3. Literature Review: Performance in Centrally-planned Agriculture

3.1 Introduction

The purpose of this chapter is to review the literature on empirical analyses of efficiency and productivity issues in agriculture in centrally-planned economies. This review is based on English language publications. A survey of these shows that not many studies have been conducted on this topic. Due to the methodological differences used in various studies and the heterogeneous natural conditions which prevail across former centrally-planned economies, it was difficult to compare the studies. However, an attempt is made, in broad terms, to demonstrate the methods employed, the data used and the major productivity and efficiency findings in the literature on centrally-planned agriculture.

The chapter is organised as follows. Section 3.2 begins with a theoretical discussion of centrally-planned agriculture from efficiency and productivity perspectives. Section 3.3 reviews the empirical studies on productivity issues in centrally-planned agriculture. Section 3.4 reviews efficiency-related studies of centrally-planned agriculture. Finally, Section 3.5 summarises the overall findings and draws conclusions.

3.2 The Performance of Socialist Farming: Productivity and Efficiency Aspects

Poor efficiency has been traditionally connected with low competitive pressure (Hicks, 1935; Alchian and Kessel, 1962) and ownership form (Alchian, 1965).

Theoretical arguments for the lower efficiency of centrally-planned economies compared to that of market economies dates back to Hayek (1935) and Keynes (1936). Although the theoretical plausibility of a centrally-planned system was not denied, the large costs of gaining the information required for a centrally-planned system was seen as prohibitive, thereby yielding less economic efficiency compared to a decentralised market economy (Hayek, 1935).

For instance, Keynes (1936, p. 380) wrote:

> *The advantage to efficiency of the decentralisation of decisions and of individual responsibility is even greater, perhaps, than the nineteenth century supposed; and the reaction against the appeal to self interest may have gone too far... The authoritarian state systems of today seem to solve the problem of unemployment at the expense of efficiency and freedom.*

Since then a large number of hypotheses have been put forward to explain the slowdown and ultimate collapse of the centrally-planned economic systems – see Easterly and Fisher (1995). Among them, lack of efficiency and technical change have often been suggested as the major deficiencies of the system (Bergson, 1987; Offer, 1987). The performance of centrally-planned economies has been found to be inferior relative to market economies (Moroney and Lovell, 1991).

With regard to socialist farming, similar arguments were made (Gregory and Stuart, 1981; Ellman, 1981; Brooks, 1983; Brooks *et al.*, 1991, Johnson *et al.*, 1994). For instance, Gregory and Stuart (1981), in the case of Soviet agriculture, argued that poor managerial bonuses and worker wage systems, wrong investment decisions, and the lack of incentive to develop and introduce new technology inevitably led to low technical and allocative efficiency.[1] Brooks *et al.* (1991, p. 152), with reference to centrally-planned agriculture in Eastern Europe and the Soviet Union, suggest:

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[1] There is an extensive debate in the literature about the importance of technical vs. allocative inefficiency in centrally-planned economies. For instance, Whitesell (1990) argued that technical inefficiency is far more important than allocative inefficiency in Soviet economy, Nove (1991) pointed out to the evidence of substantial allocative inefficiency in Soviet economy, but said that it is difficult to capture them in any formal modeling framework and measure them effectively. Overall, the debate seems remaining open.

> *Poor incentives and relatively low capital stock per worker in stylised economy reduced labour productivity. ... The capital/labour ratio in socialist agriculture is lower than in developed market economies, and this reflects inefficiency of investments...*

Thus, most theoretical discussion appears to be in agreement. However, the actual empirical studies conducted on centrally-planned agriculture have yielded ambiguous results. These are discussed in the next two sections.

3.3 Productivity Studies

This section reviews empirical studies of productivity in centrally-planned agriculture.

Wyzan (1981), using aggregative panel data for the 15 Soviet Republics for the period 1960 to 1976, estimated translog production functions for five separate crops (grain, sugar beet, cotton, potatoes and vegetables). His main finding was that the Soviet decisions on agricultural production were technologically well-founded, contrary to the conventional views which prevailed. Technical change as a proxy for productivity change was positive and significant. He also concluded that the high elasticity of substitution between land and labour in grain production, accompanied by faster-growing investments, demonstrates that the programme was based on sound technological grounds. He found that 12 out of 15 elasticities of substitution between land and labour or capital (for different crops) were greater than one. This implies that the relative increase in capital use was larger than the decrease in its marginal productivity, thus giving more potential for further output growth by increasing capital use.

Brooks (1983) estimated the total factor productivity (TFP) of Soviet agriculture based on 15 separate republics together with 14 States of the USA, Canada and Finland which have comparable climatic conditions. She estimated the TFP of Soviet and non-Soviet agriculture using an econometric approach involving a simple Cobb-Douglas production function for the pooled Soviet and non-Soviet data. The difference between Soviet and non-Soviet TFPs for agriculture was captured by using separate dummy variables to give different intercept terms. The study covered the period 1960 to 1979 and the empirical results indicated that the productivity level in the USA and Canada was about double that of comparable areas of the Soviet Union. She concluded that the difference between the two TFPs was mainly due to differences in labour productivity (i.e., output per worker), not to land productivity (i.e., yield per unit of land). An interesting conclusion by Brooks (1983, p. 197) was that:

> *... Substantial narrowing of the productivity gap between Soviet agriculture and its western counterpart will require not only increased investment in human capital in rural areas, but major changes in the management and supervision of farm labour, as well as achievement of a much closer relationship between individual productivity and pay or reward.*

This implies that technical progress and issues associated with efficiency improvement should be addressed. It was also concluded that climatic factors were not the major cause of the Soviet poor agricultural performance as conventionally believed.

Wong (1986) used a growth accounting approach to estimate agricultural TFPs of nine socialist countries. The data covered national-level aggregate output and input data for the period 1950 to 1980. After estimating a Cobb-Douglas production function, he used the estimated production elasticities of the different inputs to construct a geometric productivity index. The assumption underlying this approach was a competitive equilibrium and constant returns to scale. Contrary to the strong upward trend in partial factor productivities of major inputs, Wong (1986) found that the TFPs were declining, implying that the increases in land and labour productivities were at the expense of TFP. This implied that there were serious inefficiencies associated with misallocations of resources in the socialist agricultural system. However, he was not able to separate the various effects of productivity change and stated: "... these analyses indicate that technical change makes little net contribution to the process of agricultural growth" (Wong, 1986, p. 109).

Lazarcik (1988) used a growth accounting approach to estimate partial factor productivity (PFP) and combined factor productivity (CPF) of agriculture in the six Eastern European countries: Bulgaria, Czechoslovakia, German Democratic Republic, Hungary, Poland and Yugoslavia. The national-level data covered the period 1965 to 1983. This data set was divided into the two periods, 1965 to 1975 and 1976 to 1983. The combined factor productivities for the two time periods were calculated using a geometric index. The principal finding of this study was that the combined factor productivity increased in the first time period but decreased in the second time period. In the first period, all partial productivity indicators (land-, labour- and capital-productivities) increased in the six countries. In all the countries except Poland, the TFP increased at a rate of about one per cent or more annually during 1965 to 1975. While the annual TFP of Yugoslavian agriculture rose by two per cent, the TFP of Polish agriculture decreased slightly. For the period 1965 to 1975 the TFP of agriculture in Eastern European countries increased by a total of 11 per cent. In the period, 1976 to 1983, the largest increase in TFP was for Yugoslavian agriculture, estimated to be 20 per cent. The agricultural productivities of the rest of the centrally-planned economies slowed down. For instance, productivity fell by three per cent in Czechoslovakia, six per cent in the German Democratic Republic and 13 per cent in Poland. As a whole, there was no improvement in the productivity of Eastern European countries in the period 1976 to 1983. Productivity slowdown in these countries was attributed to setbacks in the application of new technology on farms, a sharp decline in the import of feed, a shortage of hard currencies, a certain degree of re-centralisation in management and a consequent decrease in incentives.

Using a growth accounting approach, Fan (1991) analysed Chinese agricultural production and decomposed agricultural growth into three elements: technical change, efficiency change and input change. He estimated a stochastic frontier production function (generalised Cobb-Douglas frontier production function) using panel data for 29 provinces for the period 1965 to 1985. Efficiency change was represented by the changes in distances of individual farms from the production frontier and non-neutral technical change was represented as shifts in the production frontier over time. His main finding was that the household responsibility system introduced by the economic reform of 1979 had a significant impact on the efficiency of Chinese agriculture. The decomposition of production growth showed that 57.7 per cent of growth was attributed to input growth and the remaining 42.3 per cent was due to productivity increase. In productivity change, efficiency improvement dominated technical change, suggesting that further potential productivity increase could be made by accelerating technical progress.

Gemma (1991) used both growth accounting (arithmetic and geometric indices) and econometric approaches (involving a Cobb-Douglas production function) to estimate the TFP growth for both private and socialised farms in Poland. Two sets of aggregative data, one for socialised agriculture and one for private agriculture, for the period 1950 to 1986 were used in the study. The main finding of the study was that productivity change showed a cyclical pattern, reflecting different policy changes. But there were no significant differences in productivity between private and socialised agriculture. The post-Stalinist period beginning in the early 1960s was initially favourable for increased productivity. But this period was replaced by a period of relative stagnation of productivity growth at the end of the 1960s. TFP then increased until the mid-1970s after which it fell again. A new economic system introduced at the beginning of the 1980s helped boost agricultural production until confronted by the global economic crises of the mid-1980s. The conclusions drawn from the two different approaches (growth accounting and econometric) were similar.

3.4 Efficiency Studies

Boyd (1987) employed an econometric approach involving the estimation of production functions in a comparative analysis of socialised versus private farming in Yugoslavia. He estimated Cobb-Douglas production functions for the socialised and the private sectors using data for eight regions over the period 1956 to 1979. Using dummy variables for different regions (to account for differences in natural endowment) and time periods, he established that the efficiency level in the socialised sector was higher than that in the private sector. The overall findings were: socialised agriculture is not inherently less productive than its private counterpart; producers of both sectors were responding to their environments and the existing policies in a similar way; and that socialist farming is quite capable of introducing technical advances.

