction of nearly two thirds. The proportion of directly irrigated plots increased from 21% before FC to 97% after FC, and the proportion of directly drained plots rose from 19% before FC to 98% after FC. After FC the yield of the first crop of rice (of a double rice cropping system) increased by 30%, labour input per unit of land fell by 20%, and other production costs decreased by 15%. Liu et al. (1998) provides further information on the effects of the first Ten-Year Programme on rice yield and basic farming conditions for selected years.

The first FC programme ended in 1971. By about this time the economic structure of Taiwan was undergoing a fundamental transformation. 1973 saw industry overtaking agriculture in share of employment, having already overtaken agriculture in share of GDP in 1962 (see Fig. 3.1-3.2). Thus industry became the second largest sector in both output and employment (just after the largest sector, the service sector). Although agriculture still accounted for 30% of employment, its share of output had fallen to just over 12%. In the midst of this fundamental structural change, and given that over 28 percent of total cultivated land in Taiwan had already been consolidated, the government decided to further step up FC in rural Taiwan.

1973 saw the launching of the second FC programme, the Four-Year Programme. Other programmes later followed. The basic mode of implementation of this second and other subsequent programmes was similar to that of the first programme. One important difference concerns cost sharing. Partly due to a sharp increase in costs, the government in the subsequent programmes bore a much greater share of the costs.

Because of the increased costs and engineering difficulties (increasingly land less suited to FC was brought under FC), between 1973 and 1992 only a total of 116,267 ha of land were consolidated. Adding the area achieved under the first programme, by 1992 the total consolidated area was 365,443 ha, over 40% of Taiwan's total cultivated land.

It may be said that if the emphasis of the first Ten-Year Programme had been on promoting agricultural growth by improving irrigation and drainage and facilitating farm operations and management generally, then the emphasis of the subsequent programmes was firmly on creating the right infrastructural conditions for a mechanized agriculture in order to achieve sustained agricultural growth with reduced labour inputs and increased “part time farming” (farming by using one’s “odd hours” and/or deploying the “economically non-active” labourers of a family

such as the very young, the old, the weak and married women with kids). Since the 1970s, part-time farming has become a characteristic feature of farming in Taiwan.

Table A1 summarises information of the first Ten Year and various subsequent FC programmes in Taiwan. Figures 4-5 plot the growth of the agricultural sector in Taiwan from the early 1950s to the early 1990s while the economy underwent rapid structural changes, and the shift to “part-time farming” from 1960 to 1990. Liu et al. (1998) provides a detailed study of the effects of the FC programmes on the basic farming conditions, the shift to part-time farming, and the sustained growth of the agricultural sector in Taiwan.

2.2 FC Programmes in Mainland China

In Mainland China, extensive FC effort was made during the commune period (1958-78), principally by communes themselves with little or no state support. The state (the central and various local governments) did invest in agricultural infrastructure, but was principally responsible for major river control and irrigation works (e.g. large reservoirs) encompassing counties and sometimes provinces. The state did in many cases provide certain essential construction materials, then in short supply (as in a shortage economy), for the commune-initiated FC projects and in some cases also limited financial help, but FC as we have defined was in the main carried out by the communes themselves using their own resources and abundant labour. In the first decade that followed the rural reform begun in 1978, FC works largely ceased. Starting in the late 1980s, the state began its Comprehensive Agricultural Development (CAD) Programme in the rural areas, a central flank of which was to fund and organize FC works in selected areas.

The Great Leap years

The communes were established and universalised in rural China at the end of 1958, largely by amalgamating the former agricultural co-operatives. While the former co-operatives also undertook FC, it was not until after the establishment of the commune that large scale FC really took place. In the three ensuing years 1959-61 (known in China as the three Great Leap or disaster years), extensive capital construction works took place in rural China, a principal part of which was FC as we have defined. Most of the FC works during this time were irrigation projects such as building up reservoirs, irrigation stations, and irrigation ditches. The move coincided with the spread of power irrigation in Mainland China at the time.

Following this initial spurt of FC, by the late 1959 and early 1960, severe macro economic imbalances and food shortages forced the leadership to stress essential farming. Among other things, the scale of FC was cut back. Many FC projects were left uncompleted. Some were later completed but few new ones were launched.

A major problem with the irrigation works completed in the Great Leap years was that their scale was overly large, intended to serve large-scale farming the government had then planned for Chinese agriculture. However, what emerged after the Leap years was in fact small-scale village-based team farming involving 30-40 households. Different teams made diverse cropping decisions involving different water demands. That meant enormous difficulties for irrigation management. For example, irrigation water might be required by a team several miles down from the irrigation station, and water therefore had to flow from the station to the team along the full stretch of the ditches, but along the way other teams might not need water. Managing irrigation water in these cases would clearly be costly. Water seepage along the way would not only waste

water, raising the cost of irrigation, but also damage crops in plots adjacent to the ditches. Large trunk irrigation canals also, of course, occupied a great deal of farmland.

A further major problem with the FC works carried out during the Great Leap years was that it was not coupled with steps to re-size and re-shape farm plots. Traditional farm plots in Mainland China, and in Taiwan, were of diverse shapes and irregular sizes, which meant that often only a small proportion of plots could be directly irrigated from an irrigation ditch in spite of having had large-scale irrigation works.

In addition, during the Leap years, while irrigation was emphasized, drainage was by and large neglected. The drainage of excess water from plots was left to the traditional haphazard ways of digging a makeshift ditch across adjacent plots to reach a nearby outlet. Many plots were consequently not well drained. This does not deny the fact that in places where waterlogging had been the main problem hindering agricultural production, drainage systems were built and were often the focus of FC work. However, even in these cases, direct drainage for plots was often not an objective.

During the Leap years farm roads were built only to the extent that irrigation ditches were built. The two banks of some trunk irrigation canals served as main farm roads. Except for this, few new farm roads were built.

There are no complete and reliable statistics on the scale of FC investment and labour input for China as a whole in the Leap years. Anecdotal evidence, however, abounds for particular localities (for example, see *Changshu Suili Zhi*, 1990, for FC works during this period in Changshu, Jiangsu Province).

The post-Leap commune period

After the debacle of the Leap, FC in rural China went through a respite. However, by the late 1960s it was resumed upon Mao's call of "Learning from Dazhai" (Dazhai being a production brigade in Shanxi province which successfully overcame its extremely adverse natural conditions and transformed its farming infrastructure by almost entirely relying on its own resources and labour). The extensive FC works by the communes in the 1960s and 1970s were known in China as "labour accumulation", referring to the fact that the FC works carried out in this period principally relied on commune members' own labour input, paid in "workpoints" which increased their relative share of the collective's income but not necessarily immediately the collective's income.

The FC works in this period differed greatly from those in the Leap years. For example, irrigation systems were organized on a much smaller scale, that of a "brigade" (a brigade then was a collection of teams that typically had a combined cultivated land area of about 100-200 ha). These smaller-scale systems eased the problems of water management, and enabled better and more timely water control.

In certain places like southern Jiangsu, beginning in the early 1970s the previous over-ground irrigation ditches were converted into underground canals (the underground canal walls were built of a mix of lime and a type of local clay). This enabled the collectives then to build roads on top of them. Where underground irrigation ditches reached, so did roads. The roads built on top of the underground canals were of a much greater width than traditional roads and were mostly adequate for tractors (and now also motor cycles and cars) and other farm machines to pass.

Today, most of the main farm roads in southern Jiangsu are built over underground irrigation canals.

Apart from irrigation works and road building, starting from the late 1960s important efforts were made by communes in some areas to consolidate and transform farm plots. Former minute, irregular-sized and -shaped plots were consolidated into regular-sized and -shaped ones, usually of a standard dimension (typically of a rectangular shape of about 2.5 mu in area). Typically on the narrow sides of these plots would be farm roads (and underground irrigation canals) and drainage ditches. As noted earlier, plot drainage had not been an important consideration in FC works during the Leap years. In reorganizing farm plots in the 1970s in some areas, this became an explicit and important component.

The reorganizing of farm plots was by far the most demanding and labour-intensive part of FC works carried out by the communes. The newly consolidated plots had to be properly levelled to make them suitable for paddy cultivation. However, the former adjacent plots might have had different elevations. Furthermore, traditional paddy fields were often sandwiched between dry land and graveyards (both with a higher elevation), small ponds and river ends. In reorganizing plots these would either have to be levelled or filled in. Almost all land levelling during the commune period was done manually by commune members.

Again there are no reliable and complete statistics on the scale of the FC works undertaken by the communes in the post-Leap years. However, anecdotal evidence abounds for some localities, and most people would accept that the scale of the FC works carried out under the commune in the post-Leap years had been simply colossal.⁴

The post-reform period

The Chinese commune system was well known for its ability to mobilize members' labour to undertake FC works. The system was, however, abolished in the rural reform begun in the late 1970s. With its abolition, the practice of mobilizing farmers' labour for FC by rural communities themselves also ended for close to a decade. At the same time, state investment did not increase *pari passu* to make up for the loss of investment in FC previously made by the communes. In fact, throughout the early reform years, state investment in agriculture both as a whole and in supporting small irrigation and land projects in particular fell or at least did not increase.

Although FC and other investments in agriculture fell after the reform, in the early post-reform years output nevertheless increased sharply due to improved work incentives liberated by the institutional reform. Under the commune, effort-monitoring problems had caused widespread shirking. By making commune members essentially private farmers responsible for their own output increases or losses, the institutional reform eliminated the cause of such shirking limiting China's agricultural growth. However, from the mid-1980s onwards, China's agricultural output, in particular grain output, entered into a period of prolonged stagnation lasting for several years. It was then widely recognized that the lack of continued investment in the agricultural infrastructure was at least one cause of such stagnation. After several years' neglect, in many places irrigation and drainage ditches had been silted up, pumping stations had been left poorly maintained, and farm roads had been unrepaired (Liu et al. 1998).

