

1 Introduction

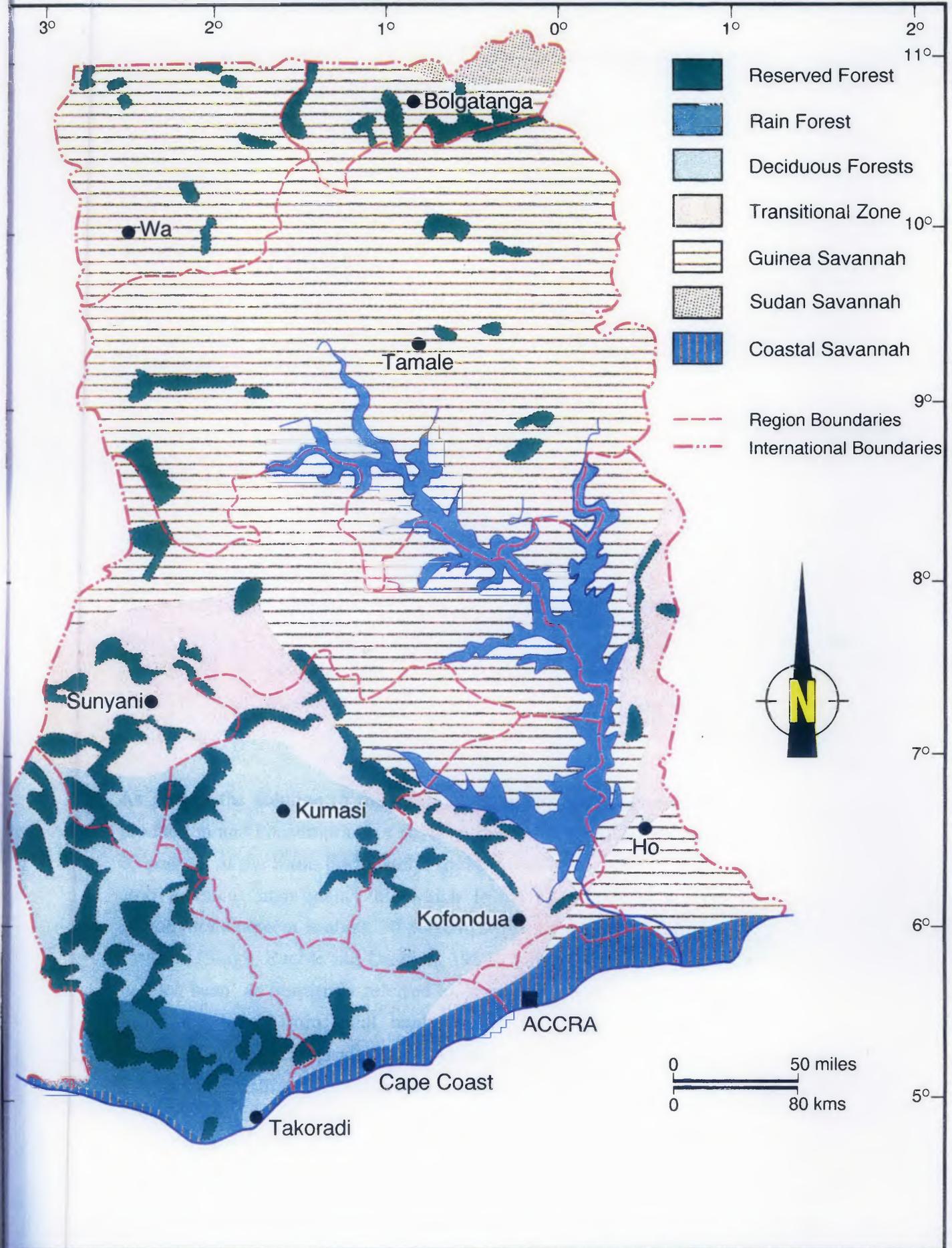
1.1 An Overview of the Ghanaian Agricultural Sector

Ghana is a small country on the West African coast, located between latitudes 4° and 11° N. Its total area is 238 540 square km with a boundary of 2093 km. It has tropical conditions with light textured top soils, mostly sandy loam and loams. Lower soil horizons are of slightly heavier textures varying from coarse sandy loams to clays. There are six main agro-ecological zones defined on the basis of climatic conditions and soil type. The agro-ecological zones are the rain forest, deciduous forest, transitional, coastal savannah, Guinea savannah and Sudan savannah zones. A map showing these zones is found in Figure 1.1. Climatic and soil conditions support several food crops with the major ones being maize, rice, millet, sorghum, cassava, yam, cocoyam, plantain, groundnut, cowpea, pineapple, citrus, banana, tomatoes and other tropical vegetables.

Agriculture is both the largest and most important sector in the Ghanaian economy. The sector's importance is by virtue of its contribution to several economic variables. Agriculture's contribution to GDP has fluctuated between 45 and 60 percent annually since 1980. Export tax on agricultural commodities forms a significant portion of government revenue. Export tax on cocoa alone accounted for 12 percent of the total government revenue in 1990 (ISSER, 1991). Agriculture provides 60 percent of total export earnings (PPMED, 1991). The sector employs 66 percent of the labour force, while it supports some 80 percent of the population directly or indirectly through farming, distribution of farm produce and provision of other services within the sector (PPMED, 1991). These proportions are likely to increase with employees in the public sector being redeployed under the Structural Adjustment Program (SAP) launched in 1986.