Koopman (1989) analysed the efficiency levels of Soviet agriculture using a stochastic frontier production function framework. Two data sets separately collected at the republic-level were used, one for agriculture of 15 Soviet republics collected from the official Soviet statistics, the other covering agriculture sectors of 15 Soviet republics, 10 U.S. States, four Canadian Provinces, and Finland – the same data set as used by Brooks (1983). The Soviet data covered the period 1964 to 1985. The primary reason for using the two independently collected data sets was to check the robustness of the technical efficiency estimates and also to enable a comparison of technical efficiency between Soviet and non-Soviet agriculture (Koopman, 1989, p. 5). Cobb-Douglas and translog functional forms were used in the study. A time variable was introduced in the main function as a proxy for Hicks' neutral technical change. The principal findings of the study were the following:

1) The efficiency level of Soviet agriculture was relatively high (0.926) contrary to conventional belief. However, some variations in efficiency levels between the republics within the Soviet Union were observed.

2) There were no substantial differences in efficiency levels between the Soviet Union and its western counterparts (0.926 versus 0.915).

Thus it was concluded that the growth difference between the two sets of agriculture (Soviet and Western) lay not so much in efficiency levels as in the lack of technical change in Soviet agriculture. He then argued that the lack of technical change in Soviet agriculture could be explained in terms of the induced innovation theory proposed by Hayami and Ruttan (1971).

Koopman (1990) also conducted a technical efficiency analysis of Soviet cotton production using both stochastic frontier and average production function frameworks. He used a translog functional form with Hicks-neutral technical change for oblast (region) level data for the period 1978 to 1985. In contrast to his previous global study of Soviet agriculture (Koopman, 1989), he found substantial inefficiencies in Soviet agriculture. The average efficiency of Soviet cotton production was found to be 0.860. The calculation of marginal productivities of individual inputs suggested that in Soviet cotton farming, while labour and machinery are used rationally, land is used not rationally. Furthermore, the relatively high elasticity of substitution between major inputs implies that the technological structure of Soviet cotton farming supports their long-term development plans.

Hofler and Payne (1993) extended Boyd's (1987) analysis of Yugoslavian farming with a different analytical framework - a stochastic frontier production function - and came to a different conclusion. Using the same data set as Boyd (1987) and employing Cobb-Douglas production functions, they concluded that the efficiency level in private farming was higher than in the socialised sector, although the technology frontier was determined by the socialised sector. This implies that technical change comes from the socialised sector, although the private sector produced closer to the frontier on average. Hofler and Payne (1993) also reported that the poorer regions were less efficient than the wealthier regions, implying that the less developed republics could not absorb the substantial resource allocation transferred to them from the Central Government at the time. The overall average efficiency score was 0.929 for private farming and 0.889 for the socialised sector.

Brada and King (1993) conducted a comparative efficiency analysis on socialised and private farming in Poland using a deterministic frontier production function framework. A translog production frontier was estimated by a mathematical programming technique in which the restriction of constant returns to scale was imposed to avoid the interpretational difficulties associated with the results because farm-level data were not available for the analysis. They used panel data aggregated for 17 counties over the period 1960 to 1974. Their analysis assumed that any differences in efficiency between the two types of farming systems, given that all other variables were constant, could be attributed to the difference in the nature of the two systems: any efficiency difference could be associated with the internal organisation and the farm structures of the two different types of farms. On the other hand, any differences in allocative efficiency[2] could be attributed to the farming policy and mechanisms of prices or allocations of inputs. The results obtained did not show any systematic differences in technical efficiencies between the two ownership forms: the mean technical efficiency was 0.637 for the state farms and 0.617 for the private farms. However, there were considerable differences in allocative efficiency within the two farming systems, implying that the poor performance in agriculture was not due to its socialised nature but rather to the policy environment and the failure of the bureaucratic input-distribution system. The main implication of this study was that, by current mass privatization, one can hardly expect a considerable increase in efficiency and productivity. However, higher productivity gains could be achieved by allowing a free flow of resources between the socialised and private sectors, and by correcting the distorted input markets.

Tran *et al.* (1993) conducted a technical efficiency analysis of Vietnamese state rubber farms using stochastic frontier analysis. They used the Cobb-Douglas functional form for the 34 rubber farms for the period 1986 to 1990. They found statistically significant inefficiencies in the Vietnamese rubber farms. The average efficiency for that period was 0.590 and any statistically significant time trend in the efficiency was not established. However, it should be noted that he did not take into account the effects of possible technical change in the frontier model.

An interesting comparative efficiency analysis was conducted by Carter and Zhang (1994) in which the growth accounting approach was employed to analyse the agricultural labour and land productivities of nine centrally-planned economies: Bulgaria, Czechoslovakia, German Democratic Republic, Hungary, Poland, Romania, Yugoslavia, Soviet Union and People's Republic of China during the time periods 1965 to 1977 and 1978 to 1989. In this analysis, after

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[2] The allocative efficiency here is associated with resource allocation, which in its turn is influenced by the policy environment, input distribution system etc. The authors called it "economic efficiency" in their paper.

taking account of the contribution of inputs to output growth, the residual is identified as inefficiency. Carter and Zhang (1994) used input elasticities estimated from a Cobb-Douglas meta-production function as factor shares which were used for estimating efficiency. This approach implicitly assumed competitive equilibrium and constant returns to scale. The main finding of the study was that the production slowdown in the second period, 1978 to 1989, was due to a slowdown in the growth of essential inputs, particularly fertiliser. Contrary to common belief, the efficiency levels in all countries increased. This implies that, in order to attain higher efficiency, farm privatization may not be necessary. It also perhaps explains the reason why many farm cooperatives have remained since the political and economic reforms of previously centrally-planned economies started in the early 1990s.

The study of Ukrainian agriculture by Johnson *et al.* (1994) using micro-level data on 11 440 state and collective farms for the six-year period 1986 to 1991 and a stochastic frontier production function with time-varying inefficiency effects model found that technical inefficiency increased over the period. The average technical efficiency of all crop farms was 0.714. In addition, technical change was shown to be either not significant or negative. This finding of regressive technical change and increasing technical inefficiency supports the need for the radical economic reform which is currently being carried out. Johnson *et al.* (1994) found considerable variation in the level of technical efficiencies of the farms. This implies that, with the existing technology, there is a considerable potential for improving farm efficiency, perhaps by institutional reform. The lack of evidence for economies of scale suggests that there is no support for breaking up existing large farms to improve efficiency.

Brock (1996) studied the efficiency of Russian agriculture using micro-level data on 320 state and collective farms in Volgograd Province for the period 1988 to 1990. He used a stochastic frontier production function with time-varying inefficiency effects model. The results suggest that the average technical efficiency of all crop farms was 0.714 and the efficiency was decreasing over time. A considerable variation in the levels of technical efficiencies of the farms within the same soil/climatic regions was also observed. Land quality, access to transportation and state procurement had little effect on farm performance. Also, it was found that diseconomies of scales were observed in the state and collective farms during the study period. However, no significant difference was found in the mean efficiency levels between state and collective farms. A zero technical change was assumed in his study as it covered a relatively short time period (1988-1990).

Elasticity-of-Substitution Debate

Although not related to agriculture, a few other studies conducted on former centrally-planned economies should be noted as they are of particular relevance to the current study.

The dominant explanation for the Soviet economic slowdown until the beginning of radical economic reforms in the early 1990s is that the Soviets relied excessively upon an extensive growth policy, that is, increasing capital investment along with a declining marginal productivity of capital, and a stagnant or moderate growth of labour which eventually caused economic stagnation – see Ofer (1987). This hypothesis was first put forward by Weitzman (1970) for the case of the Soviet industrial sector. The suggestion was elaborated and empirically supported by Desai (1976) and Rosefielde and Lovell (1977) for the Soviet industrial sector and was generalised to the whole Soviet economic sector by Easterly and Fisher (1995). Weitzman's main argument was that the Soviet industrial sector had an elasticity of substitution between capital and labour significantly less than one and that therefore a constant elasticity of substitution (CES) functional form better describes the Soviet industrial sector than a Cobb-Douglas functional form which assumes the elasticity of substitution between inputs to be one. This implies that with a constant increase of the capital-labour ratio, the on-set of diminishing returns to capital caused a decline in the relative capital share in the production function, thus causing a slowdown in production growth. Easterly and Fischer (1995) used the CES production function and made an extensive comparison with other national economies. Their main finding was that after controlling for input contribution in output growth, Soviet economic growth was disappointingly low in comparison with other countries and the main cause of the Soviet economic slowdown was not the productivity slowdown but a low elasticity of substitution between capital and labour, implying acutely diminishing returns to capital. The testing of this hypothesis for centrally-planned agriculture could be very relevant given that agriculture in centrally-planned economies generally involves large-scale production with investment and labour policy similar to that for the industrial sector. This hypothesis has not been tested vigorously in centrally-planned agriculture, except in Wyzan's (1981) work, in which the finding was the reverse of the conclusions of Weitzman and others for the case of industrial production or the overall economy.

3.5 Summary and Conclusions

Most of the studies conducted so far on the efficiency and productivity of centrally-planned agriculture were done either by way of international comparison or at a highly aggregative national level (see column 2, Table 3.1) except for a few recent studies.[3]

The majority of productivity studies reviewed here used a time trend as a proxy for neutral technical change (see column 4, Table 3.1) and ignored the efficiency component of TFP (see column 5, Table 3.1). Furthermore, most efficiency-related studies assumed constant (as opposed to time-varying) efficiencies - exceptions are Johnson *et al.* (1994), Tran *et al.* (1993) and Brock (1996). This assumption of time-invariant efficiency can be particularly inappropriate when a study covers relatively longer time periods.

In many cases, the growth accounting approach (with an implicit assumption of competitive input and output markets) was used. This assumption is not realistic for centrally-planned agriculture. In the econometric approach, most researchers have used the simple Cobb-Douglas functional form without a priori justifications (see column 4, Table 3.1). By imposing such strict restrictions on functional

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[3] Only a few recent stochastic frontier-based studies on centrally-planned agriculture, including those of Tran *et al.* (1993), Johnson *et al.* (1994) and Brock (1996), have used farm-level data.

forms, one cannot satisfactorily investigate important technological aspects such as scale economies, technical change and factor substitution without obtaining possibly biased results and misleading conclusions.

In the context of centrally-planned economies, the use of more general functional forms is of particular importance given the fact that in a few past studies, shifting from simple to more complex functional forms often reversed the research findings – see Weitzman (1970), Desai (1976) and Easterly and Fischer (1995).