⁴ A small body of literature exists reporting on the scale of FC in the post-Leap commune years. Some also provides estimates of the labour input involved. See Nickum (1978), Rawski (1979), Ullerich (1979), Ishikawa (1982), Perkins and Yusuf (1984).

Apart from the halt to the infrastructural investment that followed the collapse of the commune, the redividing of land into smaller parcels for allocation to households, a fundamental aspect of the rural reform, had caused or further worsened land fragmentation. The reason is the following. In allocating land to households for private farming, in order to ensure an equitable land distribution, in nearly all places a team's land was first divided into several zones according to distance from the village, irrigation conditions, soil quality, and a host of other factors. Each household then received a share of land from each of these zones depending on the household's size and/or labour force. The fact that this would cause or worsen land fragmentation is then easy to see. As widely quoted, after land allocation, nationally each household on average had over 9 pieces of land, often scattered at as many locations.⁵

Such land fragmentation would clearly have caused severe problems for farm management. Even more importantly, however, in places which had already undergone FC, and where plots had already been directly irrigated and drained, and had direct access from main roads, such land fragmentation inevitably meant a sharp deterioration in basic farming conditions. For instance, few new plots would be directly irrigatable and drainable, or have access from main roads.

In recognition of such deteriorations in the basic farming conditions, in the mid-1980s the state renewed its former emphasis on investment in the farming infrastructure and stepped up its funding and organizational role. In 1988, it officially launched its Comprehensive Agricultural Development (CAD) Programme.

The CAD programme represented a major policy shift from most of the previous state agricultural investment programmes that had focused on large-scale irrigation and river control projects. It emphasized investment in the basic farming infrastructure, including small irrigation systems, roads, plots' re-sizing and re-shaping, and so on, that is, FC as we have defined. In part, such a role was forced upon a reluctant state following a general absence of such investment from rural communities themselves after the abolition of the commune. Vast resources have been allocated to the programme. In the period 1988-94, CAD investment accounted for 7.6% of the total state agricultural investment. In absolute terms, from 1988 to 1996, around 46.2 billion yuan was invested in the programme. Table A2 lists the types of projects funded by the programme.⁶

The programme has undergone several phases. Initially, it was restricted to only two designated areas, the Huang-Hui-Hai Plain in eastern-central China and the Three-River Plain in North-Eastern China. Subsequently, its geographical coverage was widened. In 1994, CAD projects were found in 1024 counties, about 50% of the counties in Mainland China. The resources it mobilizes have also gone beyond the initially designated source, namely, the taxes raised on farmland used for non-agricultural purposes, but now also include various

⁵ Note that the fragmentation of land referred to here does not relate to the fragmentation of a given area of land into many holdings, although the collapse of the commune and a return to private farming necessarily implied that, but the fragmentation of a given land area into an increased number of plots, and the fact that each farm household then received a large number of such plots, often scattered in as many locations.

⁶ Projects eligible for CAD funding are generally of two types: (1) land consolidation projects, and (2) diversified economic development projects. When the CAD programme was first launched in 1988, it was known only as the Land Development Programme, with the focus almost exclusively placed on "land development". In 1989, after a reappraisal of the programme's objective by the central government, the diversified economic development component was added, in recognition of the fact that while land consolidation would change the basic farming conditions, the development of the farming sector would also have to rely on the development of other non-farming activities. (In 1994, the objective of the CAD programme was officially stated as "to improve basic farming conditions and to promote the comprehensive production capacity and diversified use of the farmland".)

central and local government budgetary contributions, bank loans, and farmers' own contributions. As well as contributing resources, farmers have also been the provider of labour. Being the recipient of the benefit of the programme, farmers have carried out such work as land levelling, earth digging and moving (associated with road, irrigation and drainage ditch building) without monetary compensation, in shares corresponding to their estimated future benefits.

Table A3 provides information on the total funding by source, indicating the scale of CAD investment. Some data on the area of farmland that has benefited from CAD are given in Table A4.

3. Small Family Farms, Sustained Agricultural Growth and Economic Structural Change: A Model of Farmers' Time Allocation and Migration Decisions

The above provides a background of FC programmes in Taiwan and Mainland China. To develop an understanding of the role of FC in ensuring sustained agricultural growth amid rapid structural changes and in facilitating these changes by relieving rural-urban migration pressures on cities, we develop a model of a farmer's time allocation between three activities: farming, non-farming and urban employment. As a preliminary, we make the following two assumptions:

1. Even though in the course of economic structural changes the agricultural sector must decline in relative importance in the economy, a sustained growth of the sector (in terms of its GDP value) is nevertheless desirable and ought to be an important policy objective.
2. The current household-based small farms existing in Mainland China are unlikely to change and are likely to remain as the dominant rural tenurial institution in the decades to come, shaping the future structural changes, just as it had done so in Taiwan previously. The reasons are both political and economic, which we cannot go into here.⁷

3.1 Rural non-farming activities

Existing models of migration mostly focus on a person's choice between farming and employment in the urban areas. Given the particular rural tenurial institution of small family farms in Mainland China and Taiwan (i.e. given the very limited land resource per family farm), however, it would appear that the choice is a foregone conclusion. As the other sectors grow offering increasingly better income opportunities, there is no way that farming can compete with the lures provided by these expanding sectors.

Under the particular condition of small family farms, farming can at best be only a complementary activity for a farm family. The reason is as follows. In both Taiwan and Mainland China, the typical size of a family farm is extremely small indeed. In the Mainland, currently it is on average one acre per farm; in Taiwan, it has not been significantly greater than this. Limited land area inevitably means limited income from farming, even with the possible help of advanced modern inputs (advanced seed strains, etc.) and modern cultivation methods.

⁷ See Liu (2001) for a discussion of these reasons. See also the Nanfang Zhoumo (14 June, 2001) report of an interview with Wen Tiejun.

To satisfy the rising income aspirations of a farm family, alternative rural-based income opportunities, that is, rural non-farming activities, must be sought.

The difference between pursuing rural non-farming activities and urban employment for a farmer is that s/he can *simultaneously* engage in the former *and* farming, while s/he has to abandon farming altogether if s/he pursues urban employment. While limited possibilities may exist for a farmer both to pursue urban employment and at the same time to engage in farming (as in some outskirts of a city), normally because of the geographical distance involved between the point of urban job and the rural farm, this would not typically be possible or practical. For analytical purposes, we shall assume that taking up urban employment necessarily rules out the possibility of one then also being engaged in farming (or any rural non-farming activity). For a farmer to stay with the agricultural sector, the combined income opportunities offered by both farming and non-farming activities must offer a maximum welfare (utility) greater than if s/he chose urban employment.

Note that in the above we have just spoken of *a farmer* and not a farm family, and have considered him or her as the unit of decision-making. Although it would not typically be possible for one person simultaneously to pursue farming and urban employment, it is possible for a farm family both to have members engaged in farming and in urban employment. Thus if the decision-making unit is a farm family, the impossibility of it simultaneously to engage in farming and in urban work would not be as strong a feature. On the other hand, while cases of a “split family” are possible, they are unlikely to be common or a long-term feature for a family. Eventually, the whole family will either move to cities or the migrant family members return home. Thus although a family being the decision-making unit will complicate the picture, the basic idea that a decision-making unit cannot simultaneously engage in farming (or any rural non-farming activity) and urban employment should still hold. In what follows, for expositional convenience we shall first assume the decision-making unit to be a farmer; it will then be extended to be a family farm to capture aspects that cannot be properly handled when the decision-making unit is a single farmer.

4.2 The model

Let there be three economic activities: farming (A); rural non-farming (B); urban employment (C). As noted, taking up an urban job would mean that the person leaves farming altogether (completely abandons farming), while he can simultaneously engage in activities A and B. In the absence of B, the choice for a farmer is either A or C. In this case, let us suppose that the farmer chooses C. The maximum welfare offered by A cannot compete with that offered by C. (Note that while the farmer abandons farming, he need not abandon his land holding, which he may lease to another farmer, the rent he collects already being accounted for when he decided to choose C).

Now add activity B. On its own B cannot compete with C in the maximum welfare it offers to the farmer. But the farmer can simultaneously engage in this and A. The combined income opportunities offered by A and B give the farmer a higher maximum welfare than that given by C. He therefore chooses A with B instead of C.

The formal model shall not be given here.⁸ Figure 1 provides a graphical representation. The four schedules A, B, C and AB are maximum income schedules associated with activity A, B, C and

⁸ The reader may request from the author for a copy.

the combined activities A and B, respectively. They are derived as follows. Let the farmer maximize his income with respect to each of these activities and the combined activities A and B subject to a constraint on his labour time supply, while allowing him to use whatever other non-labour resources at his command (if there exist markets for land lease and credit, he may lease in additional land and/or borrow capital from these markets). Consider the farming activity A, for example. Given the assumed total amount of labour time the farmer is able to spend on farming (he has no other activity to expend his labour on), he then decides how best to use his labour (how best to combine his labour with other resources), and on the optimal amounts of other resources to use. The solution to the problem should define a maximum level of income for the assumed total labour expenditure. Now let the constraint on the labour expenditure change. The maximum achieved level of income will then also change. Schedule A traces out this relationship. The maximum income increases as the constrained labour expenditure increases. Schedules B and C are derived in the same way.

Note that in deriving schedules A, B and C, we did not assume a given wage rate in each case. While an externally given wage rate may be a realistic case in respect of activity C, the same cannot be said of A and B. Under the condition of small family farms, it is hard to think that there can exist a competitive labour market to set a wage for A and B, at which one can supply as much labour as one wants. Even the presence of non-farming activities need not imply that a farmer would be able to do so. For one thing, many rural non-farming activities are household based and do not hire outside workers. And even rural industries may not entirely base their hire decisions on non-personal factors. For generality, we have assumed all three activities respectively not to be subject to a given ruling wage rate.

The AB schedule is derived in an analogous way, except that a farmer now solves the problem of maximizing income subject to a joint constraint on the total available labour time, by allocating this total labour time between activities A and B (the farmer can simultaneously engage in both). The AB schedule traces out the positive relationship between the assumed amount of total labour time, and the maximum income. Note that, as drawn, the AB curve first follows schedule A, and then deviates upwards to be above it, indicating that income opportunity B is being utilized.