With an estimated annual population growth rate of 2.6 percent, Ghana's population is expected to increase from 14.1 million in 1990 to 18.7 million in the year 2000. It is important to note the implications of such population growth for increased demand for food. The population distribution is skewed in favour of the very young. Estimates show that 47.2 percent of the population are under 15 years and 35.6 percent are less than 10 years. The high youthful population, coupled with a high rate of rural-urban migration,

Figure 1.1:
Agro-ecological Zones in Ghana



has given rise to population pressures on the demand and supply for food as well as for social and community services. Statistics show that domestic food production has not kept pace with rapid population growth (ISSER, 1991). Agricultural gross domestic product grew at only 1.5 percent per annum between 1987 and 1989 and was negative in 1990.

The poor performance of agriculture in Ghana is mainly due to the fact that the sector is still heavily dependent on natural factors (ISSER, 1991). Eighty-five percent of the 1.8 million land holders are small-scale operators, farming less than two hectares and using traditional labour intensive methods of cultivation. Food crops that showed encouraging growth rates in recent years were groundnuts, maize and cowpeas (PPMED, 1991).

Production of meat is insufficient to meet local annual demand of about 200 000 tonnes due mainly to prevalence of animal diseases and low production. Imports of livestock and meat have continued to fall in recent years due to foreign exchange shortages. Meat is therefore relatively expensive. Domestic fisheries supply only about 50 percent of the total annual demand of 600 000 tonnes.

The statistics provided indicate that aggregate nutrition requirements are not adequately met. This factor, among others, contributes to the poor state of health of the people, particularly of the rural folk who are predominantly farmers. It is therefore not surprising that agricultural productivity and output are low and this vicious cycle continues.

As part of the solution to this nutrition problem, Government sought to promote the production and consumption of soybean due to its high-quality protein content - about 40 percent of the bean. Fortunately, soybean can be adapted to tropical conditions. The crop produces high-quality oil which forms about 20 percent of its content. The carbohydrate content is about 30 percent, while soluble sugar forms about 10 percent of the bean (Singh, Rachie and Dashiell, 1987). Indeed, there is no doubt that the crop is a 'golden bean' as frequently referred to. Incentives to farmers for its production include subsidised loans from local banks to purchase high-yielding seed and fertiliser. Promotion of soybean production in Ghana has received considerable support from the International Institute of Tropical Agriculture (IITA).

The goal of the Ghanaian Ministry of Agriculture, in launching the Medium Term Agricultural Development Program (1991-2000), is to achieve food-sufficiency by the year 2000. The Ministry is determined to:

provide an enabling environment for the efficient production of food and agricultural raw materials at world competitive prices by encouraging those commodities and value-added activities where Ghana has both comparative and competitive advantages (PPMED, 1991, p.vii).

1.2 The Research Problem

The Ministry of Agriculture is currently engaged in a project to promote soybean production and consumption. This seems to imply that Ghana has a comparative advantage in the production of the crop. However, soybean is generally a new crop to most regions in Ghana and does not form part of the traditional diet. The demand for human consumption is low for various reasons, including taste, discouraging cooking properties and ignorance.

Efforts to process the pulse into vegetable oil have not been encouraging due to competition from groundnut which has a higher oil content and a higher production growth rate. In addition, groundnut is a popular crop and forms part of the diet of most households. Ghana does not export soybean or soybean products (Kolavalli, Williams and Kauffman, 1987). Hence, there is a marketing problem for farmers.

An obvious solution, as suggested by many, is to generate effective demand for the commodity through processing and developing markets (domestic and overseas). However, due to very limited resources, it is necessary to establish the economic profitability of producing, processing and marketing the commodity in Ghana before more resources are sunk into its promotion. Moreover, with the current economic structure, the potential for expansion depends on the capacity of the product to provide a remunerative level of yield and on favourable incentives for farmers to begin or to increase production (Kolavalli, Williams and Kauffman, 1987).

In this context, the research problem to be studied will be limited to the investigation of the economic efficiency (profitability) of producing soybean in Ghana under the country's current socio-economic structure.

1.3 Objectives of the Study

The purpose of this study is to evaluate the production of soybean in Ghana, using the domestic resource cost (DRC) approach, and to test the sensitivity of the results to changes in the opportunity cost of land and labour, the world price of soybean and the official exchange rate. The main objective of this study is to ascertain whether Ghana has a comparative advantage in the production of soybean.

Subsidiary aims are to:

- i) estimate the financial viability of producing soybean in Ghana under the current socio-economic structure;
- ii) estimate the economic viability of producing soybean in Ghana under the existing social structure;
- iii) calculate the financial Domestic Resource Cost (DRC) ratio of producing soybean under the existing socio-economic structure;
- iv) calculate the economic DRC ratio of producing soybean under the current social structure; and
- v) use the findings of the study to make recommendations for policy decisions related to soybean production in Ghana.

1.4 Definition of Terms

1.4.1. Comparative Advantage

A country has comparative advantage in the production of a commodity if the social opportunity cost of producing an incremental unit of the commodity is less than its border price. This definition is based on the concept of social opportunity cost. Evaluating the comparative advantage of producing a commodity is equivalent to evaluating its net social profitability (NSP). A country has comparative advantage in the production of a commodity if the net social profitability is positive (Pearson, Akrasanee and Nelson, 1976).

1.4.2 Net Social Profitability

NSP is defined as the net gain or loss derived from an economic activity when all commodity outputs, material inputs and factors of production employed are evaluated at their social opportunity cost and when all external effects on the domestic economy are given a social valuation and included directly (Pearson, Akrasanee and Nelson, 1976). It is therefore, a measure of economic efficiency.

1.5 Hypotheses

Based on the problem and objectives set out for the research, the guiding hypothesis will be:

Ghana has a comparative disadvantage in producing soybean under the current socio-economic structure.

Since this hypothesis could be tested in different ways, the following will be the working hypotheses:

- i) Producing soybean is financially unprofitable in Ghana under the current socio-economic structure;
- ii) Producing soybean is economically unprofitable in Ghana under the existing social structure;
- iii) Ghana has a comparative disadvantage in financial terms to produce soybean; and
- iv) Ghana has a comparative disadvantage in economic terms to produce soybean.