Although the main argument for pushing the current radical economic reforms (post 1990) in ex-centrally-planned agriculture has been poor efficiency and productivity performance in the pre-reform period, this literature review of that period does not provide strong and unambiguous evidence for deteriorating productivity and efficiency trends. Exceptions are Johnson *et al.* (1994) and Brock (1996), where some deterioration in farm performance was found in the late 1980s and early 1990s. Most studies found that there was a large variability in productivity and efficiency levels and that these levels appeared responsive to changing policy environments. There was less evidence on structural, global decay of socialised farming. Comparative studies on socialised versus private farms within the former centrally-planned systems did not give clear evidence of one being superior to the other. Although a few comparative studies on centrally-planned versus market economies gave a significant disparity in efficiency and TFP, the results were sensitive to the choice of methodology – for instance, Boyd (1987) and Hofler and Payne (1993) in the case of Yugoslavia and Brooks (1983) and Koopman (1989) in the case of the Soviet Union. It is notable that only one study (Fan, 1991) of productivity and efficiency in centrally-planned agriculture has so far decomposed the productivity change in terms of its separate components of technical and efficiency change. However, Fan did not explicitly model changes of efficiency, instead he first estimated annual efficiency scores of individual farms and then calculated the annual percentage changes in efficiency.

Technical change has always been considered as a proxy for productivity change; efficiency change was treated separately (Lovell, 1993). Recent developments in the productivity measurement literature have enabled researchers to decompose productivity change into technical change and efficiency change, thus adding another dimension to productivity measurement (Lovell, 1995). Each of these elements of productivity have different sources of change and different policy implications. Omitting one or more of them may bias the results and give ambiguous conclusions (Grosskopf, 1993). It should also be noted that so far only one study (Brock, 1996) has attempted to investigate the sources of efficiency variation.

Surprisingly, no study has yet involved Mongolia, despite the fact that there was a close similarity of production technology and farm structures between crop farming in Mongolia and the rest of the centrally-planned agricultures. Furthermore, successive attempts at gradual policy reform and technological renovation that have taken place in the last two decades in Mongolian agriculture have closely followed those in the centrally-planned economies of Eastern Europe and former Soviet Union. It is thus expected that an analysis of productivity and efficiency using farm-level production data for Mongolian agriculture could give valuable evidence on agricultural development during the pre-reform period in both Mongolia and other former centrally-planned economies. It is also expected that this information will be useful for setting policy during the ongoing post-1990 radical economic reform of Mongolian agriculture that is presently underway.

Table 3.1 Productivity and efficiency studies of centrally-planned agriculture

Country	Reference	Period covered	Data used	Methodology	Functional forms used/assumed	Technical change	Efficiency component
I. Productivity Studies							
Soviet Union	Wyzan (1981)	1961-1976	Republic level	Econometric approach	Translog	Hicks neutral	Ignored
Soviet Union	Brooks (1983)	1960-1979	Republic level	Econometric approach	C-D	Hicks neutral	Ignored
Nine socialist countries*	Wong (1986)	1950-1980	Country level	Index number approach	Implicit C-D[a]		Ignored
Six socialist countries*	Lazarcik (1988)	1965-1983	Country level	Growth accounting approach	Implicit C - D		Ignored
Poland*	Gemma (1991)	1950-1986	Regional level	Econometric and index number approaches	Implicit C-D	Hicks neutral	Ignored

Table 3.1 (Continued)

China	Fan (1991)	1965-1985	Province level	Econometric approach	Generalised C-D	Hicks neutral	Included
II.Efficiency Studies							
Yugoslavia	Boyd (1987)	1956-1979	Regional level	Econometric approach	C-D	Hicks neutral	Static
Soviet Union vs. USA, Canada and Finland	Koopman (1989)		Republic level	Econometric approach	C-D	Hicks neutral	Static
Soviet Union	Koopman (1990)		Regional level	Econometric approach	Translog	Hicks neutral	Static
Yugoslavia	Hofler and Payne (1993)	1956-1979	Regional level	Econometric approach	C-D	Hicks neutral	Static

Table 3.1 (Continued)

Poland	Brada and King (1993)	1960-1974	County level	Mathematical programming approach (deterministic frontier)	Translog	Hicks neutral	Static
Vietnam	Tran *et al.* (1993)	1986-1990	Farm level	Econometric approach	C-D	Ignored	Dynamic (time-varying)
Nine socialist countries*	Carter and Zhang (1994)	1965-1989	Country level	Growth accounting approach	Implicit C-D	Hicks neutral	Static
Ukraine	Johnson *et al.* (1994)	1986-1992	Farm level	Econometric approach	C-D	Hicks neutral	Dynamic (time-varying)
Russia	Brock (1996)	1988-1990	Farm level	Econometric approach	C-D	Ignored	Dynamic (timc-varying)

Note: Those studies marked by * in the first column implicitly assumed competitive input and output markets which are irrelevant to the case of centrally-planned agriculture.

[a] C-D denotes Cobb-Douglas form.

4. Discussion of Mongolian Crop Farming and Data Sources

4.1 Introduction

The main objectives of this chapter are, first, to explore the farm structure and the development patterns of crop farming which prevailed in the pre-reform period 1976-1989 in Mongolia and second, to describe the data used in the empirical chapters of this study. In order to elucidate the actual problems of the farming sector and select adequate analytical methods, it is important first to describe the basic farming background and farm peculiarities of the pre-reform period.

4.2 Crop Farming in Mongolia

4.2.1 Crop land and topography

The country is divided into five principal agro-ecological regions as shown in Figure 4.1. The 1.3 mln ha of land suitable for crop farming represents only one per cent of the country's total land (United Nations Development Programme, 1992). The overall land suitable for crop production is distributed unevenly throughout the country (see Table 4.1). Most of the land suitable for crop farming lies in two major agro-ecological regions, the Selenge-Onon (46.5 per cent) and the Central and Eastern Steppe (34.8 per cent).

Land suitable for crop farming does not always match with actual cropping practices due to climatic factors including precipitation and length of growing season (United Nations Development Programme, 1992). The high slope of much of the better crop lands (up to 13° of slope) makes farming difficult (Asian Development Bank, 1992b).

Figure 4.1 Principal agro-ecological regions of Mongolia

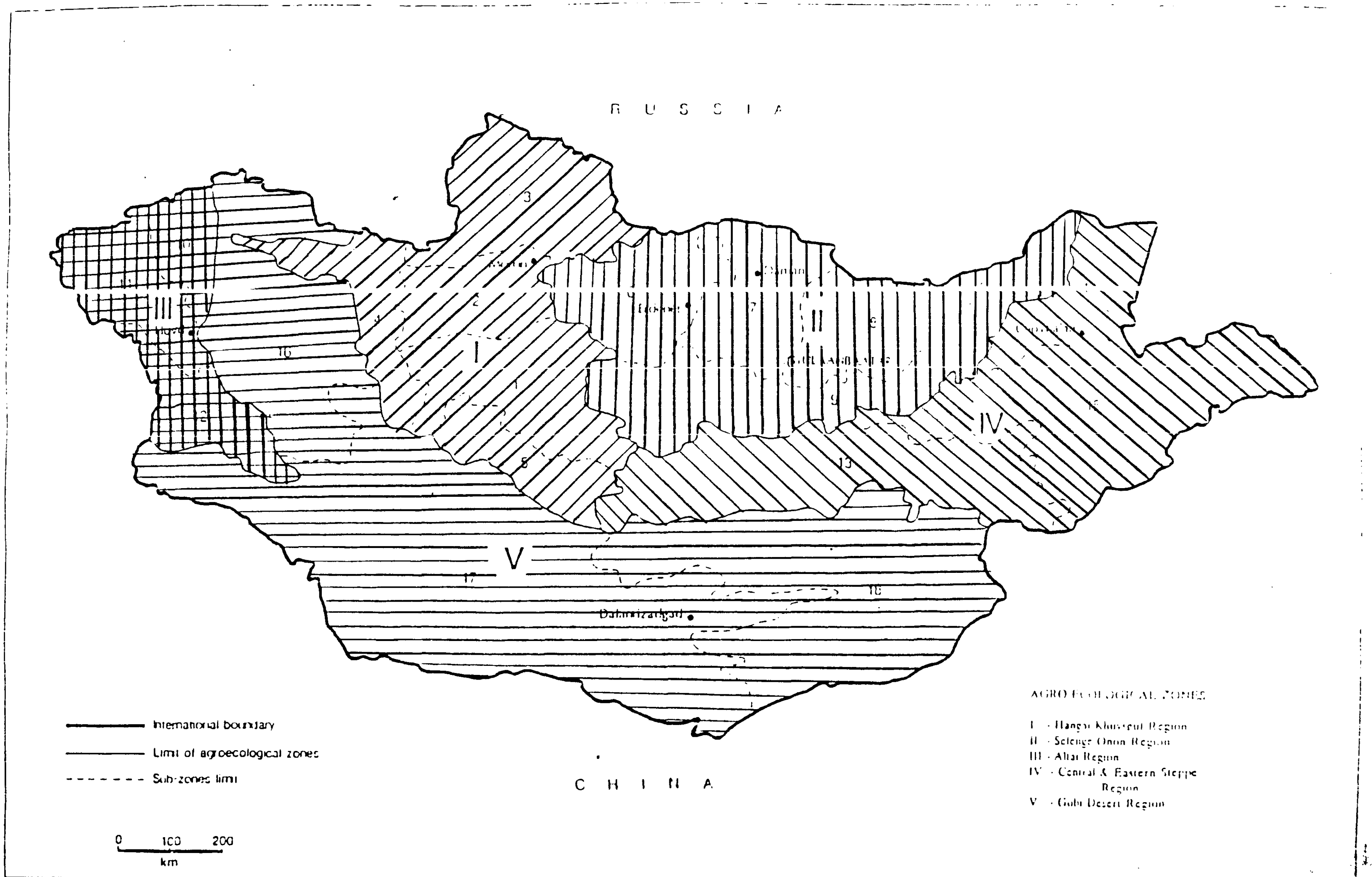


Table 4.1 Land assessed as suitable for crop farming

Agro-ecological region	Distribution of land suitable for crop farming (per cent)
Selenge-Onon	46.5
Central and Eastern Steppe	34.8
Hangai-Khuvsgul	9.7
Altai	6.9
Gobi Desert	2.1

Source: United Nations Development Programme (1992), Ulaanbaatar.