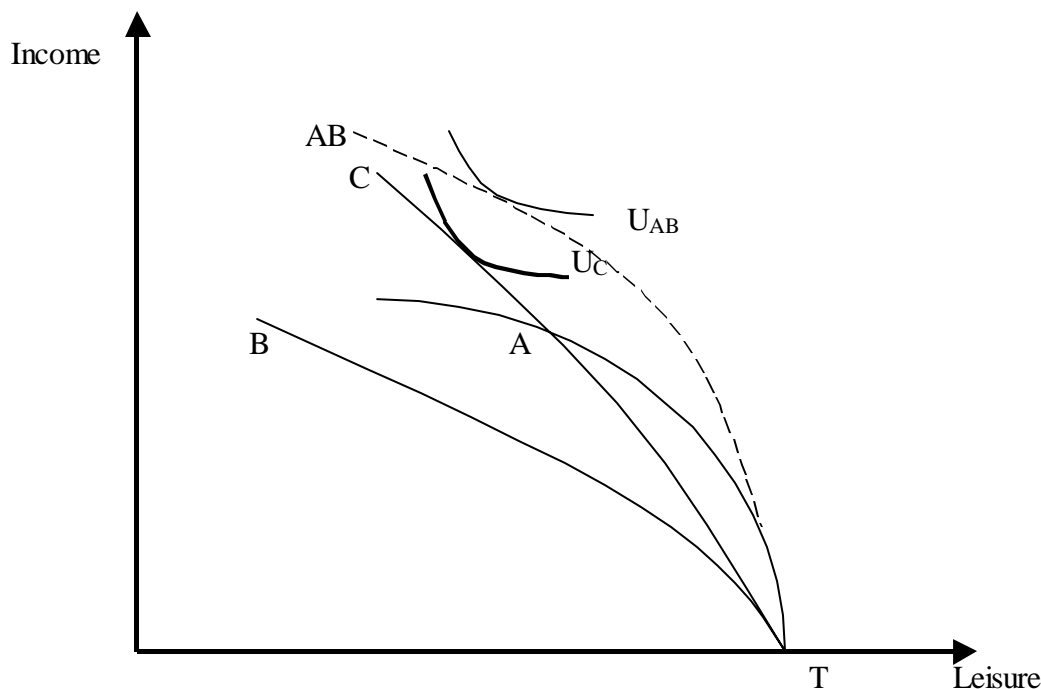


Figure 1

There can be many possible juxtapositions of the four schedules. In combination with the farmer's tastes, this should give rise to a variety of possible cases. In Figure 1, we have only indicated a particular possibility, where without activity B to complement A, or vice versa, the farmer will choose C, implying leaving farming and leaving agriculture altogether and migrating to cities. However, with both A and B, the combined income opportunities of these enable the farmer to reach a higher level of welfare of U_{AB} than that offered by C, and he therefore chooses A and B.⁹

A sufficient condition for a farmer to choose to stay with agriculture is for the combined income schedule AB to lie everywhere above schedule C.¹⁰ However, even if this is not satisfied, so long as it lies above schedule C in the relevant range (so that the tangency between AB and a relevant indifference curve gives the farmer a higher level of welfare than that associated with the

⁹ Strictly, one needs to consider the risk or probability of a farmer leaving agriculture to migrate to cities but not finding an urban job. This risk is equated with the rate of urban unemployment in Harris and Todaro (1970), which allows them to derive intersectoral equilibrium migration, the number of people who would leave agriculture before migration ceases. Intersectoral equilibrium migration is not the concern of this paper. Note that Harris and Todaro assumed each farmer/potential migrant to be risk neutral. Making the same assumption here, our model can be extended to incorporate risk readily: the C schedule then represents the expected incomes for each level of time a migrant spends on C. An increase in the risk of not finding urban employment then has the effect of pivoting the C schedule downward through point T. Depending on cases, this may or may not lead a farmer to change his migration decision.

¹⁰ Note that this is not the same as requiring the constant average rate of pay offered by C to be below that offered by the combined activities A and B, which would be in the spirit of Harris and Todaro's condition of a person's migration choice. Harris and Todaro (1970) assume both urban and rural employment to be of wage labour, in which case a person's migration decision simply rests on a comparison of two alternative (expected) wage rates.

tangency between another relevant indifference curve and the schedule C), still the farmer will choose activities A and B in preference to C.

While the introduction of activity B induces a farmer to stay with farming, nevertheless B does compete with A for labour and other resources. In equilibrium, marginal incomes of labour, and marginal returns to each other production factor, should be equal across the two activities.

An extension

The model above assumes that the person will be able to choose the level of time he allocates to either activity C or between A and B. This may be a realistic assumption in respect of A and B. Certainly, since A involves a farmer farming his own plots, he has all the freedom to decide how much time he wants to spend on farming. If B is an entirely family-based activity, the same applies. If it is not (if it is a factory or office based activity with a fixed work schedule and a fixed level of total time required of him (and no more) in a given period), however, then the above analysis needs to be appropriately modified. Specifically, there will then exist an upper bound or ceiling on the level of time the person can allocate to B.

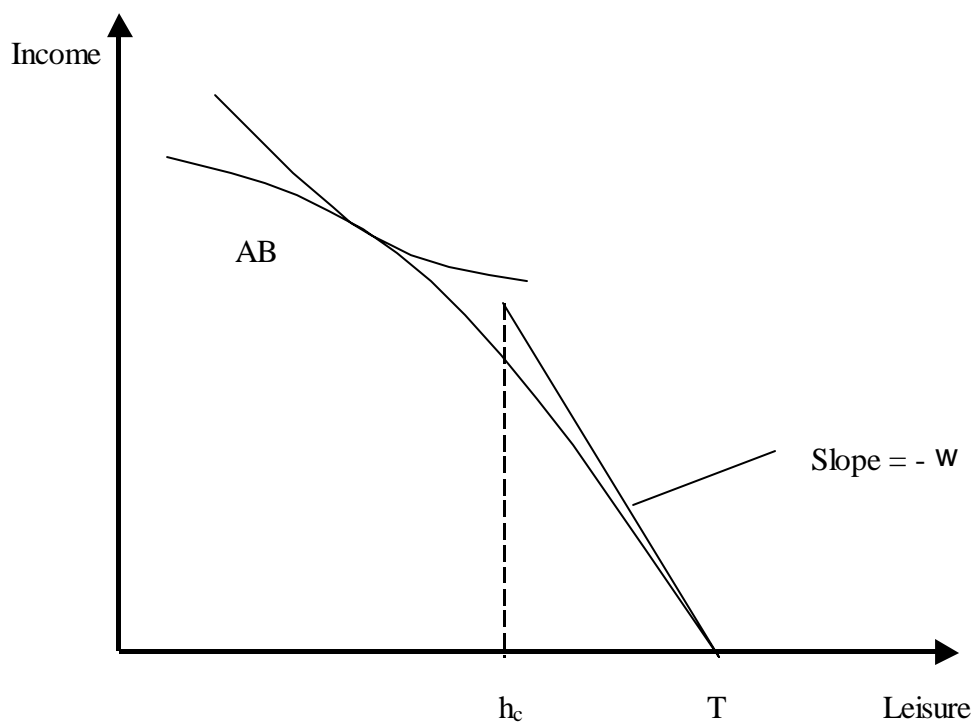


Figure 2

Although some rural non-farming activities are office or factory based with a fixed work schedule, others are not. For simplicity, we assume that B is entirely family based and is not subjected to a formal work schedule.

The same would be an inappropriate assumption for C. While urban employment may not in every case subject a person to a fixed work schedule (like self-employment or certain types of informal sector employment), most urban jobs (and certainly those in the formal sector) do subject a person to a fixed work schedule and fixed total time to be supplied in a given period. Most urban jobs also pay a person at a given wage rate.

Figure 2 takes account of these features of urban employment. A ceiling h_c is imposed on C, and within it the person is paid at a constant wage w . We have assumed that the wage rate is sufficiently high that the C schedule lies above AB. In spite of this, however, the person chooses activities A and B, which give him a higher level of welfare. Needless to say, this is entirely due to the presence of the ceiling h_c on C. However, the case does show that in considering a person's migration decision, looking at the rates of pay offered by alternative employments is not sufficient. Even if the wage rate of urban employment is higher, because of its implicit ceiling on the hours worked characteristic of urban (office and factory based) employment, a farmer may nevertheless not choose it.

3.3 Farming and non-farming activities: Levels of time allocation and “patterns of hours”

The foregoing makes it clear that, alone, neither the farming activity A nor the non-farming activity B may be able to compete with the lure of urban employment C. However, combined A and B may compare favourably to C. While A and B will compete between themselves for a farmer's labour and other resources, in the cases we have portrayed in Figures 1-2, they are also mutually supportive of each other, and are indeed dependent on each other for survival. Without B there can be no A, and vice versa. The analysis also suggests that in cases where the combined activities A and B cannot compete with C, by improving returns to labour in either sector, both sectors can benefit, to the extent that it would otherwise be abandoned by the farmer.

Before considering the specific roles of FC in influencing a farmer's time allocation and migration decisions, it will be helpful to look still more closely at the competitive (and in the cases considered above, also mutually dependent) relationship between farming and non-farming activities. It is worth recalling that the analysis above rested crucially on the assumption that a farmer is able *simultaneously* to engage in both activities A and B. This is true in principle, given that these two activities are not so geographically separated that a farmer must choose either A or B (as is true of the choice between C and A, or C and B). However, the introduction of the non-farming activity does have implications for farming in terms of (1) the level of time and (2) the “pattern of hours” available for farming. It is necessary to examine these aspects further, following which we shall also extend the decision-making unit from a farmer to a farm family whereupon we generalize the concept of the “pattern of hours”.