1.6 Justification of the Study

It is apparent that the major objective of promoting the production of soybean in Ghana is to ensure social equity in terms of nutritional standards. As the primary aim of the Government, relative to soybean production, is to promote its consumption at fairly low prices, it must be established whether it is more viable economically to produce the product locally or import it. Findings from this study will form the basis for suggesting how the primary objective could be attained with minimum tradeoff in terms of economic efficiency. However, the economic calculations do not provide the only basis

for deciding to encourage or discourage the production of soybean in Ghana. Nonetheless, they give an estimate of the real benefits and costs to the Ghanaian economy of producing the crop domestically.

1.7 Outline of the Study

The study is presented in seven chapters. In the next chapter, the second, literature on the socio-economic structure of Ghana, food self-sufficiency, and conceptual and methodological aspects of comparative advantage are reviewed.

The Ghanaian soybean commodity system is discussed in the Chapter 3. In Chapter 4, the theoretical framework of the method of analysis is presented. This involves an explanation of the analytical procedures. Chapter 5 presents an empirical analysis of soybean production in Ghana by applying the analytical method discussed in Chapter 4. Results of the analysis and policy implications will be discussed in the sixth chapter. Recommendations are provided in the same chapter and conclusions of the study form the content of the final chapter.

2 Literature Review

2.1 Introduction

The major economic reason for nations to aim at self-sufficiency is to save foreign exchange. There is the assumption that producing a commodity locally, by any system, will use less foreign exchange than importing it. Unfortunately the real cost of saving foreign exchange is often overlooked. According to Herdt and Lacsina (1976, p.213):

while domestic production may save foreign exchange under some conditions, it is of considerable interest to identify the efficiency of saving foreign exchange by alternative production system or an integration of them.

In their view, it is necessary to evaluate the scarcity values of domestic resources and of tradable inputs. Further more, subsidies and taxes make prices paid by producers differ from those borne by the economy. Hence, it is necessary to measure the efficiency with which foreign exchange can be saved or earned from a particular production process. This economic efficiency of production can be determined using the domestic resource cost (DRC) approach.

In the next section, literature on Ghana's socio-economic structure is reviewed to provide the supposed justification for the country's policy of food self-sufficiency. This is followed by reviewed literature on food self-sufficiency and nutrition policies. Conceptual and methodological aspects of comparative advantage form the content of the fourth section of this chapter. The final section consists of reviewed literature on previous studies using the DRC approach.

2.2 The Socio-economic Structure of Ghana

2.2.1 Macroeconomic environment

The Ghanaian economy experienced its worst performance during the period between 1974 and 1983 and started recovering after the introduction of the economic recovery program (ERP) in April, 1983. During the decade prior to 1984, the economy registered a decline of 1.3 percent per annum in real national income. The decline is even more

depressing after accounting for population growth which implies a decline of 3.5 percent per capita per annum. On average, since 1984, real national income has increased at a rate of 5.3 percent per annum or when population growth is accounted for, at 2.3 percent (ISSER, 1992).

Fiscal, monetary, investment, credit, income distribution and trade policies are the main policies that define the macroeconomic environment. Changes in these policies affect all economic activities but at varying degrees and in different directions (Tshibaka, 1993). Ghana initiated a series of fiscal and monetary policy reforms between 1983 and 1991 to stimulate an economic recovery. The major components which have implications for government finances are:

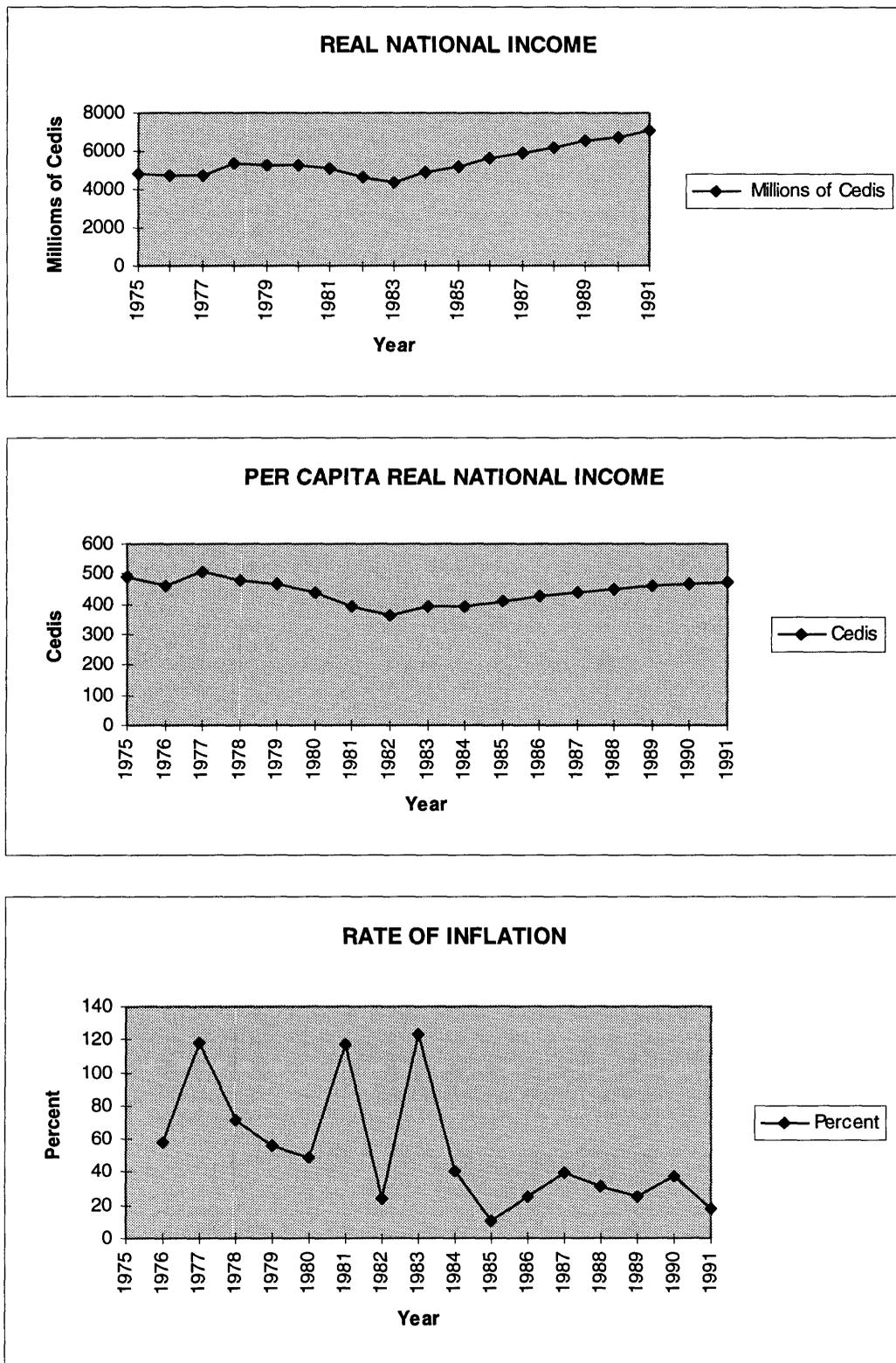
- reforms of the tax system;
- measures to eliminate government budget deficits through government expenditure rationalisation;
- instruments used to move toward a more realistic exchange rate with a series of devaluations of the Cedi (the Ghanaian currency); and
- trade and exchange rate liberalisation measures.

