Staff Paper P93-3 **January 1993**

Staff Paper Series

Why Are Farms So Small?

by

Nancy Johnson
and
Vernon W. Ruttan

DEPARTMENT OF AGRICULTURAL AND APPLIED ECONOMICS
UNIVERSITY OF MINNESOTA
COLLEGE OF AGRICULTURE
ST. PAUL, MINNESOTA 55108

Staff Paper P93-3 **January 1993**

Why Are Farms So Small?

by

Nancy Johnson
and
Vernon W. Ruttan

Why Are Farms So Small?

Nancy Johnson and Vernon W. Ruttan

Most of the research on the issue of farm size has focussed on explaining the steady increase in the average size of farms in both developed and developing countries. This research effort has been extremely fruitful and offers many insights into the causes of farm size growth. In spite of their growth, however, farms are still far smaller than industrial enterprises. The mechanization process in agriculture does not appear to have led to as much expansion in size of the operational unit as did the mechanization process in industry. Less is known about why this is true.

This paper examines the experiences of some very large agricultural operations which have been undertaken in developing countries over the past several decades. Due to low factor costs and local government interest in increasing production through mechanization, extremely large scale, mechanized projects have been attempted. The record of such projects in uniformly poor, which suggests a different question for researchers: why are farms so small?

Large-scale agricultural projects in developing countries have existed since colonialism (Voll, 1980). They became particularly popular in the post-WWII period because of increases in the availability of machine technology. This paper will focus on the following post-war projects: the Tanganyika Groundnut Scheme (1947-1949); the Molinos Nacionales sorghum project in Venezuela (1964-1966); Jari in Brazil (1967 to the present); the Dez agribusinesses in Iran (1968 to mid-1970s); the Philippine Corporate Farming Project (enacted in 1974); and Hershey's Hummingbird Farm in Belize (1976-1992).

Though diverse in terms of time, geographic location and type of crop, these projects had many things in common, not the least of which was that sufficient data was available for analysis. Such projects are often initiated with a great deal of fanfare, but their failures are rarely analyzed. This is particularly evident in the fact that many mistakes made by early managers were repeated decades later by managers who were apparently unaware of what had happened before. Much can be learned from the histories of these projects, including many useful insights on issues of farm structure and management, and in particular the question of farm size.

What Are Economies of Scale?

The key assumption underlying the establishment of these projects is that agriculture is characterized by economies of scale. In theory, economies of scale are defined by a production function which exhibits a more than proportional increase in output for a given increase in magnitude of all inputs. In practice, the term is difficult to apply because there is rarely an occasion when an increase in magnitude of some inputs does not also imply a change in the factors of production (Mellor and Mudahar, 1992; Putterman, 1983). In order to address this problem economists have formulated somewhat broader definitions. Peterson and Kislev offer the following: "a) that the production function for the typical firm in the industry is characterized by increasing returns to scale, and b) that small farms are less efficient than larger ones" (Peterson and Kislev, 1991, p. 4).

Binswanger, Deininger and Feder (1992) suggest three instances under which economies of scale could exist in agricultural production. The first is when economies of scale in processing or marketing are transmitted backwards to the farm level. This is typically the case with plantation crops such as sugar cane, tea and oil palm. The source of the increasing returns is in the post-harvest activities, but the strength of the advantage there allows the operation to be competitive with small-holders at the production level as well. This interdependence between production and processing, combined with the fact that plantations produce year round and have full-time labor forces, make plantation operations significantly different from other types of annual crop farms. For this reason plantations as described here are not included in this study.

The second opportunity for economies of scale occurs when the intensification process involves the adoption of "lumpy" inputs. Biological or chemical inputs can be adopted over a continuous interval and are, as a result, generally scale neutral. Other inputs, such as machinery or even management, must often be adopted in discrete intervals, which can result in some scale benefits to expansion (Hayami and Ruttan, 1985; Etherington, 1973). The advantage exists only in the short run, however. Machinery can increase the minimum efficient size of operation, but once this adjustment is made, the increasing returns to scale tend to disappear (Binswanger, Deininger and Feder, 1992).

The third type of economies of scale which can characterize agriculture is what is known as external economies of scale. External economies of scale occur when, as farms increase in size, they experience advantages in terms of access to inputs, capital, services, storage facilities, or marketing and distribution opportunities relative to smaller farms. This means that large farms can have real advantages relative to small farms due to pecuniary economies or policy distortions rather than to greater efficiency.

It has also been suggested that agriculture might sometimes experience diseconomies of scale. The usual evidence for this conclusion is the apparent inverse relationship between farm size and productivity. This relationship used to be widely accepted, particularly as a justification for land reform. However de Janvry, in defining the types of situations where this phenomenon is likely to occur, concludes that it is less common than previously held. Nonetheless there are still situations when it is the case, in particular when the labor market fails or does not exist, when transactions costs in the labor market are high, or when the effort of hired labor is significantly affected by supervision (de Janvry, 1987, p. 4).

Do Scale Economies Exist in Agriculture?