Levels of time allocation

First, the introduction of the non-farming activity B implies that there will be less time available from a farmer to be spent on farming. Unless the marginal returns to labour expended on the non-farming activity is everywhere lower than that on farming, under usual assumptions regarding tastes and technologies, a farmer's time allocated to farming will unambiguously fall, and other things being equal this will also mean a shrinking of the farming activity (both in terms of labour allocated to it and in terms of output).¹¹

¹¹ Think of the initial case without non-farming activity B as one where B gives lower marginal returns to labour than A everywhere except at the point of equilibrium, and in the equilibrium the marginal returns to

The case where marginal returns to labour expended on the non-farming activity is everywhere lower than that on farming implies, however, that the combined income schedule of A and B in Figure 1 is effectively that of A. Under the analysis given before, and if the case is as shown in Figure 1, then the farmer will leave agriculture altogether. So non-farming activity B with sufficiently high marginal returns to labour is required if the farmer is not to abandon farming and agriculture. Thus the case of interest is one where time allocated to farming by a farmer falls, and the farming sector shrinks, as a result of the introduction of activity B.

This situation will not change unless there is an improvement in the farming technology such that output does not necessarily fall even though labour allocated to it falls. Note that, in this case, comparative static analysis would show that labour allocated to farming will not necessarily fall either. Nevertheless, one would normally expect it to fall.

When improvements in the farming technology are considered, it is possible to think of a case where a farmer will not leave agriculture (farming) even if no non-farming activity is introduced, so long as returns to farming are *sufficiently* raised (the income schedule A pivots sufficiently upwards through T). Under the condition of small family farms (with limited land holding and other resources), however, this is an unlikely case. Therefore, there will be a need for non-farming activities to complement farming, even with improvements in the farming technology.

Improvements in the farming technology will raise the attraction of agricultural employment as a whole, helping agriculture (and farming) to survive. At the same time, improvements in the farming technology will also enable this sector to be in a better position to compete with the non-farming sector for labour and other resources.

Patterns of hours

Second, we consider the pattern of hours available for farming. By the “pattern of hours” of an activity is meant a particular time sequence of the hours required by that activity, with the time specific requirements as to *when* (at precisely which point in time) each hour is to be spent on the activity. Underlying this sequence of hours are *tasks* that are required to be performed at particular points in time, tasks that make up the activity. Understandably, how much time to be spent on an activity (or its tasks) at each point in time will also depend on the total time to be spent on the activity. In the above we only considered the implications of the presence of non-farming activities for the total time allocated to farming; the implications for the pattern of work hours available for farming are not considered.¹²

labour for B (its highest possible rate) is just equal to that for A. Then under usual assumptions regarding tastes and technologies, an increase in the marginal returns to labour for B everywhere will necessarily imply a fall in the time a farmer allocates to farming. The assumptions regarding tastes and technologies include that all first partials of the utility and production functions are positive, the second partials negative, and the cross partials non-negative. Among other things this implies that leisure is a normal good. A formal proof of these results may be requested from the author.

¹² Any one of the tasks making up the activity may be required to be performed at a particular point in time (e.g. the sowing of a crop will need to occur at a particular time in a year). There thus arises a particular time sequence of the (numbers of) hours to be expended on the activity (to be expended on the tasks making up the activity). Such a sequence shall span the whole period in which the activity is supposed to take place. Note that the sum of the numbers of hours to be spent on each task is then the total time allocated to the activity. These numbers of hours to be spent on each task making up the activity need not be fixed or given, but are to be chosen by the person engaging in the activity. The person chooses these numbers of hours optimally for any assumed level of total time to be

The introduction of a non-farming activity is, however, likely to compromise any existing pattern of hours required by farming. Just as farming requires a particular pattern of work hours (for any given level of total time to be spent on it), so may and usually does a non-farming activity. Specifically, the conflict takes the form of a clash of the time at which a non-farming task and a farming task both are required to be performed. The extent to which such “clashes of time” will occur will depend on the patterns of hours imposed by the two activities in question. In turn, they depend on factors ranging from seasonal (as is true of farming) to institutional considerations (e.g. a system of formal working hours like office hours).

Some non-farming activities may impose a very “demanding” pattern of hours, in that the sequence of hours to be worked is very exact and there is little flexibility with the timing of the different hours to be worked. An example of this is office or factory work, which usually imposes a standard work schedule (standard working week, day, and hours). Other non-farming activities may impose only a much less exact pattern of hours, in that the timing of each hour (or task) to be worked (performed) is relatively flexible such that, within limits, the performance of the work in question can be postponed, or brought forward. Examples of this are certain household-based non-farming activities.

It is unlikely that any activity will impose a “completely demanding” pattern of hours to the extent that there is no flexibility whatsoever with the timing of the various hours to be worked. Nor is there likely to be a “completely flexible” activity such that its hours can be worked any time. Typically, some flexibility will exist, but there is not complete flexibility, allowing a person to postpone or bring forward the performance of a task within limits, and typically at a cost. The cost in question is the reduction in the income contribution of the task in question. Needless to say, this cost will be a critical factor in determining whether the person will indeed bring forward or postpone the performance of a task, and if so, to what extent (assuming this cost to increase with the extent of the postponement or bringing forward).

In light of the above, it is clear that in deriving the combined income schedule AB in Figures 1-2, one would in fact have to assume either that the patterns of hours imposed by activities A and B do not conflict at all (i.e. are completely flexible) or, equivalently, that the cost of postponing or bringing forward the performance of a task is zero for every task.

A farm family as the decision-making unit and “patterns of labour inputs”

In the discussion above, we used a farmer as the relevant decision-making unit. This is adequate for considering the impact of a non-farming activity on the level of labour and pattern of hours available for farming. It is, however, not adequate for considering the full roles of FC. In Taiwan and many developed parts of Mainland China, household division of labour between farming and non-farming activities has been an important phenomenon, facilitated by FC (in the case of Taiwan, see Figure A5). To accommodate household division of labour and to examine the effect of FC on it, a richer analytical framework is required.

allocated to the activity, by maximizing his income from the activity subject to this constraint. For solving this problem, income needs to be assumed to be defined over the *tasks* in the first instance, rather than over the total time allocated to the activity. Such an income function may be assumed to have the usual properties of being “well-behaved”.

To be brief, let there be a farm family whose members have different job-specific skills for farming and non-farming activities.¹³ For simplicity, suppose that the family has only two members who have identical preferences between income and leisure but different abilities or skills for carrying out activities A and B. The family maximizes the sum of the two members' utilities. We shall not explicitly model this problem here but a necessary condition is the maximization of the combined incomes for any given expenditures of labour from each member. This is akin to the Ricardian trade problem, for which we know that there will be specialization, in the present case specialization between the two members in carrying out the two activities, with one member undertaking only one activity and the other member possibly undertaking both activities.

This enables us to define the concept of the “pattern of labour inputs” for an activity, by which is meant not only the “pattern of hours” as defined previously, but also the “pattern of the types of labour inputs” (i.e. from which particular members of the family). With the introduction of a non-farming activity, some family members may completely specialize in it, or they may specialize in it but they also engage in farming, while the rest of the family members engage in farming only.

5. Roles of FC in Taiwan and Mainland China

The analyses and discussions in Section 3 have provided a theoretical framework for us to examine in concrete terms how FC may affect a farmer's time allocation and migration decisions, and what roles it may have in promoting agricultural growth in an economy that undergoes rapid structural changes. In this section, we hypothesize three different but related roles of FC drawing on the FC programmes in Taiwan and Mainland China. Note that our evaluation of these roles of FC in the two economies will only be qualitative and suggestive. It remains to test the hypotheses in future research.

5.1 Roles of FC

The three roles of FC we hypothesize are: (1) In the short run, FC can directly contribute to certain production inputs, so that other things being equal, FC can increase the output and labour productivity of farming. (2) In the long run, FC also facilitates factor substitution, in particular capital-labour substitution, by making certain agricultural machinery more productive and economical to use. (3) Depending on the condition of land holding in an economy (e.g. small family farms as in Taiwan and Mainland China), in the long run FC can have the further effect of adjusting basic farming conditions to available patterns of labour inputs for farming. As noted, in both Taiwan and Mainland China, small operational land holdings have been and are likely to remain the rural tenurial institution. FC has the further role of allowing farmers to utilize effectively available labour inputs and patterns of hours for

¹³ They may also have different job-specific skills for urban employment but this is not a relevant consideration here. As pointed out earlier, while a farm family could enable its members to pursue both agricultural (farming and non-farming) activities and urban employment, typically cases of “split families” are not common and not long lasting. That being so, and since our concern here is with the effect of a non-farming activity on farming, we need only consider a farm family allocating its members' labour time between farming and non-farming activities to maximize a “family utility function”. Note that the latter raises intricate issues of aggregation of the family members' preferences, which we cannot go into here.

farming, subject to the presence of various rural non-farming activities. Such labour inputs and patterns of hours could not otherwise be utilized by a farm family.

The short run role: increasing output while leaving the farming technology unchanged

By the short-run role of FC is meant the contribution FC makes to output and labour productivity by directly augmenting certain production inputs. In production function analysis, FC directly increases output by increasing the value of certain factor inputs. A typical production function includes labour, capital and land as the input variables. In certain cases, the irrigated area is also included as a production factor. If one defines the production function in this way, by expanding the irrigated area FC directly increases the value of that independent variable in the function, and thereby output. In certain cases, the principal role of FC may well be, in fact, to improve irrigation and drainage conditions of the farmland (for example, by raising the rate of directly drained and irrigated plots as in Taiwan and Mainland China). One can also include these rates as additional input variables in the function, and study their effects on output. Aside from irrigation, FC may (but may not) in net terms increase the cultivated land area, in which case the value of the land factor in the production function rises. Other things being equal this should also raise output. Other cases where FC increases the value of a certain production input are also possible.