These macroeconomic policies are supplemented by sectoral and institutional reforms aimed at encouraging savings and investments and introducing efficiency.

The effect of these measures on some key macroeconomic indicators are summarised in Figure 2.1 which shows trends before and after the introduction of the ERP. The rate of inflation is measured by using the consumer price index (CPI); it is therefore a good measure of the cost of living of Ghanaians (ISSER, 1992).

Until 1986 government expenditure exceeded total government revenue but the prudent fiscal measures since then have brought about a change. From Table 2.1, it is clear that government expenditure on economic services decreased at the expense of social services. The situation is due to government's intention to reduce its participation in production and distribution systems.

Figure 2.1: Trends in Key Ghanaian Macroeconomic Indicators



Source: Ghana Statistical Services; Bank of Ghana.

**Table 2.1: Composition of Government Expenditure
(percentages)**

	1983	1984	1985	1986	1987	1988	1989	1990
General Services	27.1	27.1	29.4	24.4	49.0	21.8	20.6	21.2
Community and Social Services	31.6	36.3	37.7	39.7	43.2	44.7	44.5	46.4
Economic Services	20.9	18.4	16.6	15.1	18.5	17.2	16.2	14.5
Other Purposes	17.6	15.3	11.8	17.2	14.9	12.4	14.9	14.4
Net Lending	2.8	2.9	4.4	3.6	4.5	4.0	3.9	3.6

Source: ISSER (1992, p. 39).

The balance of trade has been in deficit since 1981 with the exception of 1982 as shown in Table 2.2.

Table 2.2 : Balance of Trade (million US\$)

Year	Trade Balance
1980	132
1981	-310
1982	10
1983	-100
1984	-114
1985	-96
1986	-56
1987	-198
1988	-210
1989	-293
1990	-423
1991	-417

Source: Bank of Ghana, Accra.

Since 1983, the value of foreign exchange transferred by the private sector into the country has exceeded the corresponding transfers to outside the country. Unfortunately, the positive net private transfers could not offset the huge deficit in current account. The deficits in the current account balance have been financed by a combination of grants, official long-term and short-term loans, direct foreign investments and International Monetary Fund (IMF) financing arrangement (ISSER, 1992).

Tshibakata (1993) indicates that credit and investment policies appear not to have received proper attention in the development of Sub-Saharan Africa. His assertion is

confirmed by credit and investment information provided by ISSER (1992). Lending by the banking system is dominated by the public sector—about 62 percent between 1980 and 1987. Until 1988 the Bank of Ghana prescribed sectoral limits to be applied by banks in lending. The limits, which were altered periodically to reflect macroeconomic aspiration, hardly coincided with the economic considerations of the banking system. Fortunately, the removal of sectoral limits began in 1988 and the last direct control measure (i.e., 20 percent of all banks' lending to the agricultural sector) was removed in 1991. In adopting a financial sector adjustment program in Ghana in 1985, it was expected that banks would set interest rates to reflect credit supply and demand conditions, and increase credit to competitive sectors. Contrary to this expectation, the volume of loans made by the banks has shrunk and deposit rates lag behind lending rates. By 1990, interest rates had not had significant impact on savings mobilisation in Ghana. As far as agricultural credit is concerned, preference is given to cash crops over food crops (Yaker, 1993).

While public investment strategies have helped to rehabilitate the country's roads, harbours and other forms of physical infrastructure, reduction of liquidity in the financial system has constrained the flow of investible funds to the private sector (ISSER, 1992). Yaker (1993) notes that investment in other support services such as research and extension, technical inputs, and mastering of adapted biotechnological discovery are inadequate. Marketing, processing and storage also leave much to be desired.