There is a considerable amount of debate on the issue of whether there are economies of scale. However a consensus seems to exist that, except under certain circumstances, agriculture is generally not characterized by increasing returns to scale (Peterson and Kislev, 1983; Lele and Agarwal, no date; Berry and Kline, 1979). If it cannot be assumed that economies of scale exist in agriculture, then what determines optimal farm size and structure? Exactly why do we not, as Marx predicted, see "factories in a field?" (Putterman, 1983). The following section will briefly discuss three important issues in farm size determination: relative factor prices, labor costs, and risk.

Peterson and Kislev explain their results of constant returns to scale in terms of relative factor prices. The capital intensity of United States agriculture can be explained by the fact that high wages led to the substitution of capital for labor. If returns to scale are constant, then the conditions for "optimal" farm size can occur at many sizes. The tendency towards larger and larger farms in the U.S. is an indirect effect of this substitution process because capital substitution in U.S. agriculture is achieved through increased use of machinery. Machinery, as Hayami and Ruttan suggest, can allow farmers to work progressively larger units of land.

Brewster (1950) offers considerable insight into the question of optimal farm size by addressing the role of labor in mechanization. Brewster suggests that the mechanization process in industry leads to a situation where machinery is stationary and the number of workers can be increased substantially without greatly increasing labor supervision costs. In agriculture, on the other hand, labor and machines are both mobile, and this leads to a situation where supervision of hired labor is extremely costly. Further, agricultural tasks must be done sequentially due to the annual cycle of production, which limits the opportunity for gains from specialization and division of labor. As a result, Brewster implies that there are few advantages to expansion beyond the size of owner-operator.

The durability of the family farm has been further explored since Brewster's article, and the advantages of owner-operator farms with regard to labor costs can be broken down into two parts. The first is that family labor is inherently more productive than hired labor due to its greater incentives. Because of this, management costs increase significantly when hired labor is used. Binswanger and Rosenzweig conclude: "monitoring costs in effect set up diseconomies of scale which are generally not offset by the kinds of economies of scale present in much of mass manufacturing" (cited in Klock, 1992, p. 7).

Secondly, because of the nature of industrialized agriculture, as described by Brewster, workers frequently perform their tasks in relative isolation. Many of the tasks in agriculture require decisions being made on the spot, with no managers around to give guidance or see that the right choice is made. This is especially important because the capital intensity of agriculture often has employees making decisions regarding equipment use and maintenance. A great deal of responsibility can rest on labor, and this, combined with the moral hazard issue raised earlier, makes the owner-operator the most efficient size of farm.

A final factor affecting farm size and structure is risk. Ruttan (1988) hypothesizes that the optimal farm size should decrease as risk increases. Little work has been done to clarify this relationship, however several observations have been made which shed light on the issue as it relates to this paper.

First, Binswanger and Rosenzweig, looking at small farm insurance, conclude that it is "not attractive to pool risk across farmers in a given area because of the high covariance of their natural risks" (cited in Klock, 1992, p. 6). This seems to imply that in areas characterized by high risk, for example from weather, small farms would be more common than large ones. However they also discovered that wealth is a mitigating factor in this relationship. Wealth reduced the effects of risk and "induced greater risk and greater return." They found, for example, that weather posed virtually no risk to the overall portfolio of the richest nineteen percent of farms studied (Klock, 1992, p. 9).

Second, Hirschman (1967), writing from a project analysis perspective, observed that industrial projects in developing countries are less risky than agricultural projects, and as a result are more likely to be undertaken. The more industrialized an agricultural project becomes, therefore, the more likely it appears to be transferable from one situation to another. As an example he offers the many river valley projects modeled after the Tennessee Valley Authority. As the proportion of capital and other inputs increases, the proportion of the project left up to chance appears to diminish.

Sanders (1973) offers farm-level evidence that mechanization can indeed reduce risk. For example, before mechanized plowing was available, farmers on Brazil's poor, hard "cerrado" soils couldn't plow until the rains came and softened the ground. As a result, much of the benefit of the early rainfall was lost in runoff. Mechanization allowed them to plow in advance of the rains and therefore reduce runoff, the risk of inadequate moisture, and delayed planting.

Case Studies

The following six projects were selected because of their representativeness and because of the availability of sufficient information on their operations. In order to focus more closely on the issue of farm structure, the analysis was restricted to large-scale agricultural operations only. Colonization schemes and large, integrated development projects with agricultural components were not included for the reason that their success or failure is often a function of events far beyond the viability of their agricultural operations alone. Five of the six projects were private sector operations, which provides further assurance that they were operated and evaluated on the basis of business principles rather than political or other considerations. The only publicly-funded project is the Tanganyika Groundnut Scheme, which is included because it is generally viewed as the classic example of an ill-fated large-scale project.

The Tanganyika Groundnut Scheme[1]

The Tanganyika Groundnut Scheme was the British government's answer to the post WW-II edible oils shortage. The scheme was conceived in 1947 by an executive of the United Africa Company, a subsidiary of Unilever, and involved the mechanized clearing of three million acres in three areas of what was then British Tanganyika, Kenya and northern Rhodesia. Anticipating yields of 1200 lbs/acre, the scheme's goal was to produce 600,000 tons of peanuts in five years at a cost of £26 million (Samuel, 1947). Two years later, after spending £36 million, clearing 220,000 acres, and producing fewer nuts than were originally used as seed, the scheme was abandoned (Voll, 1980).