An important point about the short-run role of FC is that it does not change the *technology* of farming, where a technology refers to particular sets of factor substitution possibilities for producing given levels of output. In terms of a production function, a technology is represented by the form of the function. In terms of production isoquants, a technology refers to a given set of production isoquants each representing a given level of output and a particular set of factor substitution possibilities for producing that output. In its short-run role, FC merely increases the level of certain inputs but does not change the set of production isoquants, or the set of sets of factor substitution possibilities for producing given levels of output.

The long run roles of FC: facilitating factor substitution

In the long-run, FC has the effect of changing factor substitution possibilities, in particular capital-labour substitution possibilities. Note that it is not implied here that without FC capital-labour substitutions are not possible, but that the extent to which they can occur are more restricted.

FC can facilitate capital-labour substitution in a number of ways. Typically, an important component of a FC programme (as in Taiwan and parts of Mainland China discussed in Section 2) is farm road building. Traditional farm roads are narrow and poorly built (in Southern Jiangsu in Mainland China, before FC typically roads separating plots were about a foot wide and built of mud, and the "main farm roads" leading from one's village compound to sets of plots at various locations were not much more than a foot wide and were built of mud without any paving). Main roads are few, plots are of irregular shapes and sizes, and most plots are not directly accessible from main roads, and some might even be several plots away from them. Access to these plots by machines would be difficult, if not impossible. And because of the small size and irregular shape of the plots, even if a farm machine made its way to a plot, its operation would be severely hampered. All this means that the use of machines will be costly and uneconomical. Both technically and economically, the extent of capital-labour substitution in these cases is severely limited.

Having pointed out the limitations of capital-labour substitution under pre-FC farmland conditions, it remains to see how FC can facilitate such substitution. By building wider and more solid and better roads adequate for farm machines to pass through, by realigning plots and making them directly accessible from main farm roads to allow the access of machines as well as workers, and by re-sizing and re-shaping plots so that they are of a regular size and shape appropriate for machine operations, mechanization of a range of farm operations becomes a realistic and economic option. (Examples of typical farm operations whose mechanization is made possible by FC includes transporting harvests, fertilizers and manures to and from farm houses and between plots, ploughing, harvesting, and so on.)

Apart from making the mechanization of a host of farm operations more feasible and economical, FC directly saves labour in a variety of ways. For example, a reduction in the time spent on travelling between plots and the farm compound helped by a better road system and modern means of travelling (cars, motor-cycles, etc.). A reduction in land fragmentation or in the number of plot locations of a farm also helps reduce the time spent on travelling. Further, crop management is facilitated by having regular-sized and -shaped plots (for example, in respect of fertilizer and pesticides application and irrigation), and so are a range of other farm operations.

A discussion of the technical feasibility of capital-labour substitution facilitated by FC and farmers' economic incentives for such, and the relationship between farmers' such incentives and stages of economic development is given in Section 5.2. For the moment, we comment on a related and important concept of surplus labour, in view of our foregoing discussion of the role of FC in facilitating capital-labour substitution. We have argued that as economic development takes place, other expanding sectors are likely to draw labour away from agriculture. As labour is transferred away from agriculture, it becomes an important issue whether and how agriculture may continue to grow. The solution, we have argued, is capital-labour substitution.

In many LDCs, however, economic development appears to have been accompanied by a release of huge quantities of surplus labour from agriculture, not all of which is absorbed by other expanding sectors. Therefore, it might be argued that the capital-labour substitution facilitating role of FC is unimportant. In reply, it needs to be pointed out that the real function of FC is perhaps not to facilitate capital-labour substitution so that farming, and agriculture, releases enough labour to satisfy rising labour demands in other expanding sectors, but to facilitate capital-labour substitution so that farming and agricultural labour productivity rises sufficiently for agriculture to remain an attractive enough occupation for people. One can have a stagnant agriculture with stagnant labour productivity and under-utilized land, while large numbers of farm labourers leave land, or one can have a growing agricultural sector with rising labour productivities attracting a sizeable share of the economy's labour force. In both cases, more farmers may leave agriculture than the absorption capacity of the other sectors, and the excess migrants end up as the urban unemployed. But not to raise agricultural labour productivity through capital-labour substitution would not be a correct policy if the objective is indeed to retain farmers in the agricultural sector.¹⁴

The long-run roles of FC: adjusting farmland conditions to available labour inputs

¹⁴ A social planner might adopt policies to keep such surplus labour in agriculture. This was essentially what the Chinese government had done before the more liberal policies on rural-urban labour movements were adopted. The effect had been to depress agricultural labour productivity. Aside from the question of the desirability of such a policy, more liberal policies on labour movements also meant that it was no longer practical to administratively keep the surplus labourers within agriculture. Under a market based decentralized system, any policy aimed to keep large numbers of farmers in agriculture would have to be based on farmers' economic incentives to stay on.

In our analysis in Section 4, the unit of analysis was initially a farmer, and we defined the concept of the “pattern of hours” of an activity. It was subsequently extended to be a farm family, and this enabled us to consider different types of family members with different activity-specific abilities and skills. This results in specialization by different members in particular activities. The presence of a non-farming activity then implies a particular pattern of the types of labour from a family to be allocated to it. For example, an adult male of the family (or more generally an “economically active” worker) may then specialize in the non-farming activity, although he may also spend time on farming. A female adult (or an “economically non-active” worker), on the other hand, may specialize in farming entirely. This in fact appears to be a widespread pattern of family division of labour in rural Taiwan.

Restricted by the pattern of hours demanded by the non-farming activity, however, the male adult may only be able to spend his “odd hours” or “spare time” on farming, that is, those hours on which he does not have to be engaged in the non-farming activity. If the non-farming activity is strictly office or factory based that implements a formal work schedule, this would mean that the male adult will only have those off-office hours to be spent on farming, and there may be little flexibility in this regard.

Although we have said that a female adult may specialize in farming, she need not be the only family member to do so. Typically, as in Taiwan, other members of a family such as children, the old aged, and the weak, may also engage and specialize in farming. This gives rise to a “marginalization” of the farming work force, as happened in Taiwan, since essentially only those “marginal” or “economically non-active” workers now engage in farming. To pair with the “marginalization” of the work force, we may also speak of a “marginalization” of one’s work time on farming, referring to the fact that typically adult males or the “economically active” workers in general typically only spend their odd hours, if at all, on farming.

Both the marginalization of the farming work force and the farming work time in the case of the economically active workers have been important features of Taiwanese agriculture after FC and rapid economic structural changes, and they are now also becoming important features of farming in some relatively developed parts of Mainland China (such as Southern Jiangsu). However, it remains to see the connection between these and FC.

First, the role of FC in facilitating capital-labour substitution and mechanization in farming has already been noted. Clearly, the reduction of the time to be spent on various farming tasks then creates necessary conditions for some members of a farm family to switch to other non-farming activities, while farming is not neglected. Without the saving of the time on farming made possible by the mechanization and FC, this would not be possible. Secondly, the mechanization of many especially physically and skill-wise demanding farming tasks (e.g. ploughing, transplanting rice, harvesting, transporting, etc.) also makes it possible for farming then to mostly rely on labour inputs from the economically non-active or marginal workers (the old, the weak, women, etc.). Without such mechanization facilitated by FC, this would not be possible. Thirdly, the mechanization of certain physically demanding and time-consuming farming tasks at peak seasons especially reduces certain seasonal labour shortages which may well constrain a farmer or farm family’s ability to practice farming while engaging in other non-farming activities. That is, through mechanization of certain farming tasks and generally reducing the time required for farming during peak seasons, FC helps to reconcile the patterns of hours imposed by farming and non-farming activities during the peak seasons. Fourthly, by cutting down on labour needed for farming while output does not as a result fall or in fact increases (as a result of better irrigation

brought about by FC, coupled by other modern advances in fertilizers, pesticides, herbicides and seed strains), labour productivity dramatically increases, which makes it worthwhile for a family farm still to practice farming. Without such increases in labour productivity, a farmer or family farm may well abandon farming altogether, and that may well mean abandoning agriculture altogether.

5.2 Stages of economic development and FC

Having stressed the roles of FC in promoting agricultural growth during rapid structural changes of the economy and in facilitating such structural changes under the condition of small family farms, it is important also to point out that this does not imply that FC is desirable at any stage of economic development. Figure 3 explains why.

Although we have stressed that in the long run FC performs two separate roles of facilitating capital-labour substitution in farming and in adjusting farmland conditions to available patterns of labour inputs, the more important long run role is capital-labour substitution. This is portrayed in Fig. 3, where the effect of FC on capital-labour substitution possibilities is modelled as a technological change due to FC, represented by a southeast shift of the whole map of production isoquants (only one such isoquant is drawn for before and after FC related to a particular level of output Q_1). Note that the new factor-substitution possibilities (for producing output Q_1) are made technically feasible only by FC.

However, while feasible, it need not follow that the new set of substitution possibilities is necessarily welcomed by a farm family. For that one needs to examine a farm family's economic incentives. Before the start of economic structural transformation and the rapid expansion of industries and non-farming activities, and the rising income opportunities these provide, the opportunity cost of agricultural labour tends to be relatively low, and that of capital high. The steeper iso-cost line in Fig. 3 depicts this. The optimal capital labour combination chosen by the farm family is given by point a. However, with structural transformation, the opportunity cost of labour generally rises, and that of capital relatively falls, giving rise to the new flatter iso-cost line. The new optimal capital-labour combination chosen is given by point b.