There is an implied assumption in the policy package of the SAP that institutional arrangements are in place, and investors are ready and waiting for the right signal to respond to the challenges. Unfortunately, in Black Africa:

... favourable economic conditions for manufacturing such as an integrated domestic market, a literate and technologically adaptable labour force, and the necessary network of institutional mechanisms (financial, legal and regulatory) are not the only problems confronted with. They are also faced with the problem of political instability which puts them high on the risk scale for venture capital (Fitzgerald, 1992, p. 90)

For this reason, while the favourable economic environment in Ghana may be attractive to foreign investors, the likelihood of a rapid inflow of private capital is remote.

2.2.2 Social structure

A study of social indicators for Ghana leaves one with mixed feelings about the structural adjustment program introduced in 1986. Statistics provided in the previous section suggest positive economic growth; however, it has been associated with some unfavourable social costs such as poverty and unemployment. On realising its failure to address social welfare in the SAP, the Ghanaian government introduced the Program of Action to Mitigate the Social Cost of Adjustment (PAMSCAD). This has led to notable increases in government expenditure on community and social services as shown in Table 2.1.

For the purpose of the study, the social indicators discussed in this section are poverty, hunger and malnutrition, education, and health. Of equal importance is population structure which was mentioned in the introductory chapter. These factors, invariably, have direct relationships with other social factors that are mentioned occasionally for illustrative purposes. A summary of government expenditure on community and social services is given in Table 2.3.

Table 2.3: Composition of Government Expenditure on Community and Social Services (percentages)

	1983	1984	1985	1986	1987	1988	1989	1990
Education	62.9	53.9	56.5	58.1	58.1	58.1	52.4	35.0
Health	13.5	22.8	22.1	20.1	20.6	20.6	21.8	21.0
Social and Welfare Services	13.1	11.3	12.4	13.0	13.0	14.2	15.8	15.0
Housing and Community Amenities	5.1	5.9	4.6	4.7	4.7	1.8	5.7	5.5
Recreational, Cultural and Religious Services	5.4	6.0	4.4	4.1	4.1	4.7	4.2	5.6

Source: ISSER (1992, p. 40).

According to ISSER (1992), 6.6 million people were estimated to be below the poverty line in 1990, with 56 percent of these living in rural areas. A study based on the Ghana Living Standard Survey (GLSS) shows that during 1987-88, 36 percent of Ghana's population were in household units with per capita consumption of less than two-thirds of the overall average.

Poverty is normally associated with hunger and malnutrition. Monckeberg (1983) asserts that there is a direct correlation between income and the amount of calories consumed in less developed countries; those groups of population with higher income

receive more calories. Between 1984 and 1986 most Ghanaians obtained only 76 percent of their daily calorie requirement. This percentage was below the estimated average of 89 percent for least developed countries (ISSER 1992).

Derban (1971) lists the following as the other factors that contribute to malnutrition in West Africa:

- food taboos, superstition, prejudices towards some kinds of food, religion, customs and traditions influencing patterns of food consumption;
- habits;
- ignorance of the general principles of nutrition;
- wastage in production, distribution and storage (about 20 percent of output); and
- relatively high food price (compared with wages).

A study on food intake and nutritional status in Ghana revealed that protein intake was more than adequate. However, under conditions of insufficient calorie intake most of the protein is broken down to provide energy; thus it is not available for its usual function of tissue building (Ewusi, Dapaah and Atsu, 1984). This leads to poor health and low levels of resistance to infections. Research findings also indicate that full-term African babies are often more precocious than American and European babies. However, the precocious development quotients of African babies start falling as early as six months and lags behind norms by the time the children are weaned.

Generally, health is considered as a public good and its consumption falls if provided in the market place, especially in developing countries. Government involvement is, therefore, imperative in Ghana. Development attempts in the health sector are geared towards increasing access to quality health services through the implementation of effective primary health programs designed for both rural and urban communities. Unfortunately, medical and health facilities are often absent or inadequate in the rural areas. The main constraints are lack of funds and too few medical personnel at all levels for the type of coverage that is envisaged (ISSER, 1992). From Table 2.4 it is observed that even the few medical personnel available are poorly distributed among the regions of the Country. The Greater Accra region, which is the smallest, has the best health facilities in Ghana. Statistics show a remarkable disparity between life expectancy in rural and urban areas, and the average national figures are 53 for male and 56 for female (Songsore, 1992).

**Table 2.4: Regional Inequality in Access to Health Care
(percentages)**

Region	Specialist Doctor	Medical Officer	Professional Nurses	Doctor/ Population Ratio	Bed/ Population Ratio
Greater Accra	46.5	43.8	38.1	1:6400	1:400
Ashanti	20.9	22.9	16.8	1:18 000	1:500
Western	2.3	7.9	6.2	1:27 000	1:800
Volta	2.3	6.8	8.2	1:34 000	1:500
Eastern	4.7	5.0	11.9	1:65 000	1:800
Central	6.9	5.2	6.5	1:40 000	1:800
Brong- Ahafo	2.3	2.9	2.8	1:79 000	1:850
Northern	9.2	2.9	4.8	1:65 000	1:1100
Upper East	2.3	1.1	3.3	1:110 000	1:700
Upper West	2.3	1.6	1.5	1:63 000	1:850
Total	100	100	100	1:24 000	-

Source: Adapted from Songsore (1992).

Information provided by ISSER (1992) indicates that justification for government's involvement in education is both economic and social since education is both an investment and a consumption good. There have been considerable reforms in education in Ghana since 1987. The rationale for the reforms is to increase access to first cycle education and also to increase the practical and vocational content of education. The main constraint to the reforms has been lack of adequate funds to improve existing facilities and provide additional facilities in the form of classrooms, workshops, equipment and tools. The result is a wide variation in the standard of education between the urban and the rural schools, with advancement to higher levels of education being heavily skewed in favour of urban children.