Climate and Soil

Low temperature, low precipitation and short growing seasons are the principal climatic features characterising agricultural production in Mongolia. The country has long and cold winters and short but warm summers. The annual average daily temperature varies between -5.4° C and +4° C. In terms of crop production, the level of incident energy is a major limiting factor. The annual average of sunny days in central agricultural provinces is around 270 and there are about 1 500 to 2 200 hours above 10° C (Ulrich, 1994).

The average annual precipitation in the main cropping areas varies between 250 and 350 mm, 70 per cent of which falls in the period between May and September (Chalmers, 1993). The growing season varies between 100 to 120 days depending on altitude and location (World Bank, 1995). The intermediate seasons of spring and autumn are short, and late spring and early autumn frosts occasionally cause crop losses of up to 30 per cent (United Nations Development Programme, 1992, p. 5).

The cropping regions are dominated by mollisol types of soils, which are similar to those of the great plains and prairies of North America. This type of soil is generally characterised as fertile with high organic matter (3 to 4 per cent) and mostly suitable for grain production. However, the light sandy structure of the soil makes it susceptible to wind erosion and its water retention capability is normally poor (Ulrich, 1994, p. 2). Due to a light snow cover in winter, the soil gets completely frozen. As a result, only spring crops are grown.

So it is the low and erratic precipitation and short growing seasons rather than soil quality which are the main climatic constraints in Mongolian crop farming (Ulrich, 1994).

4.2.2 Farming practice, farm structure and functioning

Under the centrally-planned system, the crop sector was organised as a pyramid system with highly centralised lines of authority (Sloane, 1990) . At the national level was the Ministry of Food and Agriculture. It consisted of technical (crop, livestock and veterinarian), economic, finance and planning departments. At the provincial level (Aimag), the Aimag Board of Agriculture was organised similarly with its branches corresponding to the Ministry of Food and Agriculture's technical departments (see Asian Development Bank 1994, p. 17). At the district level, state farms were the basic decision-making enterprises (Sloane, 1990).

State farms were also the principal crop producers of the country. In 1985 state farms accounted for about 81 per cent of the total national planted area (see Table 4.2) and produced over 50 per cent of the total national crop output (Ulziibat, 1992).

The focus of the present study are the 48 state farms producing grain and potatoes for human consumption.

In the period between 1960 and 1990, the number of state farms increased from 10 to 73[1] (United Nations Development Programme, 1992).

Table 4.2 Distribution of cultivated land between state farms and co-operatives, 1960-1990

Year	Total sown area (000 ha)	of which: State farms (per cent)	Co-operatives (per cent)
1960	265	78	22
1970	455	75	25
1980	704	79	21
1985	790	81	19
1990	786	N/A[a]	N/A

Source: State Statistical Office (1990), Ulaanbaatar.

[a] Not available

State farms were almost exact prototypes of the Soviet Sovkhozy (state farms) in terms of structure and functioning (Chalmers, 1993). State farms had multiple enterprises including crop, livestock and service activities as well as other

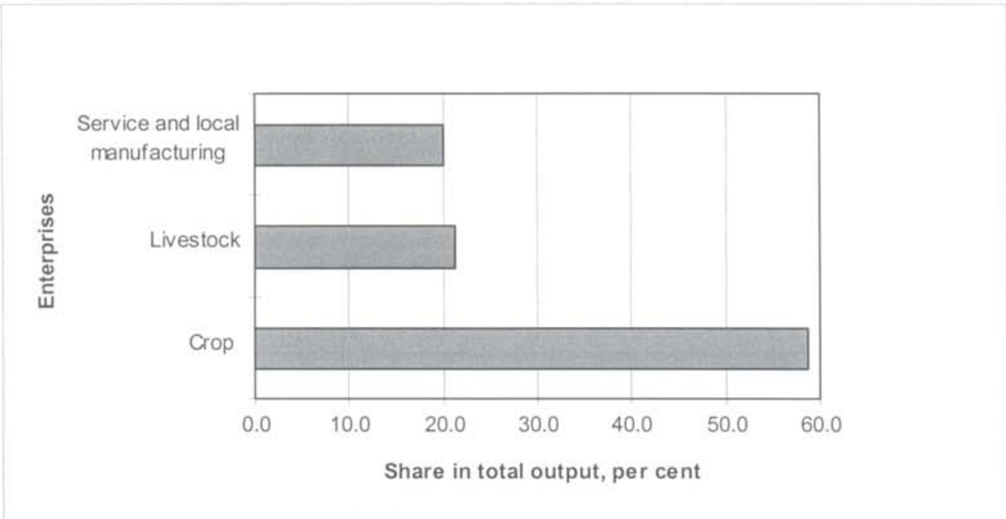
1 Of the total of 73 state farms in 1990, 48 were state farms primarily producing crop outputs for human consumption and the rest were so called fodder farms primarily built for producing animal feeds for agricultural co-operatives.

2 Of the total of 73 state farms in 1990, 48 were state farms primarily producing crop outputs for human consumption and the rest were so called fodder farms primarily built for producing animal feeds for agricultural co-operatives.

enterprises with social roles. The crop and livestock enterprises were again divided into sub-units specialised in individual commodities such as grain, potato, vegetable, sheep and cattle units, each of them having separate management and recording systems (United Nations Development Programme, 1992).

Within the multi-activity farming pattern of state farms, crop farming was a dominant sector representing 59 per cent of total farm output followed by animal husbandry occupying 21 per cent of total farm output (expressed in value terms) as shown in Figure 4.2. Other auxiliary units and service industries make up the balance. This pattern did not change throughout the 1980s (United Nations Development Programme, 1992).

Figure 4.2 Share of individual enterprises in total state farm output, average 1981-1987 (per cent)



Source: Ministry of Food and Agriculture (1989), Ulaanbaatar.

State farm sizes were large relative to most western farms (Sloane, 1990; Chalmers, 1993). For the period 1981 to 1989, an average state farm had 15 931 ha of crop land, 21 mln tgs of capital assets, 213 workers and produced 9 467 t of cereal, 1 425 t of potatoes and 501 t of vegetables (Table 4.3). However, the actual size varied substantially between farms. For instance, in 1987, the largest grain farm had 29 371 ha of land producing 29 999 t of grain, whereas the smallest grain farm had 801 ha of land and produced 841 t of grain (Ministry of Food and Agriculture, 1988).

In the period from 1981 to 1987, the average size of a state farm decreased in terms of area of crop land but increased in terms of capital assets and labour as well as overall output as shown in Table 4.3. During this period the area of crop land on an average farm decreased by 1.6 per cent per year. Capital assets and the number of farm workers of an average state farm increased annually by 6.2 and 2.0 per cent respectively.

This substantial increase in capital assets was due to the accelerated capital investment policy of that period. Annual total output of an average state farm (expressed in real value terms) increased at a much higher rate (17.4 per cent) than did inputs, perhaps suggesting that farm productivity (total output divided by total input) grew over this period. In terms of physical outputs, highest annual growth was observed in potato production (25.6 per cent per annum) followed by grain and vegetables, 15.2 and 2.5 per cent respectively (Table 4.3). In summary, through the 1980s an average state farm became larger in terms of capital, labour and overall output but not in terms of crop land.

The management and decision-making process at the farm level were highly restricted and regulated by production plans and output targets determined from the Ministry of Food and Agriculture (Coleman, 1989).

The central management of a state farm consisted of the manager, deputy manager and a team of senior technical officers appointed by the Ministry of Food and Agriculture (Coleman, 1989). This team of senior technical officers would comprise a chief economist, an accountant, an agronomist, a livestock specialist and a veterinarian, each of whom would have their own professional staff with lower qualifications.

Table 4.3 Resource endowment and output of an average state farm, crop sector, 1981-1987

Performance indicator	Unit	1981	1982	1983	1984	1985	1986	1987	Average (1981-1987)	Average annual change (%)
Total crop land	ha	15 604	15 631	16 531	16 685	16 588	16 527	13 951	15 931	-1.6
Capital assets	mln tgs	16.7	18.1	19.4	22.2	22.9	22.9	23.8	21.0	6.2
Capital investment (whole-farm)	mln tgs	4.0	5.1	5.4	6.7	5.3	5.2	5.7	5.0	7.1
Average workers	persons	190	196	217	216	226	232	212	213	2.0
Total output (in fixed prices)	mln tgs	3.8	5.3	7.6	5.8	7.6	9.6	8.6	7.0	17.4
Grain production	t	5 544	7 746	12 181	7 902	12 096	11 488	9 315	9 467	15.2
Potato production	t	596	1 156	1 388	1 764	1 446	1 710	1 915	1 425	25.6
Vegetable production	t	450	521	496	449	521	571	502	501	2.5

Source: Ministry of Food and Agriculture (1989), Ulaanbaatar.

The crop and livestock sub-sectors had their own internal structures (Sloane, 1990). For instance, grain units were quite distinct from potato or vegetable units in terms of management, resource allocation and outputs.

Planning was the key management tool for farming. The overall planning practices exercised from the top were very detailed and strict in almost every aspect of production, marketing and input supply arrangements (Coleman, 1989). The production plan for each state farm on what and how much it was to produce, and where it was to sell, was decided at the Ministry of Food and Agriculture (Coleman, 1989). The allocation of most material inputs, such as machinery, fertiliser and capital investment, to individual farms was done by the Ministry of Food and Agriculture. All the profits, if any were made, were transferred back to the Ministry (Sloane, 1990).

With fixed prices[3] for both inputs and outputs, and pre-determined tight production plans for both enterprise choice and scale, the primary role of the manager was to administer the resources at his or her disposal so as to meet the production targets set for the enterprise (Sloane, 1990). Thus managers had little choice over what and how much to produce using what kind of inputs. Rather, their discretion lay in the actual internal organisation of human and material resources so as to meet production targets. The production targets given to each state farm were based on progressive averages of past years' performance and were often set close to the maximum technical capacity of farms (Sloane, 1990). Therefore, farms could be characterised as output maximising units and farm

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[3] Output prices were set by the central price authorities as a nationwide uniform price with some variations reflecting quality differences of the products. The basis for output prices were actual average production costs. So, output prices were set very close to production costs and whenever production cost exceeded the output prices, the losses were covered through direct financing and subsidies from the Ministry of Agriculture. In a system where management objectives were output-oriented rather than profit-oriented, the level of output prices was not important.

managers had a certain degree of control over the performance of technical and human resources but not over allocative decisions between enterprises.