In spite of a high level of initial enthusiasm and a vigorous publicity campaign, the scheme's difficulties began almost immediately. Finding equipment in the post-war years was difficult, and getting it to the remote project site was a further complication. The project eventually had to build rail cars, railroads and even a new port to support the scheme.

When equipment finally did arrive on site, it promptly broke down, unsuited as North American-made tractors were to the African bush. Since maintenance arrangements were inadequate to say the least, much of the equipment stayed in the shop for most of the first year, which helps explain the low acreage planted. Even when the equipment was functioning, it was often ineffective due to poor design or unsuitability for the task. For example, specially-designed rooting machines ordered from England were utterly inadequate for the job of removing Baobab roots. An old disc plough turned out to be the most successful rooter, but because this was not foreseen, only one was on site.

The scheme also suffered from labor problems which contributed both to its high overhead costs and its low productivity. First, finding workers in the remote project area was difficult and the project undertook the costly construction of housing, schools, utilities, hospitals and other social infrastructure to attract and accommodate its workforce. Second, because mechanization was not used in the region previously, no skilled workers were available who could operate and maintain the equipment. Expensive training programs had to be developed. However, neither the infrastructural investment nor the training programs solved the project's labor troubles because, in general, the native workers did not want to become full-time employees of the project. The preferred to do temporary or seasonal labor and then return to their villages (Voll, 1980).

The mechanical and labor problems contributed to the project's economic failure, however in retrospect the most fundamental problem was the land itself. Ecologically, the region was "unsuitable for extensive economic production of groundnuts" (Phillips, 1959, pp. 344-345). Rainfall was variable and insufficient, and the soil became so hard after the rains that it could not be broken by the ploughs.

The lesson of the Tanganyika Groundnut Scheme is that it used the wrong equipment in the wrong location. Why this happened is largely attributable to project design and management. Many of the ecological and mechanical problems could have been discovered if the project had begun with experimental plots instead of going ahead with the full-scale project. But overconfidence and haste ruled out trials. Further, had communication been open between the project site and the management in London, perpetuation of errors might have been averted. Unfortunately the managers in Africa were reluctant to pass on negative reports, and the board of directors was even less eager to receive them. The size of the project and the distance between decision makers and on-site managers ensured the scheme's failure.

After reviewing the many mistakes which contributed to the scheme's poor showing, Ruthenberg concludes:

> The main reason for the complete failure of the scheme is that mechanized clearing and motorized farming of large areas of marginal soil does not pay. Groundnuts do grow in the area under discussion. Yet yields of 400-800 lbs/acre are not high enough to justify high monetary outlay... On marginal land, hoe cultivation by the African farmers is apparently more competitive (1964, p. 47).

MONACA[2]

The Molinos Nacionales, C.A. (MONACA) sorghum growing project was an attempt by the Venezuelan subsidiary of International Multifoods to adapt to the import-substitution policies being pursued by the Venezuelan government and to meet the growing domestic demand for corn and feed grains. In 1964 sorghum was virtually non-existent in Venezuela. Fewer than 5,000 hectares were planted to the crop in the entire country, and the yields achieved were half of what U.S. farmers obtained. However domestic demand for corn was increasing rapidly, so it seemed sensible that sorghum, a corn substitute which could be grown in much less exacting conditions, should experience an increase in production.

With that motivation, MONACA leased 6,000 hectares in the agricultural Barinas region. It anticipated using large-scale production methods similar to those in the United States. However since high-yielding sorghum was not grown in the country, the first step was to import seed. Unfortunately the seeds did not produce in Venezuela the way they did in the United States, and the process of experimentation and adaptation to combat the low yields and the susceptibility to diseases and pests was so costly and time consuming that the company eventually abandoned the project before it ever reached its intended size and scale.

The seed problem was the primary reason for the failure of the MONACA project. However the company published a report for the Venezuelan government in which it pointed out two other difficulties it would have faced had it been able to expand the operation. The first was that the country lacked an organized distribution system for most commodities. Since sorghum is harvested with a moisture content high enough to be considered perishable, it cannot be stored for long periods pending sale and transportation. An efficient marketing and distribution system is a prerequisite to sustaining a large-scale sorghum industry.

A second problem concerned equipment. Although the project never reached its intended size of operation, it already experienced problems with machinery and other inputs. An increase in the availability of technical support services for both mechanical and chemical inputs would be necessary to support a large-scale sorghum industry.

The MONACA project lasted only two years and cultivated a total of 1,700 hectares at a cost of US$900,000 (Johnson, 1981). However the story does not end here. In 1973 the Venezuelan government began to support the large-scale production of sorghum through a series of policies including a support price. The support also meant a guaranteed market for the crop since the government was obligated to buy and store any unsold grain. This effectively relieved the marketing and distribution constraint. By the mid-1980s the area planted to sorghum increased from almost nothing to over 400,000 thousand hectares, with 65 percent of the increase in production coming from farms of 100 hectares or more (Atkinson and Blaich, 1983).