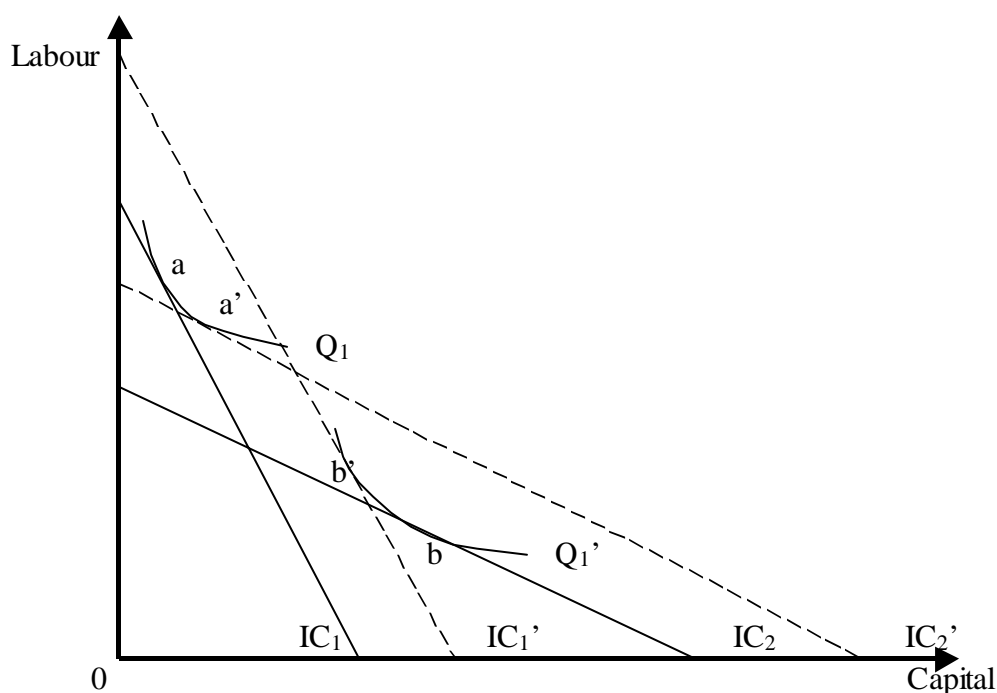


Figure 3

It is of interest to see what would happen without FC while labour and capital costs change as above. Then only the old technology is available, and the changing factor prices would mean that capital-labour combination a' would be chosen. Now compare this with the case with FC, where b is chosen. The cost of producing output Q_1 clearly increases. Thus the farm family would prefer using the new technology at new factor prices. On the other hand, if there were not changes in the factor opportunity costs, it would not be rational for a farm family to prefer using the new technology, since in this case using the new technology (and choosing point b') to produce output Q_1 would entail a higher cost. If the farm family would not prefer using the new technology, there would be no economic incentives and rationale for FC. Thus although FC might make certain capital-labour substitution possibilities feasible, nevertheless whether farmers would adopt it (and whether on social welfare grounds there is a case for adopting it) would also depend on changing relative factor prices and stages of economic development.¹⁵

¹⁵ In Fig. 3, it has been assumed that all other factors of production except labour and capital are held constant. The assumption of land being held constant is especially important, for it implies that over the course of structural transformation a farm family's land holding does not change. While this may be true in economies such as Taiwan and Mainland China, in many other economies industrialization and structural changes are often accompanied by a process of "peasant differentiation" such that some farmers become landless and leave agriculture and others enlarge their land holdings. Overall there follows a fall in the man-land ratio, and a move from more to less labour intensive cultivation methods. In other words, there occurs a process of *land-labour* substitution from the viewpoint of a farm unit (producing the same level of output by using more land and less labour). Other things being equal, land-labour substitution entails a fall in land productivity. However, this may be accompanied by technological changes such that yield or land productivity does not fall.

It needs to be pointed out that Figure 3, of course, shows only one possible case. If the new isoquant Q_1' is not situated where it is in the Figure, but a lot closer to the origin such that the new price line based on pre-FC factor prices and which is tangent to Q_1' lies below the price line IC_1 , then there is a case for FC with or without structural changes. On the other hand, if the new isoquant Q_1' is situated a lot farther away from the origin in the northeast direction than it is in Figure 3, such that the new price line based on pre-FC factor prices and which is tangent to Q_1' lies above the price line IC_2' , then there is never a case for FC with or without structural changes. So the relationship between the need for FC and economic structural changes is not a clear-cut one. Nevertheless, the analysis establishes the fact that the case for FC may well depend on stages of economic development. Typically, we would expect there to be such a dependence.

6. Conclusion

In this paper, we reviewed the farmland consolidation programmes in Taiwan and the Mainland, and qualitatively hypothesized their role. By increasing the irrigated area and improving the quality of irrigation and drainage, and by facilitating crop management, FC can raise output and yield. By building and improving farm road systems, making plots directly accessible from farm roads, and by consolidating plots into regular-sized and -shaped and appropriately aligned ones, FC can facilitate farming mechanization and capital-labour substitution in farming in general. In turn, it was argued, this enables a farm family to simultaneously engage in both farming and non-farming activities, which raises the income level of a farm family from agriculture. This increased competitiveness of agriculture vis-à-vis urban employment in the income it offers encourages farmers to stay with agriculture (who would otherwise abandon agriculture), prevents excessive rural-urban migration and unwanted excessive urbanization. At the same time, while declining in relative importance in the economy as a whole, agriculture may nevertheless achieve a sustained growth in GDP, while the economy as a whole undergoes rapid structural changes. This appears to have been the story of FC and its effects on agriculture and economic structural changes in Taiwan and some relatively developed parts of Mainland China. However, while we have qualitatively hypothesized these roles of FC, it remains to test these hypotheses quantitatively in future research.

Although further quantitative research in the area is necessary, if the above hypothesized roles of FC are true, it means that FC then poses an important policy issue worthy of attention for Mainland China. Currently Mainland China is undergoing or poised to undergo a period of rapid structural changes. The policies one takes towards agriculture during this period will almost certainly affect, in a major way, the character of these changes (e.g. in regard of the scale of urbanization, the “dynamism” of agriculture, and the balance between rural and urban sectors). And given the potential roles that we have hypothesized in this paper, FC is one important policy area in this regard.

Studying the potential roles of FC in facilitating and managing future structural changes also commands a sense of urgency. In some parts of Mainland China, rapid structural changes are already taking place; agriculture is no longer the largest sector in terms of the local GDP or even employment. Many of these areas are also where much FC had been undertaken during the commune period or through CAD, so that without further FC farmland conditions in these areas

Land-labour substitution may or may not be accompanied by FC. However, by making the kind of changes in road and plot conditions described above, one expects that FC will also enable a farmer to cultivate a larger area of land using machinery than otherwise. So in principle FC can facilitate land-labour as well as capital-labour substitution. Without FC, it may be difficult or even counterproductive for one farmer to cultivate more than a given area of land (this relates to the concept of “optimal farm size” studied by some authors).

may not be so serious as to unduly affect the character of the structural changes. However, in the remaining vast parts of rural China, this is not so. Here farmland conditions are still like those that had prevailed in Taiwan or parts of China before FC. Irrigation and drainage are haphazard; plots are minute, irregular-sized and -shaped, and badly aligned; land fragmentation in terms of the number of non-contiguous plots of a farm family is serious; main farm roads are few, badly built, and do not provide direct access to most farm plots. As development and economic structural changes spread to these areas, agriculture is little prepared to face them. Given these conditions, large-scale rural-urban migration is likely to occur (as many farmers are already migrating to Eastern Coastal regions). Some such migration is desirable, but the continuing poor state of agriculture may well result in an excessive migration, causing undue pressures on urban areas both in terms of urban unemployment and the demand for various urban facilities.

Yet in these areas, the opportunity cost of labour is still relatively low, so that financially an FC programme now is likely to be much less costly than a comparable FC programme, say, several years or a decade down the road. FC programmes of the type we are concerned with are particularly labour-intensive, and labour will consequently account for a very high share of the total cost. As the cost of labour increases, the total cost of a programme will increase sharply. Now may be the best time to spend on FC in these areas. And, of course, by increasing agricultural productivity and income in these areas, more farmers are likely to stay and less are likely to migrate to cities along the Eastern Coast, as it is currently taking place.¹⁶

It is heartening to know that since the late 1980s, the government has continued to fund and preside over the CAD programme. However, not enough attention from the media and academic circles has been given to this, with little research of the impact and role of CAD, as well as its financial and economic costs. Acknowledging that FC may have the roles as hypothesized in this paper can help us to recognize the importance of the issues, and to give the matter more attention. Through studies, it may emerge that the government is already devoting the right amount of resources to CAD and FC, but it may also emerge that it is not yet spending enough, and consequently more resources need to be devoted to it.

¹⁶ There is the added consideration that China will soon join the WTO, forcing Chinese agriculture to compete with cheap agricultural imports from abroad. Labour productivity and hence income in agriculture will have to be raised if China's agriculture is to stand a chance of surviving the competition. On the other hand, there is the socially and politically determined factor of maintaining small family farms in the rural areas. This being so, agriculture will have to accommodate an increasing level of non-farming activities as well as farming. This raises the issue of how best to enable a farm family to combine the two activities, the central concern of this paper, and an aspect where FC, we have argued, has a crucial role to play. So while we did not refer to China's imminent accession to WTO in this paper, the issues we studied are closely relevant to that.

References

Changshu Suili Zhi, 1990.

Chen, Junsheng (1995), *Do our best to create a new prospect for the CAD programme*, A speech delivered to 1995 national conference on exchanging CAD experiences.

Hang, Lianggui (1996), *A Speech Delivered to the 1996 CAD Planning and Finance Conference*, Conference Document.

Harris, J.R. and Todaro, M.P. (1970), "Migration, Unemployment and Development: A Two Sector Analysis", *American Review of Economics*, vol. 60, pp.126-142.

Hsieh, P.C.R. (1993), "Principles and Practices of Farmland Consolidation in Taiwan." Mimeo, Land Reform Training Institute, Taiwan.

Ishikawa, S. (1982), "Labour Absorption in China's Agriculture", in Ishikawa, S., Yamada, S., and Hirashima, S. (eds), *Labour Absorption and Growth in Agriculture: China and Japan* (Bangkok: ILO/ARTEP).

Liu, Chien-je and Fu, Yu-hsiu (1995), "An evaluation on Taiwan's FC", a research project supported by Taiwan Provincial Government, National Chung-Shing University.

Liu, Minquan (1994), "Farmland Consolidation in Taiwan", in Yi, Gang and Xu, Xiaonian (eds), *Taiwanese Experience and Economic Reforms in Mainland China* (Beijing: Zhongquo Jingji Chubanshe) (in Chinese).