4.2.3 Development practices

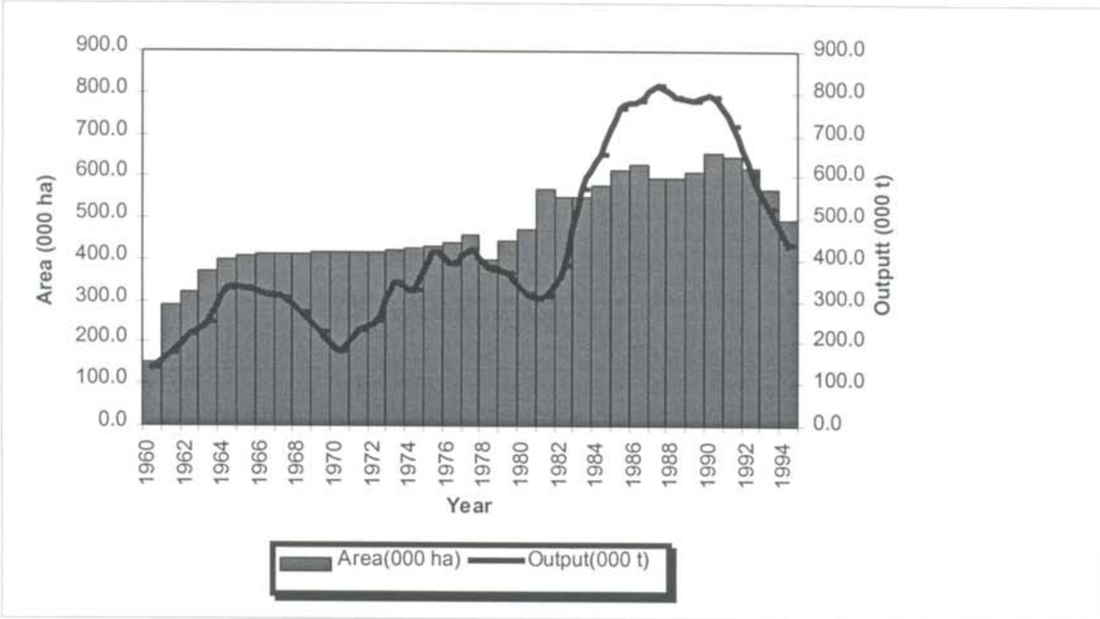
In the three decades leading up to the end of the 1980s, output growth was achieved largely by the expansion of crop land (Ulziibat, 1992). As illustrated in Figure 4.3, output growth of grain (the principal crop) has followed area expansion over the whole period with somewhat cyclical fluctuations. Per ha yield of grain varied between 0.5 and 1.4 t. Only in the period between 1982-1991 was per ha yield consistently over 1 t, despite persistent fluctuations in year-to-year harvest level.

As suitable land became increasingly scarce in the late 1970s and early 1980s, output growth was met by increased use of other inputs, in particular modern inputs (Ulziibat, 1992). As illustrated in Table 4.4, the increases in all non-land inputs of a farm expressed in per ha terms shows that, in the latter two periods (1981-1985 and 1986-1990), all inputs grew at a faster rate than land expansion compared to the first period (1976-1980). In the period 1986-1990, compared to the period 1976-1980, the fastest growing input was fertiliser (109.1 per cent) followed by power (50.0 per cent) and labour (20.8 per cent).

However, the impact of increased fertiliser has not been evidenced in previous research studies (Ulziibat, 1992, p. 100). Also, a recent World Bank study of Mongolian wheat production (World Bank, 1995, p. 45) for the period 1980-1990 found the fertiliser coefficient to be insignificant in its estimation of a production function.

In 1990, a combine harvester was allocated for every 245 ha of crop land and a tractor for every 410 ha of crop land (Ulziibat, 1992). This achievement in farm mechanisation enabled farms to complete spring sowing within two weeks and autumn harvest within four weeks as is necessary for effective handling of the risky climatic conditions (Sloane, 1990).

Figure 4.3 Sown area and total output of grain, 1955-1994 (five-year moving average)



Source: Ministry of Food and Agriculture (1994a), Ulaanbaatar.

Comparing 1986-1990 with 1976-1980, farm sales and output production increased by 159.8 and 106.4 per cent respectively, even higher than input growth (Table 4.4). The relatively faster growth of sales compared to that of output production is perhaps due to the fact that most farms increasingly became more specialised in terms of output sold to the market at the expense of those outputs produced and consumed within the farms (Ulziibat, 1992, p. 56).

So, over the period 1976-1990, as official statistics of the Ministry of Agriculture suggested, the output growth outweighed the input growth, thereby implying some productivity gain. Also, the use of modern inputs, including fertiliser, machinery and other capital grew faster than traditional inputs such as land and labour (Table 4.4). The faster growth of machinery and other modern inputs compared to the traditional inputs of land and labour may imply that embodied technical progress could have materialised through modern inputs.

Table 4.4 Input and output growth of an average state farm[a], 1976-1990

Characteristic	1976-1980	1981-1985	1986-1990	Percentage increase	
				(1986-1990)/ (1976-1980)	(1986-1990)/ (1981-1985)
Capital assets (tgs/ha)	N/A[b]	210.3	1 677.1	N/A[b]	38.6
Power(h.p/ha)	1.0	1.3	1.5	50.0	15.4
Fertiliser (tgs/ha)	18.6	29.6	38.9	109.1	31.4
Labour (mandays/ha)	2.4	2.8	2.9	20.8	3.6
Output(tgs/ha)	362.7	481.2	748.5	106.4	55.6
Sales(tgs/ha)	233.0	375.1	605.3	159.8	61.4

[a] The numbers in the table are expressed on a pre ha basis.

[b] Not Available.

Source: Ulziibat (1992).

During this period (1976-1990) a whole set of infrastructure was built to support crop production (Ulziibat, 1992). As a result, in the 1980s, the majority of crop farms were connected to nationwide electricity mains and were enabled to have close access to the paved-road network. Also, all crop farms were located in the range of up to 200 km from their market, such as large cities and processing plants (Ulziibat, 1992).

In the early 1980s the Ministry of Agriculture began shifting its policy from the so-called "extensive" to an "intensive" growth strategy (Ulziibat, 1992). The emphasis of the new approach was on the increased role of new technology, the development of workers' education and skills, and the introduction of economic reforms with the aim of achieving more efficient production (Unen, 1981 and 1986).

Over the past three decades the Ministry of Agriculture has built a comprehensive research network for the crop sector. At present there are two crop research institutes in the country with the primary responsibility of conducting basic and applied research for the crop sector and of providing extension services to crop farms. Also, there are 20 research stations located throughout the cropping regions with the primary responsibility of testing and introducing new varieties. During the past three decades, in total, 20 new varieties of wheat, barley and oats were tried and 10 new wheat and five new barley varieties were introduced into production (Ulziibat, 1992). Also a comprehensive agronomic analysis was conducted on 400 000 ha of crop land (Ulziibat, 1992). New comprehensive soil protection technology has been introduced on 10 300 ha of land , and wind breaks were introduced on 100 000 ha of land (State Statistical Office, 1988). All these efforts demonstrated the importance the Ministry of Agriculture attached to the development and introduction of new technology.

As part of the efforts to better disseminate new technology, in 1986 the Ministry of Agriculture introduced the so-called "intensive technology package" into production. Under this scheme, the actual biological and technical needs of each crop were identified at different stages of production for different agro-ecological regions. Based on this, detailed instructions to meet these requirements for higher yields were recommended during the whole growing season (Ministry of Food and Agriculture, 1991). By 1990, 6.5 per cent of total national sown area was subjected to this intensive technology package producing 9.0 per cent of the total national grain output (see Table 4.5). The official report states that average yield from the land with intensive technology was 30 to 90 per cent higher than the national yield[4] (Ministry of Food and Agriculture, 1991). Although these figures

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4 These official figures should be interpreted with caution as they could be overly optimistic in showing the real impact of new technology given that the best quality land is often the first to benefit from improved technologies. Ideally, a yield comparison from the same land before- and

showed some success in terms of per ha yield, the adoption rate was very low, representing merely 6.1 per cent of total cultivated land (Table 4.5). Perhaps the enormous resources required to maintain this system and the potential risks of the new technology, which could result in the failure to meet production targets, may have caused the poor adoption rate of the proposed new technologies (Sloane, 1990).

Table 4.5 The results of "intensive technology " application in grain production, 1986-1990

Aspect		1986	1987	1988	1989	1990
Share of sown area subject to intensive technology in total sown area (per cent)		1.1	4.9	9.8	10.7	6.5
Share of output from the application of intensive technology in total grain harvest (per cent)		1.8	9.2	14.7	15.5	9.0
Yield per ha (t)	intensive technology	2.2	2.1	1.9	1.8	1.5
	ordinary technology	1.4	1.1	1.2	1.2	1.1

Source: Ministry of Food and Agriculture (1991). Ulaanbaatar.

The workforce[5] employed in the crop sector was generally sound in terms of age and experience (United Nations Development Programme, 1992). As Table 4.6 illustrates in 1983, 55.6 per cent of the total farm workforce lay in the age group under the age of 34.

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after the introduction of new technology would give a better picture about the impact of new technology. Unfortunately such information was not available for the analysis.

5 The term "workforce" includes the workers who are directly involved actual farm production and the service personnel and as well as the managers at different levels within the farm.

In terms of years of experience in their respective positions, the total workforce was quite evenly distributed across different groups (Table 4.7). About 33.2 per cent of total farm staff had less than five years experience, and 27.8 per cent had experience of 6-10 years, the remaining 39.0 per cent of staff having over 11 years of experience.

Over the past three decades, the Ministry of Agriculture has invested a substantial amount of resources into improving the education and skills of the farm workforce. As a result, the overall level of education and skills of the workforce has markedly improved (Ministry of Food and Agriculture, 1986; Unen, 1986).

Table 4.6 Age structure of farm workforce, 1983

	Age group					
	≤ 24	25-34	35-44	45-54	≥ 55	Total
Workforce (persons)	10 939	8 990	7 877	5 356	2 644	35 806
Distribution (per cent)	30.6	25.1	22.0	15.0	7.4	100.0

Source: Ministry of Food and Agriculture (1986), Ulaanbaatar.