Jari[3]

Projeto do Jari was the largest private agricultural development project in the world, occupying over three million acres in northeastern Brazil. The combined forestry and agricultural operation still exists today, but is now owned by a consortium of Brazilian businessmen who bought it from its founder, Daniel K. Ludwig, in 1982. Ludwig, an American who made a fortune in shipping, planned to establish a pulp and paper processing concern in the Amazon, complete with on-site mills. He also planned to introduce large-scale mechanized agriculture. Both of these objectives were reached by 1981, but at a cost of US$1.1 billion as opposed to an estimated US$300 million. Nonetheless, Ludwig's reasons for selling Jari were largely political. Disagreement between Ludwig and the Brazilian government over provision of infrastructure led to a forced sale to Brazilian nationals at a price of only US$230 million.

Jari's main operation is its forest products business. A pulpmill and a saw mill were built in Japan and shipped across the ocean and up the Amazon in 1975. The plant is feed by monoculture Gmelina arborea and caribbean pine plantations established on the cleared tropical forest. Beginning in the 1970s, huge rice fields were built in the Amazon floodplain, and by 1979 4,000 hectares were planted, producing nearly nine million tons/hectare/year. Although it accounted for only five percent of the project's expenses, the rice operation was highly capital intensive. Sowing, fertilizing and spraying were carried out with six airplanes, and harvesting was done with a fleet of 42 combines (Fearnside and Rankin, 1980).

Despite some technical successes, the Jari project faced many of the same problems as the Tanganyika Groundnut Scheme. First, with regard to ecology, the fast-growing Gmelina arborea grew only half as fast on some of Jari's soils as it did in Africa or in Central American trials. As a result, the project had to switch to the slower-growing eucalyptus, which lowered the output levels and revenues. The rice operations also had ecological problems. Because rice was a new crop in the area, it had no natural pests or weed problems and grew well during the first few years. However over time, and as fertilizer use increased, pest and disease problems grew. Soil fertility also decreased as the fragile soils were "mined" for their nutrients.

Jari suffered from labor problems as well. As was the case with the Tanganyika Groundnut Scheme, its remote location made developing a work force difficult. High salaries and benefits were offered to lure workers, and the project also undertook massive infrastructural investments--schools, hospitals, an airport and over 2,800 miles of roads--to support its workforce. Despite these amenities, the project had difficulty maintaining its labor force, particularly with contract laborers who had a 200 percent annual turnover rate in 1980 (McIntyre, 1980). Again, the problem was that native workers were attracted to the project as a chance to earn money, not as an opportunity for full-time employment. This was extremely costly to Jari, in particular because of the high training costs, and the project eventually changed its labor policies from encouraging full-time employment to relying short-term contract work.

Little information is available about the profitability of the entire Jari project. However estimates for various individual operations do exist. In 1980, an estimate of profitability was made for the pulp mill based on the assumption of it operating at capacity and producing output from 1985 to 1990. Using World Bank commodity price forecasts for 1979, this production would be valued at approximately US$100 million annually in 1977 dollars. The result is that the project will probably earn only a low return on its investment, but incremental returns on post-1979 investment should be satisfactory (Skilling and Techyan cited by Fearnside and Rankin, 1980, p. 151). Since the mill was still experiencing supply problems in 1984 due to lower than anticipated yields, these estimates should be adjusted accordingly.

Estimates of the rice project's profitability have also been made using development costs based on the first 2000 hectares. Using estimates of land development costs of US$6000 per hectare in 1978 dollars, variable costs of US$1750, and a depreciation period of 11 years, Fearnside and Rankin arrive at a cost estimate of US$2295 per hectare per year. Using US$275 per metric ton as the international rice price and an average yield of nine metric tons per hectare/year, the operation lost money at a rate of US$70/hectare/year (Fearnside and Rankin, 1980, p. 151).

The Dez Agribusinesses[4]

The Khuzestan province of southwestern Iran was the site of one of the largest agrarian transformations of this century. First, in an effort to improve the region's chronically low productivity though improved irrigation, the World Bank undertook construction of a dam on the Dez river in 1958. Then in 1962, a sweeping national land reform was enacted which broke up the regions large estates. Although not its original intention, one of the main thrusts of the land reform policy became the promotion of large-scale, capital intensive agriculture. To this end the government encouraged agribusiness corporations to establish production operations in Iran. By the mid-1970s four international businesses had undertaken operations in the Dez region, but within a decade all were gone, leaving behind over US$50 million in debt and cumulative losses of more than US$1000 per day (Salmanzadeh and Jones, 1980-81).

They businesses were:

- **Hashim Narraghi Agro-Industries of Iran and America (Iran-America)**. California's largest private almond grower, Narraghi's Iran-America leased 20,000 hectares in 1968. They planted vegetables, trees, and vine crops native to the area, and did well with them. They also tried cotton, without success.
- **Iran-California** leased 10,000 hectares in 1970. They were also a California company specializing in vegetables and other field crops. They also attempted to raise cotton.
- **Iran-Shellcott**, a joint venture between Shell Oil, the Omran Bank of Iran and Mitchell Cott, Ltd., leased 15,000 hectares in 1971. They intended to grow cotton, but early failures in this area caused them to switch to wheat.
- **International Agro-Business Corporation of Iran** began operations in 1973. This project was managed by Hawaiian Agronomics, an American company which was also responsible for the Haft Tappeh sugar cane plantation. They tried to reproduce their luck with sugar cane by planting sugar beets, but were unsuccessful. They then switched to alfalfa, but had problems there as well.