Liu, Minquan (2001), "Sustained Agricultural Growth and Economic Structural Change: Some Reflections on Farmland Consolidation Programmes in Taiwan and Mainland China", Conference Proceedings, vol. 3, International Conference on Urbanization in China, Challenges and Strategies of Growth and Development, Xiamen, China, June 2001.

Liu, Minquan, Liu, Tru-Gin and Wu, Ziping (1998), "Farmland Consolidation in Mainland China and Taiwan: Impacts and Implementation", a report to Department for International Development, UK

Nickum J. E. (1978), "Labour Accumulation in Rural China and Its Role since the Cultural Revolution", *Cambridge Journal of Economics* 2: 273-86

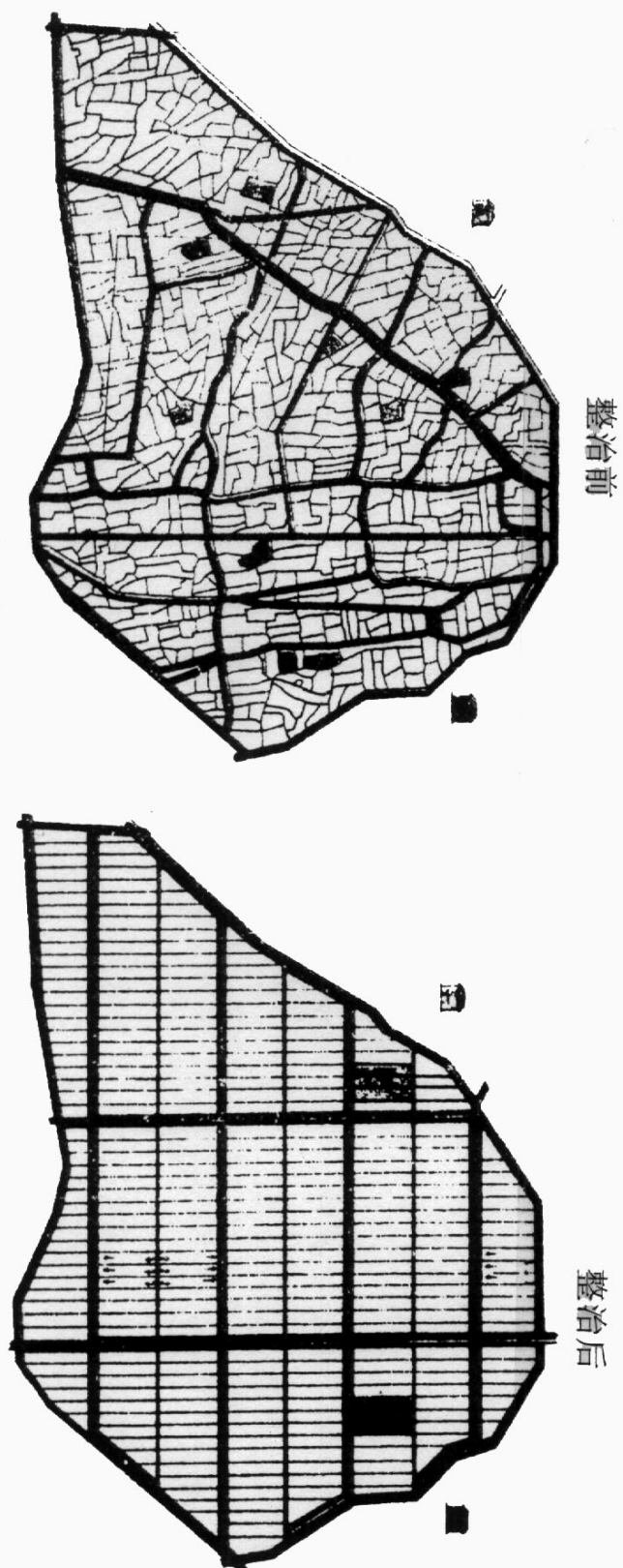
Perkins, D. H., and Yusuf, S. (1984), *Rural Development in China* (Baltimore: John Hopkins University Press).

Rawski, T. G (1979), *Economic Development and Employment in China* (Oxford: Oxford University Press)

Ullrich, C. (1979), *Rural Employment and Manpower Problems in China* (New York: M.E. Sharpe Inc.)

图 A1:

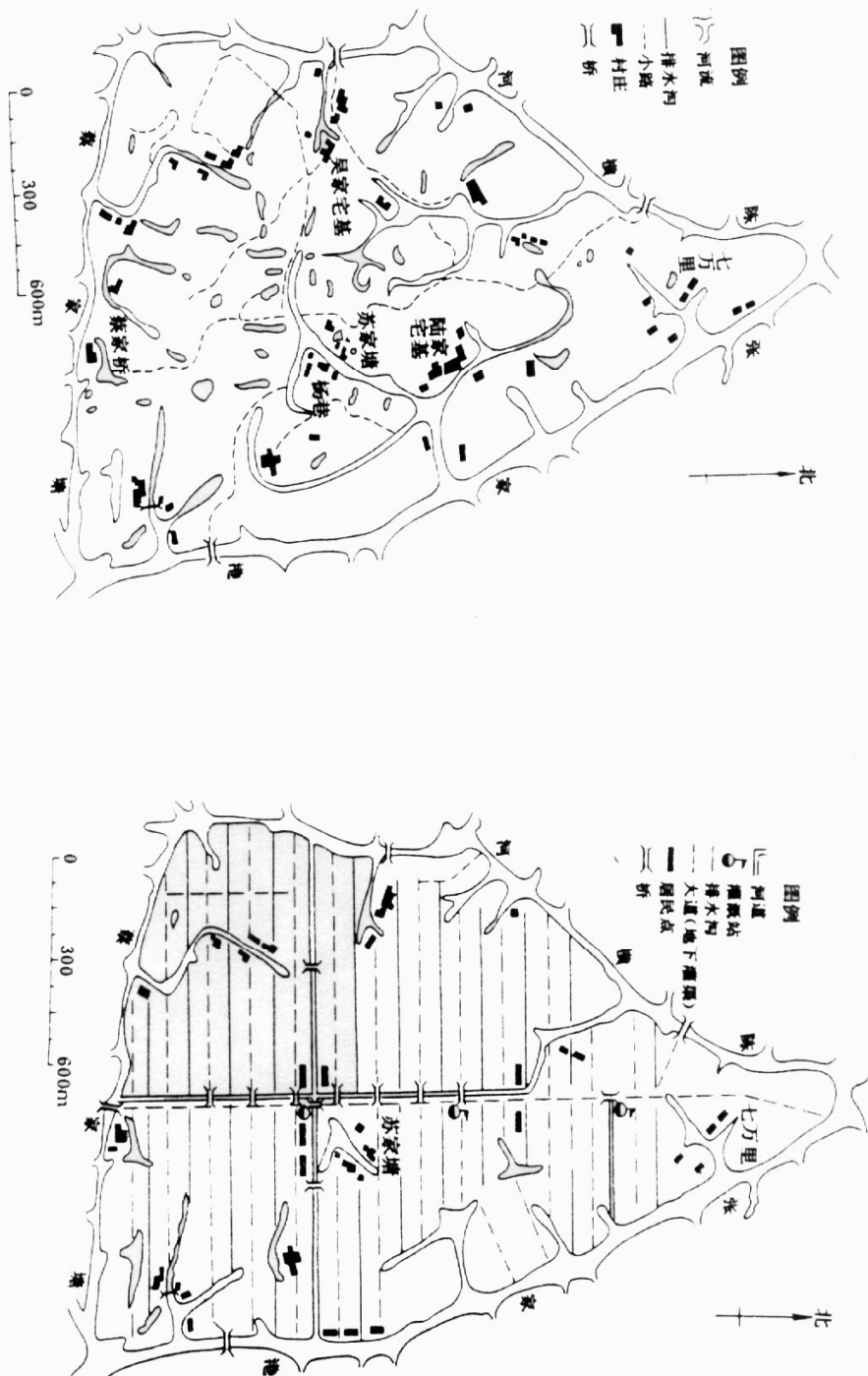
台湾某农地整治区整治前后的地块道路情况比较



资料来源：谢智荣（1993）

图 A2:

江苏常熟市某村农地整治前后的地块、灌排和道路情况比较



资料来源：常熟水利志（1990）

Fig A3.1 Shares of Gross Domestic Product (GDP) by sector

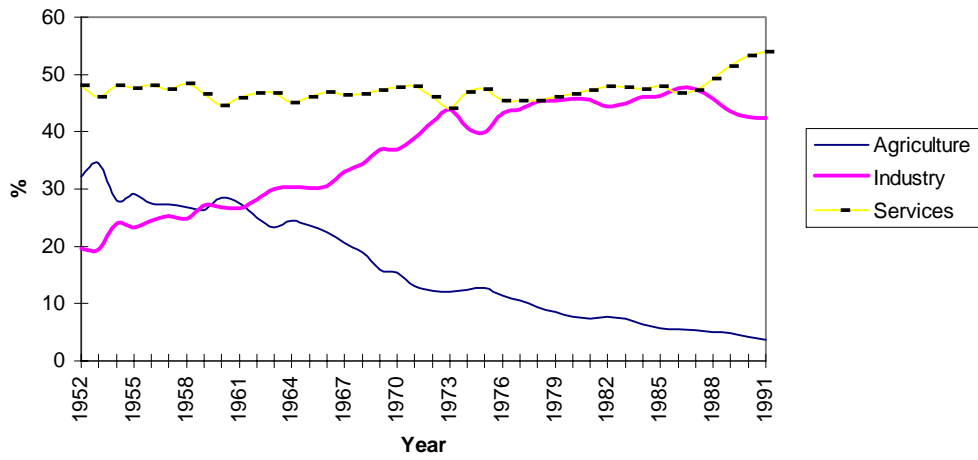
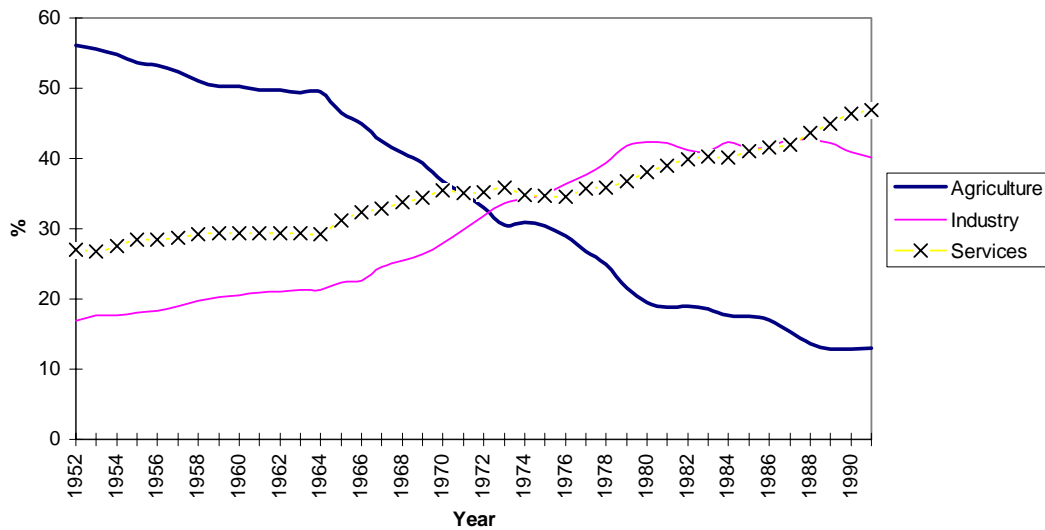
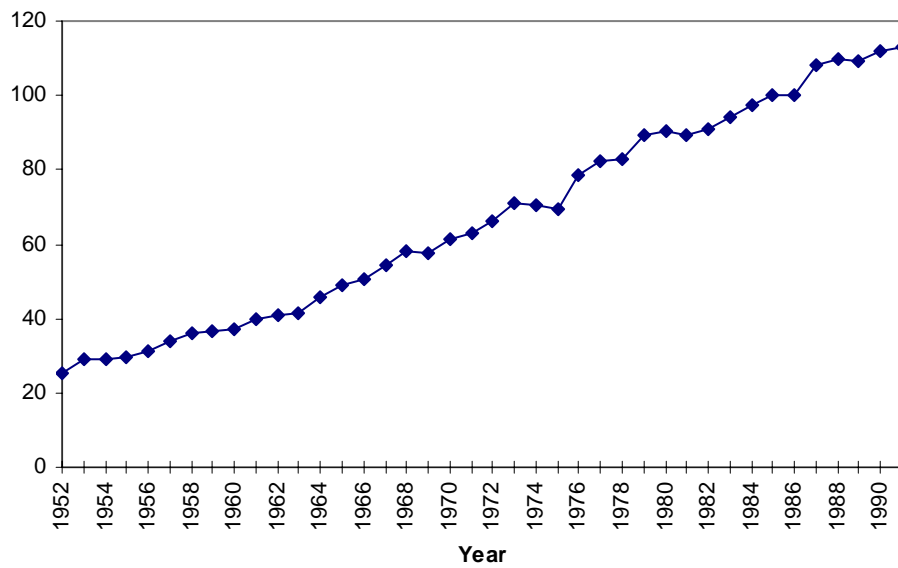


Fig A3.2 Employment by sector in Taiwan (1952-91)



Source: Liu et al. (1998).

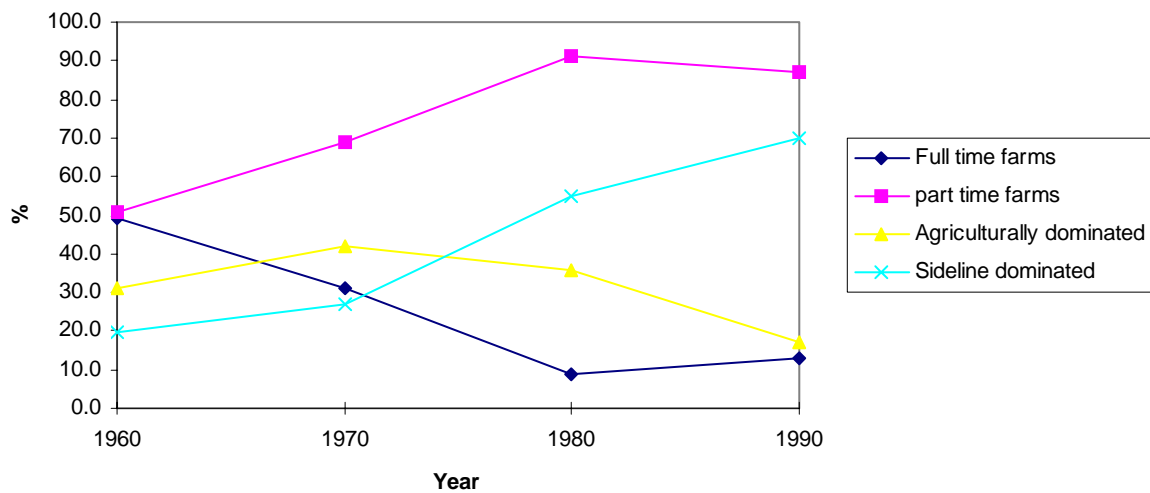
**Fig A4 Agricultural production indices in Taiwan
(1986=100)**



Source: Liu et al. (1998).

Note: Agriculture here includes crops, forestry, fishery and livestock production.

Fig A5 Farm households by category



Source: Liu et al. (1998).

Note: In Taiwan part-time households are those with one or more members working outside the household farm for over 30 days. Among these households those whose income from agricultural sources exceeds 50% are classified as *agricultural* part-time farmers, and the rest *sideline* part-time farmers.

Table A1 Taiwan's farmland consolidation projects (up to 1995)

year	name of project	no. of localities	(1) planned areas(hec.)	(2)realized areas	(2)/(1) (%)
First phase					
1958-59	FC experiments	2	525	525	100.00
1960	FC in the flood-afflicted areas	9	817	817	100.00
1961	FC demonstrations	11	3,362	3,225	95.93
1962-71	First 10-year FC project	443	300,000	249,176	83.06
Second phase					
1972-77	Rural construction and recovery project	22	-	3,349	-
1976-81	6-year economic construction	40	20,000	18,521	92.61
1981-85	5-year FC-promotion project	93	100,191	60,970	60.85
1988-97	Waterway and farm road renewing project	178 (1988-95)	32,000 (1988-95) 42,000 (1988-97)	32,048 (1988-95)	100.15
1992-95	Farm road mending and improving project in FC zones		2,400 km	2,796.4 km	116.52

Source: Liu Chien-jer and Fu Yu-hsiu (1995), "An evaluation on Taiwan's FC", Taiwan Provincial Government and National Chung-Shing University, pp.42; quoted in Liu et al. (1998).

Table A2: Categories of projects covered by CAD funds, Mainland China

Project	Covered uses	Main Engineering Items
Land Consolidation	1. Low and Medium Yield Farmland (LMYF) upgrading 2. Land Reclamation 3. Land Forestry protection belt 4. Grassland 5. Agricultural machinery 6. Extension of Agri. Techniques 7. Others	1.1 Irrigation: reservoirs, canals, irrigation stations, roads, underground pipes, electricity equipment 1.2 Agricultural measures: soil improvement, production base for high quality seeds 1.3 Others 2.1 The same as in LMYF project 3.1 Farmland belt 3.2 Forest seed base 4.1 Fenced natural grassland 4.2 Man-made grassland 5.1 Tractors 5.2 Other farming machinery 5.3 Tools 6.1 Technical training 6.2 Equipment 6.3 Model farm subsidies 6.4 Research
Diversified Economic Development (DED)	1. Diversifies Economy 2. Pump-priming project 3. Vegetable Basket Engineering 4. Crop stem to Feed Cattle 5. Others	1.1 Cash forestry 1.2 Aquatic breeding 1.3 Animal breeding 1.4 Green house vegetables 2.1 Investment in capital construction 2.2 Supplementary working capital 2.3 Others 3.1 Infrastructural construction 3.2 Development of new varieties 3.3 Technical extension 4.1 Ammoniation equipment 4.2 High quality breeding stock 4.3 Technical extension 5.1 Production equipment 5.2 Technical extension

Source: Liu et al. (1998)

Table A3: Funds for CAD from various sources, Mainland China (unit: 10,000 yuan)

Year	Central govt.	Regional govt.	Farmers' contribution	Bank loans	Others	Total
1988-90 ^p	230500	188629	79704	170287	23659	692778
1988-90 ^f	144800	112834	213859	112824	39588	623904
(%)	(23)	(18)	(34)	(18)	(6)	(100)
Fulfilled as % of the planned	63	60	268	66	167	90

Sources: Liu et al. (1998)

Notes: (1) ^p and ^f refer to planned and fulfilled fund contributions, respectively.(2) Of the local budgetary contributions, the provincial government was required to provide at least 70% and the remaining 30% would be covered by the local city (*shi*) and county governments of the programme areas.**Table A4: Planned and fulfilled land consolidation targets under the CAD Programme, Mainland China** (unit: 10,000 mu)

	Farmland upgrading	Land reclamation	Forestry	Grassland
Planned:				
1988-90	5059	732	377	280
1989-91	1988	166	145	9.6
1990-92	972	49	338	138
1988-92	8019.1	947.7	859.8	427.6
Fulfilled:				
1988-90	4483.14	646.37	352.98	209.16
1988-92	10848	1511	1565	459
1988-94	14800	1892	2400	900
Fulfilled as % of the planned:				
1988-90	88.6	88.2	93.7	74.7
1988-92	135.3	159.4	182	107

Source: Liu et al. (1998)

Note: A national level sub-programme normally lasts for three years. The first sub-programme took place in the period 1988-90.