Estimates in 1990 show that 60 percent of the population aged 15 and above could read and write (ISSER, 1992). It is clear from Table 2.3 that government has made serious

attempts to shift its spending on community and social services away from education, and especially to health.

Though a lot has been done to rehabilitate the social infrastructure of the country, Ghana is still a long way off the state of social infrastructure that existed in the mid 1970s. Thus the recent development attempts described above are likely to continue for a while with State domination in the provision of social services.

2.3 Food Self-sufficiency

Food self-sufficiency has been defined as the capacity of a community, country or region to produce within its borders all the food requirements needed by all segments of its population throughout the year on a continuing basis (Okigbo, 1984). This definition identifies three important issues which are:

- a. the provision of food requirements for all;
- b. production of the food requirements within the region in question; and
- c. availability of food at all times.

The first two of these issues are discussed in the next two sub-sections. Sustainable food production which forms the content of the third issue is beyond the scope of this study.

2.3.1 Provision of all food requirements

Available literature on food self-sufficiency emphasises the need to provide the calorie requirement of all people, e.g., Atsu, Dapaah and Ewusi (1984) and Monckeberg (1983). This calls for the availability of balanced diets for all residents of a region. The failure to meet dietary requirements is termed malnutrition.

Valdes (1983) points out this issue with the statement that 'nutritional well-being has become an explicit objective of the social policy of most countries'. Attempts at solving the problem of nutrition raise questions about which policy options to adopt and how agricultural policies can help achieve the objective. Indeed, a careful investigation of the factors that cause malnutrition is likely to suggest the policy options to adopt.

Though many experts have identified a number of factors that cause malnutrition, they still maintain the view that poverty is always the main factor, e.g., Monckeberg (1983). This view is supported by empirical findings that suggest that groups of population with higher incomes receive more calories. Monckeberg notes that the degree of severity of malnutrition is directly linked to the degree of economic and social development and that various indices of development correlate well with the nutrition status of the infant population.

There is, therefore, a growing belief that attempts at eradicating malnutrition without serious pursuance of socio-economic development are likely to be difficult if not unsuccessful, e.g., Valdes (1983) and Mora (1983). Timmer (1986) asserts that the impact of the macroeconomy on the food system (i.e., food production, processing, marketing and consumption) is so powerful that it often dooms all efforts of policy makers within the agricultural sector to make any headway in agricultural development when the macroeconomic environment sends contrary signals. Even though Timmer (1986) notes the importance of the long-run dynamism of integrating food policies into macroeconomic development, he is quick to point out that the need for the poor to live in the short-run makes it necessary to adopt potential interventions that can bridge the short-run and long-run effects. This view is supported by Tironi (1983, p. 51) who states that government nutrition intervention should 'follow a long-run strategy aimed at maximising economic growth while in the short term it implements some assistance and corrective social programs'. It is difficult to increase food production in poor countries through partial solutions and evidence shows that food production only increases in parallel with socio-economic development (Monckeberg, 1983). It is for this reason that experts who believe in the holistic approach think that nutrition programs of necessity have limited success.

Others, on the other hand, believe that what is necessary is economic growth and that resources created will permeate the different strata of society and improve the lot of more individuals. However, facts have proved this concept to be mistaken (Monckeberg, 1983; Todaro, 1989). Monckeberg cites an example from Latin America where economic development led to widening social differences.

Adequate nutrition, though it is a very basic need, is difficult to fulfil because of the complexity of the problem. This raises questions about the usefulness of nutrition intervention programs. However, when these programs are scrutinised, it becomes apparent that those that fail are either unilateral and do not consider all the factors that

condition the appearance of malnutrition, or their coverage is inadequate and not long enough to induce significant changes.

The fact that there have been instances in which these programs have been successful calls for an analysis of the reasons for success. According to Monckeberg (1983), success achieved in some nutrition intervention programs is a consequence of many years of intervention supported by some of the following elements:

- The holistic approach that involves the coordination of health, education, sanitation and nutrition programs.
- Development of efficient socio-economic infrastructure.
- Scientific support through basic applied and operational research that allows programs to be developed and evaluated with an efficient cost-benefit relationship.
- Political stability.

2.3.2 Provision of all food requirements domestically

The World Food Council and FAO argue that national food self-sufficiency is fundamental to food security. Thus, LDCs are expected to aim at self-sufficiency in basic foodstuff just as the European Community countries did in the 1960s and 1970s. According to Brown and Goldin (1992), it calls for LDCs to insulate themselves from the world economy.

For West Africa, an argument for food security based on the policy goal of import substitution favours a selective closure of the food economy. It is argued that the "import incapacity" of West African countries does not allow sustainable imports of food for a long time. As indicated by Valdes (1991), the prescription to limit agricultural trade in the region stems from the following conditions:

- External demand prospect of West Africa's agricultural exports are not seen to be favourable.
- Production of cash crops and of food crops are regarded as trade-offs rather than complements.
- Lack of congruency between food items produced and those consumed. Dietary habits are shifting away from traditional staples towards importables.

The net effects are balance-of-trade problems which often call for import substitution measures.

However, studies in West Africa by Krueger, Schiff and Valdes (1988) and Stryker (1990) conclude that the lack of “import capacity” stems directly from policies pursued and not from fundamental structural impediments in the domestic or the world economy. Until the recent introduction of structural adjustment programs, West African countries were noted for agricultural policies that tax export producers and subsidises importables. The effects of these and other macroeconomic policies are distortions in prices and exchange rates. Thus, Valdes (1991) suggests that a more efficient remedy for the “import incapacity” of West Africa’s food sector is to correct the exchange rate and allow for trade. He is, however, quick to note that there is a good case for selective nominal protection for production of thin-market tradables.