All the Dez agribusinesses were all based on the model of California. The most important thing about the climate in Khuzestan, according to a Development and Resources[5] sales brochure was that it is "much like that of the Imperial and Coachella Valleys of southern California" (D&R, no date, p. 58). Thus California-style performance was also expected. Experimental trials at Safiabad suggested that it might be possible (See Table 1). Unfortunately the promise of these trials was never realized by the agribusinesses.

Table 1 **Actual and Projected Yields for the Dez Irrigation Project Based on trials at Safiabad Trial Farm, DIP 1969 (Metric tons per hectare)**

	Actual	1970 Projected	Trial Farm 1967-68
Alfalfa	14.0	18.0	16.0
Berseem	40-45	65.0	80.0
Wheat	1.5	3.5	4.0
Milo	---	4.5	5.0
Barley	1.5	3.0	3.0
Beet, Sugar	---	60.0	70.0
Blackeye Pea	.9-1.0	1.0	2.2
Broad Bean	1.5	2.0	1.2
Sunflower	.9	1.9	2.3
Tomato	15.0	20.0	24.0
Cucumber	8-9	18.0	11.0
Eggplant	17.0	12.0	14.0
Melon	10.0	15.0	18.0
Onion	22-24	30.0	50.0
Carrot	15.0	20.0	25.0
Lettuce	20.0	25.0	20.0
Grape	2.5	7.0	5.0

Source: Strohl, 1985, p. 135.

One of the main problems was land preparation. While the climate was like California's, the land had not been developed over time like it had in the Imperial Valley to produce such high yields. The companies had to do all land preparation themselves, and they vastly underestimated the costs involved. The cost of a well-done job was US$1000 per hectare, double the estimates. Some companies took shortcuts and thus had poorly prepared fields which didn't produce well. Others took care with preparation but as a result could only bring a fraction of their land into production.

Mechanical problems plagued the schemes as well. Getting machines and other inputs through customs initially was difficult and cost at least one company almost a year's time. Further, customs problems frequently interrupted the supply of spare parts, leaving the companies' equipment unusable. Part of this problem could be attributed to the companies' lack of foresight. It has been suggested that the agribusinesses could have gotten along with only two types of tractors, but by 1977 they had 21 different models from eight manufacturers. As a result, keeping an inventory of parts was impossible, and during the summer of 1977 one company could keep only a quarter of its tractors running (Strohl, 1985, p. 146).

Exacerbating these problems was a removed and inflexible management interested in short term profit. When problems arose, managers refused to deviate from their plans, in particular from their reliance on capital intensive farming. Examples of less-expensive, labor intensive farming methods were discovered, but the companies generally refused to adapt. Part of this inflexibility was due to the fact that the projects were, in a sense, undercapitalized. They were huge operations, but they were expected to make quick profits from a limited amount of initial investment. No one expected to spend money over the long term on trial and error experiments. Iran Shellcott, for example, expected to invest £4.4 million, break even after four or five years and then realize a profit of between 10 and 20 percent (Field, 1972). Other projects were in similar straits, and by the time they realized that their original plans wouldn't work, they had too little money left to make changes. Thus they went on planting fields which would not turn a profitable yield.

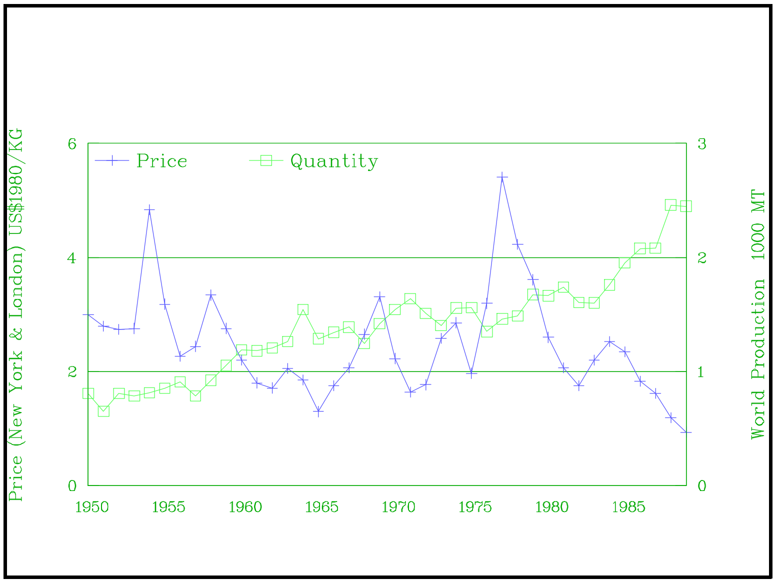
In 1979, the provincial governor admitted that "the agribusinesses would have to disappear and small-scale farms would have to be supported in order to improve the agricultural situation" (Salmanzadeh and Jones, 1980-81, p. 206).