Table 4.7 Work experience of farm workforce, 1983

	Work experience (years)					
Aspect	≤ 5	6-10	11-15	16-20	≥ 21	Total
Workforce (persons)	11 894	9 958	6 488	4 477	2 989	35 806
Distribution (per cent)	33.2	27.8	18.1	12.5	8.4	100.0

Source: Ministry of Food and Agriculture (1986), Ulaanbaatar.

As shown in Table 4.8, in the period between 1975 and 1986, the size of the farm workforce increased by 88.1 per cent. For the same period, the number of workers with a high school education increased the most (4.8 times), followed by those with university degrees (2.9 times) and technical college graduates (2.6 times) (Table 4.8).

Table 4.8 Education structure of farm workforce, 1975 and 1982-1986

Aspect	1975 (person)	1982 (person)	1983 (person)	1984 (person)	1985 (person)	1986 (person)	1986/1975 (per cent)
Total workforce	22 370	34 1[illegible]2	35 806	37 466	39 389	42 070	188.1
Univ. degree	438	8[illegible]6	863	960	1059	1 264	288.6
Technical college	908	1 5[illegible]6	1 692	1 819	1 979	2 400	264.3
High school	1 075	3 1[illegible]2	3 687	4 455	4 363	5 137	477.9
Secondary school (8 years)	9 174	15 8[illegible]2	16 147	17 254	19 221	20 334	221.6
Primary school (4 years)	8 610	10 9[illegible]7	11 513	11 154	11 060	11 453	133.0
No education	2 165	1 8[illegible]9	1 904	1 824	1 707	1 482	68.5

Source: Ministry of Food and Agriculture (1990a), Ulaanbaatar.

In 1986, of the total farm work force, 48 per cent possessed secondary school education, 27 per cent primary school education, 12 per cent high school education, six per cent technical college education and three per cent university education (Table 4.9). In the period 1975-1986, the total number of skilled workers[6] slightly increased and in 1986 they represented 45.2 per cent of total

6 Workers are defined as those directly involved in actual farm physical work often having only lower educational and technical backgrounds, whereas workforce comprises all workers as well

farm workers (Table 4.10). However, it should be noted that the percentage of skilled workers increased at a faster rate than the growth of total farm workers.

According to the 1983 official records of the Ministry of Agriculture (see Table 4.11), 100 per cent of farm managers were university graduates; and 98.4 per cent of the managers belonged to the age group of 35 years and above; but 71 per cent of them had less than five years' experience. The relatively low level of managers' experience, despite their belonging to an older age group, was perhaps partly due to the fact that multi- enterprise, large-scale and complex farms made it a requirement that individuals had certain production experience and diverse skills before they were selected for positions as farm managers.

In addition to its investment in agricultural research and extension, and farm human resource development, the Ministry of Agriculture undertook a series of reforms in an attempt to improve farm efficiency and performance (Unen, 1981 and 1986). Two distinctive stages of reform of the state farm sector were observed prior to 1990. One started in the early- 1980s, the other in the mid-1980s, where each of them watershed the beginning of a five-year plan.

These reforms reflect the similar reforms undertaken in the 1970s and 1980s throughout the whole Eastern Bloc (Csaki, 1990).

The reform wave that started in the early-1980s primarily aimed at increasing output and productivity by way of introducing a wage incentive system for farm workers. The tight planning process had gradually been relaxed and farms exercised more and more autonomy in terms of resource allocation and actual production management (Coleman, 1989). The initial procedure of mobilising all

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as managers, middle managers and senior technical staff. The skilled workers are defined here as those workers who had at least two years' professional training in their respective fields.

7 Workers are defined as those directly involved in actual farm physical work often having only lower educational and technical backgrounds, whereas workforce comprises all workers as well as managers, middle managers and senior technical staff. The skilled workers are defined here as those workers who had at least two years' professional training in their respective fields.

profits of individual farms to a centrally pooled system at the headquarters and reallocating them back in the form of investment and financial subsidy was replaced by a system where farms were allowed to retain a certain amount of their profits for later investment in farm expansion and machinery replacement. A more flexible wage system along with an increased role for managers was introduced.

In the second half of the 1980s various new forms of intra-farm re-organisation such as contract units were introduced (Ministry of Food and Agriculture, 1990b). This second reform process undertaken at that time coincided with the wider economic reform efforts undertaken in all Eastern-Bloc countries.

Table 4.9 Education structure of farm workforce, 1975 and 1982-1986 (percentage of total workforce)

Grade	1975	1982	1983	1984	1985	1986
Univ. degree	2.0	2.4	2.4	2.6	2.7	3.0
Technical college	4.1	4.6	4.7	4.9	5.0	5.7
High school	4.8	9.2	10.3	11.9	11.1	12.2
Secondary school (8 years)	41.0	46.3	45.1	46.1	48.8	48.3
Primary school (4 years)	38.5	32.1	32.2	29.6	28.1	27.2
No education	9.6	5.4	5.3	4.9	4.3	3.6
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Ministry of Food and Agriculture (1990a), Ulaanbaatar.

Table 4.10 Share of skilled workers in total farm workers, 1975 and 1981-1986

Year	Total workers	Skilled workers	Per centage of skilled in total workers
1975	19 938	7 702	38.5
1981	29 527	11 671	39.5
1982	30 6[illegible]6	11 865	38.8
1983	32 1[illegible]6	12 384	38.6
1984	33 731	12 957	38.4
1985	35 709	13 815	38.7
1986	35 808	16 181	45.2

Source: Ministry of Food and Agriculture (1990a), Ulaanbaatar.

Table 4.11 Education, age and experience of farm[8] managers, 1983

	Total number (persons)	Per centage distribution
Education:		
University	62	100.0
Technical college	-	-
High school	-	-
Total	62	100.0
Age (years):		
≤ 34	1	1.6
35 - 44	33	53.2
> 45	28	45.2
Total	62	100.0
Work experience (years):		
≤ 5	44	70.9
6 - 10	11	18.0
≥ 11	7	11.1
Total	62	100.0

Source: Ministry of Food and Agriculture, Ulaanbaatar (1986).

8 The total 62 farms here include both grain and fodder farms that were operating in 1983.

These had the following reform agendas (Csaki, 1990) which also characterised the economic reforms in Mongolian agriculture:

- greater emphasis on efficiency and quality over mere quantitative increases;
- a price policy that reflected the actual production costs more adequately;
- increased roles of various financial incentives in managing workers; and
- increased autonomy of individual farms and encouragement for private sector development in agriculture.

During this period (1986-1989), several new forms of farm incentive systems based on contracts were tried within the state farm structure (Sloane, 1990). Under these contract arrangements central farm management was obliged to provide individual production units with marketing and input supply and technical services. The production units within the farm, in their turn, were obliged to produce a minimum quantity of certain products at predetermined quality levels and to sell them to the central farm management at pre-determined fixed prices. The minimum output level that production units had to produce and the corresponding inputs given by the farm management were negotiated between the farm manager and individual contract groups. The output and input levels in the contracts were based upon the actual performance levels of each individual production unit over the previous five years (Ministry of Food and Agriculture, 1990b). As noted by Sloane (1990), as State purchase prices were fixed, farmers had few options to improve their performance and financial remuneration other than to:

- reduce production costs;
- increase outputs;
- improve quality of products so as to enjoy a price bonus for higher quality.

Under the contract arrangement, a basic production unit became a legal entity within the state farm jurisdiction and signed a contract with the farm's management to accomplish certain production tasks. The two basic features of this form of contract were (i) voluntary participation and (ii) remuneration according to the profit made by each unit (Sloane, 1990).

Two types of contracts – simple and tenancy – were available. The difference between simple and tenancy contracts was in the degree of autonomy given to individual units and the length of contract terms (Ministry of Food and Agriculture, 1990b). A simple contract was quite tight in terms of the types and quality of output and input levels and remuneration in the form of wages, and was usually signed on an annual basis. Under the tenancy contract arrangement, a group of farm members signed contracts with the management of the state farm basically on resource use such as land, machinery and buildings on a longer term basis (e.g., five to ten years) and were obliged to supply the Ministry of Agriculture with a certain percentage of previously produced output and then have the right to sell the remainder at market price to local or national markets. The tenancy groups would pay a resource use fee derived from farm asset values along with a surcharge for overall farm management. Under this arrangement production units exercised greater autonomy in terms of management and resource allocation (Ministry of Food and Agriculture, 1990b).

The official Government document on the process of contract arrangements, i.e. Ministry of Food and Agriculture (1990b) further reports that by 1990, 92.0 per cent of all crop production units and 86.5 per cent of all workers in crop production were engaged under either simple or tenancy contracts. Of all workers engaged in the contracts, 42.9 per cent were in simple contract and 57.1 per cent were engaged in tenancy contract. Furthermore, the economic performance of those engaged in contract forms was higher than those not engaged: 68 per cent of all state farms had reduced unit costs of production relative to the average actual costs incurred in the previous five years.

Despite all these positive achievements, large differences in performance of the individual state farms were still observed and numerous shortcomings and failures associated with the new contract system arrangements over the period 1986-1990 have been reported: overly keen on short-term economic outcomes, farmers quite often neglected the environmental damage caused by excessive use of land and ignored the already established farming practices while running their individual businesses (Ministry of Food and Agriculture, 1990b). Also, the mutual responsibilities of the contracted sides were not comprehended properly resulting quite often in contract failures and subsequent production decline (Sloane, 1990). Nonetheless, to conclude, the substantial initiative of the Ministry of Agriculture in farm incentive reform seems to have had some positive impact on farm performance even though the impacts of various technological and reform policies on farm performance in terms of efficiency and productivity in the last two decades remain unclear and need to be explored.

4.3 Data Sources and Variable Definitions

4.3.1 Nature of data on centrally-planned economies

Concerns regarding the data and information on the centrally-planned economies have related to their availability and reliability (Ofer, 1987). In the case of the Soviet Union, as was common to the rest of the centrally-planned economies, data availability varied drastically over time according to the degree of general openness of the system. Towards the end of the 1980s, data availability improved, but to obtain micro-level data on the behaviour of individual economic units, households or firms still remained difficult (Ofer, 1987, p. 1772). Most of the data made available to the public were disguised and kept in a highly aggregated form, mainly for propaganda or ideological reasons. The enormous quantity of data used for decision making, planning and control was not disclosed and was hidden away from wider public use. The majority of the efficiency and productivity studies related to centrally-planned agriculture, except for a few recent cases[9] used highly aggregated (either provincial or national-level) data – see Table 3.1, Chapter 3.