In their argument against food self-sufficiency, Brown and Goldin (1992) attest that some developing countries obviously have a revealed comparative advantage in the production of non-food products and in importing basic foodstuffs. Such countries are better off if they do not insulate themselves from the world economy. They argued further that there may be no plausible international price at which a country like Ethiopia has a comparative advantage in growing its traditional staple cereal, (which is unique to Ethiopia). They obviously do not perceive self-sufficiency to be a panacea for poverty and nutrition concerns within most LDCs.

One school of thought argues that food imports, at least for rapidly developing countries, are positively correlated with food production. The underlying assumption of this argument is that a successful food-based agricultural development will have multiplier effects that raise basic food demand even beyond the initial stimulus coming from additional incomes in basic food production (Brown and Goldin, 1992).

In fact, the implementation of policies for self-sufficiency is not realistic in most LDCs where agricultural growth lags behind population growth and hence, the maintenance of adequate domestic consumption requires food imports.

According to the World Food Council the concept of food security has evolved and has ‘generally come to mean all people at all times having access to enough food for an active and healthy life’ regardless of where it is produced (Brown and Goldin, 1992).

2.4 Conceptual and Methodological Aspects of Comparative Advantage Analysis

2.4.1 The Theory of Comparative Advantage

Tsakok (1990), gives two meanings to the term comparative advantage. In one sense the efficiency of production is compared among two or more trading nations. Nations with the lowest opportunity costs are relatively more efficient and have a comparative advantage since they have a cost advantage in comparison to other producers. Their international competitiveness is due to their high productivity and their exchange rate, with one or several of the following factors operating: they use fewer traded inputs per unit per output, their domestic resources have lower opportunity costs, and the value of domestic currency is not high relative to other major currencies.

The second meaning of comparative advantage refers to the efficiency of different kinds of production within the domestic economy, which are compared in terms of earning or saving a unit of foreign exchange. In this sense, the costs incurred for a given commodity are compared to the costs that would be incurred in an alternative domestic activity. The opportunity cost of foreign exchange, according to Tsakok (1990), is a good measure of this alternative activity because it indicates what the economy as a whole would have to give up in terms of domestic currency to obtain an additional unit of foreign exchange.

In Tsakok's (1990) view, the second meaning of comparative advantage is implied in the first one and vice versa. If the domestic costs of production are less than in other producing nations, then the economy gains, in efficiency terms, in producing a traded good.

The theory was developed initially to explain why countries trade and how far they should trade. Most discussions have been within the framework of neo-classical theory, but there have been some conflicting views. It has been difficult to validate the theoretical propositions in terms of international trade statistics even with considerable refinement and sophistication of the theory. This has led to the development of 'new' trade theories in recent years (Brown and Goldin, 1992).

Essentially, there have been two conflicting views in the development of the theory of comparative advantage which are labelled as 'Ricardian' and 'Heckscher-Ohlin'. In Ricardian comparative advantage, trade is driven by technology while factor endowment is the underlying force behind the 'Heckscher-Ohlin' comparative theory.

Later economists put more weight on technological and human factors. Recent views suggest a synthesis of the two approaches.

Inevitably, the general problem with the development of the theory is that, as it moves away from its original simplicity, it becomes increasingly difficult to verify empirically. Thus, most empirical works, especially for policy purposes, are loosely based on theoretical assumptions although they retain the language, concepts and analytical insights of comparative advantage theory (Brown and Goldin, 1992).

The neo-classicists inspired by Ricardo, Mill and Marshall defend the guiding principle of comparative advantage, according to which growth is promoted by specialisation. Their critics, inspired by Schumpeter, Williams and others argue that comparative advantage is a static concept and ignores a variety of dynamic elements.

It is shown in the next sub-section that the modern version of comparative advantage is a simplified version of static general equilibrium theory. What determines production and trade for a country is a comparison of opportunity cost of producing a given commodity with the price at which the commodity can be imported or exported. Some measure of the efficiency and the allocation of scarce resources in a country is required to assess comparative advantage.

A study by Haley and Abbott (1986) into the determinant of agricultural comparative advantage indicated that natural resource conditions alone do not serve to differentiate nations on the basis of production and trade. For natural resources to have an impact on production, there must be investment, thus agricultural capital complements rather than substitutes for land or other natural resource endowments.

Analysis of comparative advantage in developing countries must necessarily recognise the possibility of structural disequilibrium in factor markets; the inclusion of indirect (market and non-market) effects of expanding a given type of production; and simultaneous determination of levels of consumption, imports and variations in demand for exports. The existence of distortions does not permit trade to reflect factor endowments or costs, and hence, trade cannot be used as a proxy for comparative advantage (Brown and Goldin, 1992).

Jabara and Thompson (1980) noted that uncertainty has become an important criterion in formulating trade policy. In their view, because prices of imported food are uncertain, many developing countries have adopted policies to increase their self-sufficiency in

food and have therefore distorted prices away from the international terms of trade. They argued that, under risk aversion, the expected utility is maximised at the output bundle which is produced when domestic prices are distorted away from the international terms of trade by the subjective risk cost associated with uncertainty in its price. The implication is that there is the need to account for risk when analysing comparative advantage in the developing world.

2.4.2 Methodology

In a world of trade restrictions and distorted foreign exchange rates, considerable effort is being spent on devising frameworks which should be analytically satisfactory and at the same time practically useful for the measurement of opportunity cost of producing (or saving) foreign exchange as well as for the measurement of economic cost of the various restrictive systems. Two seemingly unrelated schools have developed in this field, that of domestic resource cost (DRC) and that of effective protection rate (EPR) measurement, but although they have been developed independently they turn out to be closely related to each other (Bruno 1972, p. 16).