Hershey's Hummingbird Farm[6]

The Hershey Foods Corporation purchased the 728-hectare Hummingbird Farm in Belize as part of a cocoa improvement plan undertaken in the late 1960s. It had two goals in mind: to make a profit and, at the same time, to prove to cocoa producers worldwide that large-scale cocoa farms employing modern technologies and farming techniques could be economically viable. Most of the world's cocoa is produced on farms of fewer than three hectares, and this, for a variety of reasons, contributes to inconsistency in quality and quantity of output. It was this situation that Hershey was trying to improve when it established its large-scale cocoa farm in 1976.

Technically Hummingbird Farm was quite successful. It achieved yields of 1200 kgs/hectare, three times the Belizean average. In order to achieve and maintain these yields the farm had to be very capital intensive, relying on both machinery and management expertise. These costs might have been sustainable had cocoa prices remained at their 1976 record high levels, however they have been falling steadily ever since and the farm has been accruing losses. Figure 1 shows the cyclical nature of cocoa prices, which go in cycles of about eleven years (Ruthenberg, 1980). In 1992, according to Director of Agribusiness B.K. Matlick, Hershey's management decided to sell Hummingbird Farm (Matlick, 1992, personal communication).

Figure 1 Cocoa Prices and Production, 1950-1988[7]



Source: **Prices**: 1950-1977, World Bank (1978); 1978-1989, World Resources Institute (1992). **Production**: USDA (1991).

The Philippine Corporate Farming Program

In 1974, the Government of the Philippines responded to a severe shortage of rice by issuing Presidential Decree 49, the Corporate Farming Law. The law required that every financially viable corporation with over 500 employees provide at least enough rice or corn to feed its employees and their families. The purpose of the program was two-fold: first, to increase food production in the short term, and second, to modernize the farming sector by bringing in the management and technological skills of large corporations.

The companies were given many incentives to comply with the new law. They had several options: they could import the grains, produce them themselves, or make arrangements with farmers to produce under contract. Favorable credit terms were available for those who opted to produce, as was the use of government lands. Corporations were also able to circumvent the country's land reform laws to obtain large tracts of farmland. The average size of corporate farms was 402 hectares (Tadem, 1978, p. 65).

By the end of 1977, 84 corporate farms existed. In spite of the heavy investment and equipment and land development, many experienced difficulties. In one well-known case, the San Miguel Corporation was forced to abandon its project at Aborlan, Pawalan because of disputes with local farmers (Gintong Butil, 1975). In general, "efficiency and productive levels were low, even by Philippine standards" (Bray, 1986, p. 192). Tadem (1978) concludes that the farms were unable to meet the requirements of their employees, let alone produce extra for the market.

Within the program, however, there are examples of farms which did increase their productivity. In contrast to the San Miguel project, two other companies, Mercalo and the Philippine Commercial and Industrial Bank, "linked up with 660 farmers, the former providing the capital and the technology, the latter furnishing the land and labor. Because of improved technology, the farmers increased their yield from 40-50 sacks of rice to 80-110 sacks of rice per hectare" (Farming Today, 1975, p. 35).

Analysis and Lessons Learned

Without further data is impossible to draw definitive conclusions about economies of scale. Nonetheless, the experiences of these projects do not suggest the existence of significant internal scale economies. In fact, this seems to be the case in spite of the fact that each project did experience some external economies of scale such as access to favorable prices and credit. The pecuniary benefits they received as a result of their size appeared to be insufficient to overcome diseconomies which they appeared to face with regard to production.

The Tanganyika Groundnut Scheme, MONACA and the Dez projects provide the clearest examples. Each received a variety of subsidies, however the yields and output they achieved were no better than what small farmers obtained. In other cases, such as Jari's rice operation and Hummingbird Farm, significant increases in production were achieved, but at costs so high as to make them economically non-viable given prevailing world commodity prices. Ruthenberg suggests that this is a familiar situation with large-scale farming in the tropics, and examples from Brazil and Ecuador suggest that when large-scale farming does exist it usually involves government subsidies without which a large farmers returns per hectare would be equal to or even less than a smallholder's (Ruthenberg, 1980). The post-MONACA boom in large-scale sorghum production in Venezuela is another example of the importance government intervention in sustaining large-scale production.

One of the reasons that the companies faced such high costs is that the performance of their machinery varied from disappointing to disastrous. As noted earlier, the Groundnut Scheme, Jari and the Dez agribusiness all had terrible problems with their equipment. Breakdown rates approached 100 percent at times. This trend is confirmed in the literature. Otieno, Muchir and Johnson reported that in 1975 only 40 percent of the tractors of private contractors in Africa were in operation at any given time. A 1968 survey in Ghana found that 78 percent of all tractors owned by the government were broken and awaiting repair (studies cited in Eicher and Baker, 1992, p. 127). MONACA made the same assumption about the transferability of modern technologies and took the same risks with regard to high-yielding seed varieties. They were equally disappointed.

Underlying the mechanization problems was the fact that the companies ignored the relative price signals. In almost every case labor was cheap relative to capital, yet the project managers opted for capital-intensive methods out of habit and/or the belief that machinery was inherently more productive than labor intensive farming. How these projects would have fared had they been labor intensive is impossible to know. The Jari tree operation and a few incidences of sub-contracting in the Dez and the Philippines suggest that that type of operation may have had potential. Labor-intensive techniques would have increased labor costs, especially in the labor scarce areas. However large costs do not seem to have been avoided by exchanging worker training costs and machinery purchase and maintenance expenses for monitoring costs. A switch to labor intensity would likely have implied some type of rental arrangement rather than management of the farms in huge blocks, restoring some of the incentives identified by Brewster.