The reliability of the data of the centrally-planned economies has often been questioned on two grounds. Firstly, possible distortions in report-producing and transmitting systems may exist, for the reason that the individual units were judged and remunerated on the basis of reports. However, as it is unaffordably expensive to keep two separate accounting and reporting systems, one for reporting to higher authorities, the other for their own management, the long-term time-series data are believed to be not overly biased and reasonably reliable (Ofer, 1987, p. 1774). Secondly, there are the difficulties associated with conceptual and definitional peculiarities. This makes it extremely difficult to use these data for Western vs. Soviet comparative studies. To overcome this problem, a lot of efforts have been made by Westerners to calculate so-called adjusted factor costs in the Soviet Union in order to make them comparable with Western definitions but these cannot hope to correct all the distortions fully (Ofer, 1987, p. 1774).

In general, it was believed that the data are likely to be more reliable the closer they are to the decision making and control apparatus and the less aggregated are the series. Those data which are defined in physical terms and more directly related to the operation of the system are regarded as more reliable, while the more aggregated data series, denominated in monetary terms, are less so (Ofer, 1987, p. 1993). In order to overcome these problems associated with data reliability, Western scholars often cross-checked the data from different sources before they used them for their particular needs (Ofer, 1987).

The price data for centrally-planned economies are not used in the same way as in market economies (Ofer, 1987). This is because the prices were established by central authorities and were fixed over time; they were not a reflection of resource scarcity. The prices were created as a sum of average cost and a profit norm,

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9 The exceptions are few recent studies (Brock, 1996; Johnson *et al.*, 1994; Brada and King, 1993; Koopman 1990) where farm-level data was used.

where costs exclude rents and at least some interest charges (Ofer, 1987). Stability of prices over time may be an advantage when time series are estimated and evaluated, and in this respect Soviet prices are an asset (Ofer, 1987, p. 1774).

After the radical economic reform of 1991 that took place in Mongolia, the huge information handling system collapsed along with state ownership of businesses (Asian Development Bank, 1994). However, all the previously collected data became available to the wider community, including to the author of this thesis.

4.3.2 Nature and sources of data on Mongolian crop farming

The farm-level recording and reporting system developed for agriculture in the centrally-planned economies was perhaps one of the most detailed and comprehensive data recording systems ever created (Sloane, 1990; Asian Development Bank, 1992b). This is simply due to the fact that the farms were owned by the State and were controlled and managed by them from the top (Coleman, 1989). For this the central authorities needed to get all the production and financial data at the top level and instructed farms to supply them with this information. As a result, an enormous amount of data related to all aspects of production and finance was gathered over the years. However, these data have only been analysed in terms of simple statistics and comparisons (Coleman, 1989; Asian Development Bank, 1992b).

The data discussed in this section underlie all the analytical chapters (Chapters 5,6 and 7) of this thesis. Farm-level unbalanced panel data[10] on 48 farms over the period 1976-1989 were obtained from the original (hand-written) annual farm financial reports of individual state farms kept by the Ministry of Food and Agriculture.

State Farms' Annual Financial and Economic Reports (reference - Ministry of Food and Agriculture, 1990c) contained the basic input and output quantity data

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[10] Unbalanced panel data refers to time series data based on panel observations where some observations are missing

for all enterprises, including grain and potato production.[11] Additional data on farm-specific characteristics (which are hypothesised to be related to efficiency levels of individual farms) were obtained from separate sources, in particular, the *Report on the Human Resources in Agriculture Sector* (reference- Ministry of Food and Agriculture, 1990a).

As all state farms producing grain and potatoes for human consumption are included in the analysis, the problems associated with the representativeness of farms and sampling procedures are not present here.

At the farm level, the financial reports were produced by a group of full time accountants, usually consisting from five to 15 people. The financial reports were produced primarily for accounting and farm financial management purposes on a quarterly, half-yearly and yearly basis. The recording system within the farm was based on a full accounting system. Thus, inputs were allocated to each individual commodity (i.e., grain, potato, vegetable, beef, milk, mutton and wool) and consequently full production costs were calculated for each of these commodities.

Data were mostly recorded manually with the use of limited electronic aids such as calculators, therefore some potential errors might have occurred during the reporting process. However, the collation process was done at each stage of reporting, including farm, province and headquarters level before the reports were accepted finally. The main purpose of this collation process was to minimise errors associated with reporting as well as to check the consistency of the procedures underlying the financial reports. All the reports were produced according to a uniform procedure, so that the problem of inconsistency between the farms in terms of methodology of reporting was minimal. The financial reports of the individual farms were received by the Ministry of Food and Agriculture

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[11] The input and output data on vegetables other than potato were incomplete. Vegetables other than potatoes, therefore, were left out of the current study. It should be noted that the other vegetables are much less significant crops compared to grain and potato both in terms of sown area and total production (see Vegetable in Table 1.1).

from the 1960s, but only from 1975 were they kept consistently and in the same format.

For this study, originally the data were collected for the period, 1975-1990, 1993 and 1994, the last two years covering the post-reform period. But the post-reform data (1993 and 1994) as well as the data for 1975 and 1990 were dropped from the analysis because they were found to be incomplete and of poor quality.

In selecting adequate variables for the production function analysis, preference was given to physical rather than value variables (wherever possible) to avoid any biases resulting from price distortions. In those cases where the variables were expressed in value terms, the price deflation indices of the whole-sale price revision[12] were used for the period 1986-1989, when the new prices took effect. Hence, the variables expressed in value term, i.e., capital (depreciation and machinery service costs), fertiliser and other costs, were scaled down by the factors of 1.22, 1.45 and 1.12 respectively – official deflation rates (State Committee for Prices, 1986).

Farm-level input and output data

Initially there were eight potential explanatory variables for the production function. In order to minimise multi-collinearity and degrees-of-freedom problems which were likely to occur, especially in the case of more sophisticated functional forms such as translog, the number of variables had to be reduced to a minimum necessary level.

The selection of adequate input variables was done by estimating an average production function on total panel data using OLS and conducting statistical tests (t- and F-tests). Those variables which were found to not be statistically significant

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[12] The wholesale price revision was conducted every ten years nationwide with the purpose of adjusting domestic prices to international price levels. The last revision was conducted in 1986 for all input and output prices (State Committee for Prices, 1986).

at the five per cent level were dropped[13] in subsequent stages and the final number of input variables used in the rest of the study was reduced to five:

- sown area (ha)
- labour (mandays)
- depreciation and machinery service costs as a proxy for capital (tgs)
- fertiliser (tg)
- other costs (tg).

In all cases output as a dependent variable was measured in physical units, i.e., in tonnes.

For the land variable, instead of following the conventional practice of choosing total crop land, sown area was chosen. This is justified on the following argument: The ratio between cultivated land and fallow differed between the crop regions depending on their long-term rainfall levels, which determine the fallow required. However, as this ratio was kept constant for each farm over time, the choice of sown area as a variable has the same effect as total crop land. It is not uncommon for sown area to have been used as land contribution in other studies where similar technological and economic conditions to those in Mongolia prevail (see Wyzan, 1981; Koopman, 1989).

The depreciation and machinery service costs were added together to represent the capital contribution to production. This was due to the fact that most of the service costs provided to the crop sector were of capital services (e.g., intra-farm auto-transport and tractor transport that are used during the sowing and harvesting periods).

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13 However, the variable of fertiliser was kept in the analysis despite being not significant at the five percent level primarily because of its generally acknowledged overall importance in production.

The other variables including seed and overhead (management) were found statistically not to be significant at the five per cent level and were consequently dropped from the analysis. The reason why the seed and management variables were found insignificant is perhaps due to fact that both of them were used on the farms according to norms per ha and thus could be multi-collinear with sown area. As far as the overhead (as a proxy for management) variable was concerned, it comprised wages of managers and chief specialists, and yet the range of salaries of managers and specialists across the farms were similar with slight differences depending on farm size. Therefore, the management variable expressed in terms of their salaries may not have sufficient variation and may represent their contribution in production inadequately.

Summary statistics of the variables used in the models for grain and potato production are given in Tables 4.13 and 4.14.

Also it should be noted that in order to get the parameter estimates directly interpretable as the partial elasticities of output in case of more general functional forms, the data of the SFPF models used in Chapters 5 and 6 were corrected by their mean values, which is consistent with the initial formulation of the translog functional form used there – see Chapter 5 for more details.

Farm-specific explanatory variables which may influence efficiency levels

Socio-economic variables such as the age, education, experience of farmers and use of extension services are commonly used as explanatory variables for efficiency variations among farms in developing countries (Bravo-Ureta and Pinhiero, 1993). However, in the case of centrally-planned agriculture, no study has yet explored the sources of efficiency variation in terms of additional socio-economic variables except for Brock (1996).[14]

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[14] Brock used a set of explanatory variables for the case of Volgograd region of the former Soviet Union. However, the set of variables used in his studies are somewhat different to the traditional variables mentioned earlier. He used the distance of individual farms to main road, the share of Government purchase in total farm sales and the differences in land quality between farms as the

In this particular case, the availability and format of the data and the development specificity of Mongolian grain farms dictated the selection of the particular explanatory variables used here.

Detailed data on the experience and educational levels of mechanisators[15] was available at the provincial level (13 provinces) but not at the individual farm level for the three year period 1987-1989. These data were assigned to individual farms depending on which province each individual farm belonged to. In other words, the farms belonging to the same province were allocated the same value for a given year. Thus these data have limited variation across the farms. But the fact that the observations were available over the three years (1987-1989) significantly improved the situation.

The following variables were selected as explanatory variables for inefficiency of grain farms:

- the percentage of mechanisators who were graduates of vocational technical schools in the total population of mechanisators;
- the percentage of mechanisators with more than six years of experience in the total population of mechanisators;

- the natural conditions of each farm (as an aggregate index reflecting three different factors affecting production: soil quality, average precipitation and average temperature). This variable was taken from the earlier work on land

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explanatory variables for efficiency variation among the farms, but none of them seemed to have had a significant influence on farm performance.

15 Mechanizators are those workers who are directly involved in the actual planting, maintaining and harvesting processes of grain production using agricultural machinery such as tractors, combine harvesters etc...