Uncertainty seems to have been overlooked in these projects. All seemed to believe Hirschman's point about industrialization reducing the part of the project left up to chance. Had they adjusted their expectations for risk, the "get-rich-quick" aspect of the schemes would likely have disappeared, and perhaps the scheme as well.

Risk fell into three categories: ecological, political and market. Ecological risk took the form of variation and uncertainty in weather, soil quality and pests and diseases. The Groundnut Scheme and Jari both contemplated large operations on the assumption that the ecological conditions were consistent throughout the area, as is the case in many developed country farming areas such as the American middle west (Ruthenberg, 1980). In reality, conditions varied dramatically over short distances. The result was that crops and machinery well-suited to one area were ill-suited only a short distance away, which has clear implications for farm size.

Political risk, from the customs problems experienced by the Dez businesses to the de facto nationalization of the Jari project, appeared not to have been anticipated by the project founders either. All these projects were foreign-owned which likely put them more at risk politically than nationally owned operations. In either case, however, political riskiness would reduce incentives for investment.

Market risk can be thought of as the uncertainty a project faces due to input and output price fluctuations. The Hummingbird Farms project was technically successful, but falling world cocoa prices made it a commercial failure because of its very high level of capital investment. Similarly, the Jari project was founded on the expectation of a significant increase in the price of agricultural products, both food and fiber. When these did not materialize, the project had difficulty covering its high costs.

Conclusion

In spite of continual increases in size, farms are still quite small relative to industrial operations. Examination of several very large agricultural projects undertaken in developing countries offer insights into why this is the case. First, internal economies of scale do not appear to exist in agriculture as they do in many industries. In fact, diseconomies of scale can exist above the size of owner-operator due to labor costs. Each of the projects benefitted from external economies of scale, however the advantages here were not significant enough to offset problems elsewhere. While mechanization allowed for an expansion in the area cultivated relative to traditional methods, in every project capital-intensive mechanized farming was either technically infeasible, commercially unprofitable, or both. The main reason was that the companies could not keep their equipment functioning due to a lack of skilled labor and technical support. This was exacerbated by centralized management structures which inhibited the flexible adaptation to local challenges and the flow of information from the project site to decision makers at home. Finally, risk was a factor in many of the projects, and appeared to affect them in proportion to their size.

Endnotes

1. Background information for this case studies comes from Wood (1950) unless otherwise cited.

2. Background information for this case study comes from Nelson (1967) unless otherwise cited.

3. Background information for this case study comes from Strohl (1983) unless otherwise cited.

4. Background information for this case study comes from Strohl (1985) unless otherwise cited.

5. Development and Resources Corporation was founded in the early 1950s by David Lilienthal, former director of the Tennessee Valley Authority (TVA). The company sought to develop large integrated development projects based on the TVA model. D&R did very well in the 1950s and 1960s, with projects in Colombia, Ivory Coast, Afghanistan, Vietnam, and, most importantly, Iran. By 1968, Iran was D&R's biggest client. During the 1970s the company suffered from extensive personnel problems, with entire departments leaving the company to form rival firms. The company was finally closed following the 1979 revolution in Iran, where D&R had 85% of its business (*Agribusiness Worldwide*, June/July 1981, p. 49).

6. Background information for this case study comes from Harler (1981) unless otherwise cited.

7. Prices for 1950-1977 were given in 1977 dollars and converted to 1980 dollars by the formula $P_i=\dot{P}_i(P_{1977}/\dot{P}_{1977})$ where P = 1980 dollars, $\dot{P}$ = 1977 dollars, and i=(1950, 1951 ... 1977).

REFERENCES

Atkinson, L.J. and O.P. Blaich. 1983. Venezuela: A Prospective Market for Grain and Livestock Products. USDA/ERS Foreign Agricultural Economic Report No. 189. Washington, DC.

Berry, R.A. and W.R. Cline. 1979. Agrarian Structure and Productivity in Developing Countries. Baltimore: Johns Hopkins University Press.

Binswanger, H.P., K. Deininger and G. Feder. 1992. "Power, Distortions and Reform in Agricultural Land Markets." Prepared for Handbook of Development Economics, Vol.III, Eds. Jere Berman and T.N. Srinivasan.

Binswanger, H.P. and G. Donovan. 1987. Agricultural Mechanization: Issues and Options. World Bank Policy Study. Washington, DC.

Bray, F. 1986. The Rice Economies: Technology and Development in Asian Societies. Oxford: Basil Blackwell.

Brewster, John M. 1950. "The Machine Process in Agriculture and Industry." Journal in Farm Economics 32: 69-81.

Coase, R.H. 1992. "The Institutional Structure of Production." The American Economic Review 82(4): 713-719.

de Janvry, A. 1987. "Farm Structure, Productivity, and Poverty." Working Paper No. 432. Department of Agricultural and Resource Economics, University of California, Berkeley.