Table 4.12 Summary statistics on input and output data for grain farms, 1976-1989

Variable	Mean	Std. d	Max.	Min.
Output (t)				
1976-1980	7942	6348	28549	150
1981-1985	11[illegible]16	9298	47848	172
1986-1989	13439	9963	65864	5
1976-1989	10905	8924	65864	5
Sown area (ha)				
1976-1980	11[illegible]17	7569	32577	500
1981-1985	11[illegible]81	6943	29010	200
1986-1989	11[illegible]18	6766	29517	50
1976-1989	11474	7094	32577	50
Labour (mandays)				
1976-1980	27867	27791	210672	20
1981-1985	33[illegible]80	23041	111645	1386
1986-1989	34[illegible]49	24147	189183	88
1976-1989	31[illegible]62	25148	210672	20
Fertiliser (000 tgs)				
1976-1980	2[illegible]7	201	960	0
1981-1985	347	277	2096	0
1986-1989	3[illegible]5	237	982	0
1976-1989	304	246	2096	0
Capital (000 tgs)				
1976-1980	1801	1284	5951	65
1981-1985	2273	2150	22989	35
1986-1989	2248	1531	6203	3
1976-1989	2108	1726	22989	3
Other costs (000 tgs)				
1976-1980	1[illegible]0	186	1105	0.3
1981-1985	3[illegible]6	361	1967	0.4
1986-1989	5[illegible]3	638	3701	0
1976-1989	3[illegible]4	452	3701	0.3

Table 4.13 Summary statistics on input and output data for potato farms, 1976-1989

Variable	Mean	Std. d	Max.	Min.
Output (t)				
1976-1980	1040	2352	16763	5
1981-1985	1443	3156	21310	3
1986-1989	1930	4039	21573	4
1976-1989	1460	3247	21573	3
Sown area (ha)				
1976-1980	116	187	840	2
1981-1985	114	193	854	2
1986-1989	152	258	1350	2
1976-1989	126	214	1350	2
Labour (mandays)				
1976-1980	6341	10078	60109	22
1981-1985	7153	11706	66330	92
1986-1989	9070	14140	87998	63
1976-1989	7474	12057	87998	22
Fertiliser(000 tgs)				
1976-1980	28	70	551	0
1981-1985	36	79	525	0
1986-1989	38	74	421	0
1976-1989	34	75	551	0
Capital (000 tgs)				
1976-1980	162	309	1771	0.5
1981-1985	207	402	2752	0.4
1986-1989	303	591	2868	0.3
1976-1989	222	447	2868	0.3

Other costs (000 tgs)				
1976-1980	28	67	453	0.1
1981-1985	51	135	897	0.1
1986-1989	89	194	1311	0.1
1976-1989	55	142	1311	0.1

valuation of Enkh-amgalan and Myagmarjav (1993) and was included both in the frontier function as well as in the inefficiency-effects function in order to establish explicitly the influence of the natural conditions on the efficiency levels of the farms;

- time in years as a proxy for efficiency change (the residual influence not accounted for by other factors). This variable was also included in the frontier function to capture technical change.

Two dummy variables were also used:

- Soviet built/assisted farms = 1, otherwise = 0;

- Farms which had introduced an economic remuneration system = 1, otherwise = 0;

As Table 4.14 suggests, during the period 1987-1989, 39.0 per cent of all grain mechanisators were the graduates of vocational technical schools and 69.9 per cent of all grain mechanisators had more than six years of work experience. The relatively high standard error for the graduates of vocational technical schools variable may also suggest that there was a significant difference between farms in terms of workers with formal technical skills. Also the same table indicates that, against the index of 100.0 for the farm with the most favourable natural conditions, the index of natural conditions of an average farm was 76.7 per cent. The dummy variables reflecting Soviet assistance and incentive systems are not included in Table 4.14. During the period 1987-1989, 47.0 per cent of all grain farms received Soviet technical assistance and 51.3 per cent of all grain farms were subjected to the economic incentive system monitored by the Ministry of Agriculture.

Table 4.14 Summary statistics on the selected farm-specific variables associated with efficiency of grain farms (percentage)[a], 1987-1989

	Graduates of vocational technical schools	Mechanizators with more than six years of experience	Index of natural conditions
Mean	39.0	69.9	76.7
Std. d	17.5	8.6	12.1
Max.	57.7	93.1	100.0
Min.	3.03	46.0	53.9

[a] The numbers in the first two columns are the percentages in total number of mechanisators of grain farms.

Environmental factors

It is generally believed that the heterogeneous environments under which farms operate affect the results of efficiency analysis. Therefore, some attempts were made to account for differences in precipitation, temperature and land quality among the farms but with not much success.

At the outset of the study, an attempt was made to eliminate the effects of long-term variations in precipitation and temperature on farm performance by adjusting the output level by weather fluctuations using OLS on the existing data of precipitation and temperature.[16] However, the regression of outputs against the

[16] As part of the data collection mission, a monthly time-series data of precipitation and temperature compiled by 25 meteorological stations scattered throughout the country was obtained for the period 1976-1989. However, as these stations were built for general

monthly temperature and precipitation did not yield satisfactory results, giving instead unexpected signs and magnitudes for the parameters of the variables. This was perhaps due to the fact that the available weather data collected by meteorological stations were too general to account for possible weather effects on the performance of individual farms.

Also region-specific dummy variables were included in the average production functions for grain and potato farms. However, they were found to be not statistically significant, suggesting that regional-specific influence on production was minimal. Furthermore, because of the fact that the majority of the national crop lands (up to 70 per cent in terms of total crop land) were situated in only two closely situated agro-ecological regions (Selenge-Onon and Central and Eastern Steppe), the differences in natural environment between most farms were unlikely to be large.

An index of natural conditions, constructed by Enkh-amgalan and Myagmarjav (1993), is included in the model which is used to identify the causes of inefficiency for grain farms in the period 1987-1989 (see Section 5.4). The purpose of including this variable is to attempt to capture and separate the effects of the differences in natural conditions on the production and efficiency levels of individual farms.[17] However the parameter estimate was not significant and of unexpected sign (see Chapter 5 for the result), hence this implies that the data were again too crude to capture the relationship. This index was not used in the analysis of the overall 14-year period, because it was compiled in 1993 and evidence of land quality deterioration over the recent decades (Asian Development Bank, 1992a) suggest that the value of this index may have varied through time.

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meteorological observations and cover the whole country's territory, many of the crop farms fall into the same meteorological station area, thus having essentially the same values of weather variables.

17 Natural condition is expressed as an aggregate index of rainfall, soil quality and temperature. See details in Chapter 5.

Furthermore, a recent study on Russian agriculture (Brock, 1996), where the natural conditions are somewhat similar to that of Mongolia, found that land quality had little effect on farm performance. Therefore, because of all of the above mentioned factors, the current study is based on the assumption that the effects of differences in natural environment on farm performance are minimal.

4.4 Summary and Conclusions

Crop farming in Mongolia is highly marginal due to existing harsh climatic and natural conditions. The low and erratic precipitation and short growing seasons are the most limiting climatic factors (Ulrich, 1994).

Under the centrally-planned system, most of the country's crop production was undertaken by state farms (Ulziibat, 1992). State farms were almost exact prototypes of the Soviet Sovkhozy (state farms) in terms of structure and functioning (Chalmers, 1993). State farm sizes were large relative to most Western farms (Sloane, 1990; Chalmers, 1993) and had multiple enterprises including crop, livestock and service activities as well as other enterprises with social roles. The crop and livestock enterprises were again divided into smaller units specialised in individual commodities such as grain, potatoes, other vegetables, sheep and cattle units, each of them having separate management and recording systems (United Nations Development Programme, 1992).

The management and decision-making process at the farm level were highly restricted and regulated by production plans and output targets determined from the national headquarters of the Ministry of Food and Agriculture (Coleman, 1989).

The crop and livestock enterprises had their own internal structures (Sloane, 1990). For instance, grain units were quite distinct from potato or vegetable units in terms of management, resource allocation and outputs.

With fixed prices for both inputs and outputs, and pre-determined tight production plans for both enterprise choice and scale imposed from the national headquarters, the primary role of the manager was to administer the resources at his disposal so as to meet the production targets set for the enterprise (Sloane, 1990). The production targets given to each state farm were based on progressive averages of past years' performance and were often set close to the maximum technical capacity of farms (Sloane, 1990). Therefore, farms could be characterised as output maximising units and farm managers had a certain degree of control over the performance of technical and human resources but not over allocative decisions between enterprises.

In the three decades leading up to the end of the 1980s, output growth was achieved largely by the expansion of crop land (Ulziibat, 1992). However, as it became increasingly difficult to ensure output growth only by way of increasing conventional inputs due to resource shortages, from the 1980s, the Ministry of Agriculture began shifting its policy from the so-called "extensive" into an "intensive" growth strategy (Ulziibat, 1992). The emphasis of the new approach was on an increased role for new technology, the development of workers' education and skills, and the introduction of economic reforms with the aim of achieving more efficient production (Unen, 1981 and 1986). A significant amount of investment was made into the development and importation of new technology in order to improve farm productivity. In addition, the Ministry of Agriculture undertook a series of reforms in an attempt to improve farm efficiency and performance (Unen, 1981 and 1986). Two distinctive stages of the reform of the state farm sector were observed until 1990. One started in the early-1980s, the other in the mid-1980s, where each of them watershed the beginning of a five-year plan. During the latter period (1986-1989), several new forms of farm incentive systems based on contracts were tried within the state farm structure (Sloane, 1990).

However, the actual impacts of various technological and reform policies of the Ministry of Agriculture directed at improving farm performance and the status of efficiency and technical progress in the last two decades in the crop sector remain unclear and need to be explored.

For the current study, farm-level input and output data of 48 farms over the 14-year period 1976-1989 for grain and potato production were obtained from the original (hand-written) individual annual farm financial reports kept at the Ministry of Food and Agriculture.

Additional data on farm-specific characteristics such as experience and technical education of farm workers, the differences in farm natural conditions, the type of incentive system in place and the presence of Soviet technical assistance for the final three years of the study period, 1987-1989, were obtained from separate sources for the 48 grain farms. In selecting the variables for the production function, the preference was given to physical measures rather than monetary values to avoid any biases resulting from price distortions. In those cases where the variables were expressed in value terms, these values were deflated by the official price changes (State Committee for Prices, 1986).