Development and Resources Corporation. No date. Farm Corporations for the Dez Irrigation Project. Produced for the Imperial Government of Iran and Khuzestan Water and Power Authority by Development and Resources Corporation.

Eicher, C.K. and D.C. Doyle. 1992. "Agricultural Development in Sub-Saharan Africa." in ed. L. Martin. A Survey of Agricultural Economics Literature. Published by the University of Minnesota Press for the American Agricultural Economics Association.

Etherington, D.M. 1973. "Economics of Scale and Technical Efficiency: A Case Study in Tea Production" Journal of Rural Development 3: 72-87.

Farming Today. 1975. "Why Some Companies Opt Out." 1:33-35.

Fearnside, P.M. and J.M. Rankin. 1980. "Jari and Development in the Brazilian Amazon." Interciencia 5(3):147-156.

Fearnside, P.M. and J.M. Rankin. 1980. "Jari and Development in the Brazilian Amazon." Interciencia 5(3):147-156.

Field, M. 1972. "Agro-business and agricultural planning in Iran." World Crops March/April:68-72.

Gintong Butil. 1975. "SMC Explains Project Pullout." 3(8):1, 5.

Harler, C. 1981. "Hummingbird Farm: Hershey's Hope for More Abundant and Improved Cocoa." Agribusiness Worldwide, April/May: 22-29.

Hayami, Y. and V.W. Ruttan. 1972). "The Induced Innovation Model of Agricultural Development." in eds. C. Eicher and J.M. Staatz Agricultural Development in the Third World. Baltimore: Johns Hopkins University Press. (1990).

Hayami, Y. and V.W. Ruttan 1985. Agricultural Development: An International Perspective. Baltimore: Johns Hopkins University Press.

Heaton, L.E. 1969. The Agricultural Development of Venezuela. New York: Praegar Publishers.

Hirschman, A.O. 1967. Development Projects Observed. Washington, DC: The Brookings Institution.

Johnson, D. 1981. "Responding to Nationalism: International Multifoods Strategy in Venezuela." Agribusiness Worldwide February/March: 38-42.

Klock, J. 1992. "Risk, Sorting and Inequality in Malaysia." Mimeo. University of Minnesota. June 22.

Lele, U. and M. Agarwal. No date. "Smallholder and Large-Scale Agriculture in Africa: Are There Trade-Offs between Growth and Equity?" MADIA Discussion Paper No. 6. The World Bank. Washington, DC.

McIntyre, L. 1980. "Jari: A Massive Technology Transplant Takes Root in the Amazon Jungle." National Geographic 155(5): 693-711.

Mellor, J.W. and M.S. Mohinder. 1992. "Agriculture in Economic Development: Theories, Findings and Challenges in an Asian Context." in ed. L. Martin. A Survey of Agricultural Economics Literature. Published by the University of Minnesota Press for the American Agricultural Economics Association.

Nelson, C.F. 1967. Ensayo sobre el Cultivo del Sorgo Granifero en Barinas: Proyecto MONACA. Caracas: Consejo de Bienestar Rural.

Peterson, W. and Y. Kislev. 1991. "Economies of Scale in Agriculture: A Reexamination of the Evidence." Staff Paper P91-43. Department of Agricultural and Applied Economics, University of Minnesota.

Phillips, J. 1959. Agriculture and Ecology in Africa. London: Faber and Faber.

Putterman, L. 1983. "A Modified Collective Agriculture in Rural Growth-with-Equity: Reconsidering the Private, Unimodal Solution." World Development 11(2): 77-100.

Ruthenberg, H. 1964.Agricultural Development in Tanganyika Berlin:Springer-Verlag.

Ruthenberg, H. 1980. Farming Systems in the Tropics. Oxford: Clarendon Press.

Ruttan, V.W. 1988. "Scale, Size, Technology and Structure: A Personal Perspective," Staff Paper P88-1. Department of Agricultual and Applied Economics, University of Minnesota.

Salmanzadeh, C. and G.E. Jones. 1980-81. "Transformations in the Agrarian Structure in Southwestern Iran." Journal of Developing Areas 15(2): 199-214.

Samuel, F. 1947. "East African Groundnut Scheme." United Empire 38(May/June): 133-140.

Sanders, J.H. 1973. Mechanization and Employment in Brazilian Agriculture, 1950-1971. Ph.D. Dissertation. University of Minnesota.

Strohl, R. 1983. "Amazon Agro-forestry: Projeto do Jari." Agribusiness Worldwide March/April: 12-19.

Strohl, R. 1985. "Farming Failures: The Fate of Large-Scale Agribusiness in Iran." in ed. J. Freivalds. Successful Agribusiness Management. Vermont: Gower Publishing Company.

Tadem, E.C. 1978. "Peasant Land Rights and the Philippine Corporate Farming Program." Philippine Social Sciences Review. 42(1-4): 56-76.

USDA/ERS. 1991b. World Agriculture: Trends and Indicators database. Washington, DC.

Voll, S.P. 1980. A Plough in Field Arable London: University of New Hampshire by University Press of New England.

Wood, Alan (1950), The Groundnut Affair, The Bodley Head, London.

World Bank (1978), Commodity Trade and Price Trends, Report No. EC-166/78, Washington, DC.

World Resources Institute (1992), A Guide to the Global Environment database.