The concept of DRC relates to the measurement of the real opportunity cost in term of total domestic resource of producing (or saving) a net marginal unit of foreign exchange. By comparing it with some measure of the economy's real (shadow) exchange rate, it can be used as an investment criterion, just as the internal rate of interest of a project is compared with some measure of the real interest rate.

Attempts by trade theorists to devise improved measures of impact of commercial policy on world trade and of implicit protection of value added in the presence of traded inputs led to the discovery of the concept of EPR (Bruno, 1972).

From an analytical point of view the concepts of EPR and of DRC should be closely related to each other as indeed they turn out to be.

The relationship between comparative advantage, NSP and DRC

According to Bruno (1972) comparative advantage can be rationalised in an input-output or linear programming general equilibrium framework in which there are many production and trading activities. Commodities and factors appear as constraints and the economy is assumed to maximise some welfare function subject to the constraints. In this form the benefit-cost or social marginal productivity criterion can be represented as an application of the simplex criterion of linear programming. Thus, a project should be

adopted if the net marginal benefit (valued at opportunity cost) is positive, indicating the existence of comparative advantage.

Assuming there is a project for commodity j in a country with n commodity groups and m primary factors; and is represented in an input-output framework by a set of $(n \times m)$ coefficients a_{ij} for commodity and f_{sj} for primary factor, the net benefit of the project defined as B_j by Bruno (1972) is:

$$B_j = \sum_{i=1}^n a_{ij}p_i + \sum_{s=2}^m f_{sj}v_s . \quad (2.1)$$

where p_i = the shadow price of the i^{th} commodity, and

v_s = the shadow price of the s^{th} primary factor.

Note that outputs are represented by positive coefficients while inputs are represented by negative coefficients.

As indicated by Bruno (1972), in benefit-cost analysis an alternative criterion for investment decision (i.e., measuring the net benefit) is the 'rate of return' criterion. The DRC is an application of this idea to the factor foreign exchange. He explains his assertion with the following hypothetical situation. Suppose the first primary factor is foreign exchange and, for simplicity, assuming the project produces (or saves) foreign exchange, the net foreign exchange coefficient f_{1j} will be the difference between the marginal dollar revenue accruing to the commodity (denoted by u_j) and the marginal dollar import requirement (denoted by m_j), the expression for net benefit becomes:

$$B_j = (u_j - m_j)d_o + \sum_{s=2}^m f_{sj}v_s + \sum_{i=1}^m a_{ij}p_{ij} . \quad (2.2)$$

where $d_o = v_1$ = accounting price of foreign exchange (i.e., the shadow exchange rate).

$$\text{Thus, } d_j = DRC = \frac{-\left(\sum_{s=2}^m f_{sj}v_s + \sum_{i=2}^m a_{ij}p_i\right)}{(u_j - m_j)} . \quad (2.3)$$

Pearson, Akrasenee and Nelson (1976) noted that the definition of comparative advantage is based on the concept of social opportunity cost (SOC) since the national

government, acting in the interest of its populace, makes its investment decisions on the basis of social prices of inputs and outputs which differ from market prices as a result of market imperfections and associated distortions in prices and foreign exchange. With estimates based on SOC, the net benefit is the net social profitability (NSP) of an activity (e.g., producing a commodity). Hence, their expression for NSP as stated in equation 2.4 has identical notations as Bruno's (1972) net benefit.

$$NSP_j = (u_j - \bar{m}_j - r_j)v_1 - \sum_{s=2}^m f_{sj}v_s + E_j \quad (2.4)$$

where NSP_j = net social profitability of activity j ,

u_j = total value at world prices of output of activity j ,

m_j = total value in foreign currency of tradable materials used in activity j ,

r_j = total value of repatriated portions of direct foreign-owned factors of production employed by activity j ,

v_1 = the shadow price of foreign exchange (i.e., ratio of local currency to foreign currency),

f_{sj} = total quantity of s^{th} primary domestic factor employed by the j^{th} industry,

v_s = the shadow price of the s^{th} factor of production in domestic currency, and

E_j = the net external benefits or costs imparted by the j^{th} activity.

There is comparative advantage (CA) when :

$$NSP > 0.$$

Thus:

$$CA_j = (u_j - \bar{m}_j - r_j)v_1 - \sum_{s=2}^m f_{sj}v_s + E_j > 0 \quad (2.5)$$

It is, however, important to note the significant difference in the two approaches. Bruno (1972) treats all locally produced inputs as non-tradable, thereby defining them with respect to actual government policy. In the approach by Pearson et al. (1976), the social opportunity cost of all inputs such as primary domestic factors are estimated with reference to optimal government policy. Consequently, a locally produced good is classified (a) as tradable if it is fully traded, i.e., if the country also imports some of the good, or (b) as non-tradable if it is non-fully traded, i.e., if the country does not import

any of the good. Inputs classified as non-tradable are further decomposed into traded components and primary domestic factors by moving backwards through the input-output chain.

The usefulness of the estimates by this formula depends on the accuracy of the shadow exchange rate. However, it is difficult to estimate the shadow exchange rate in most developing countries. In the view of Pearson, Akranesee and Nelson (1976), the use of the DRC coefficient as an investment decision criterion is not only an alternative approach but also a preferred approach since it is free of error introduced by using inaccurate shadow exchange rates. This view is not shared by Masters and Winter-Nelson (1995) who demonstrated, using data from Kenya, that the DRC formula is biased against activities that rely heavily on domestic factors (land and labour), and that a simple Social Cost-Benefit (SCB) ratio is a generally superior measure of social profitability.

In developing a formula for estimating DRC they set NSP to zero and solved for the shadow price of foreign exchange and arrived at the following:

$$DRC_j = \frac{\sum_{s=2}^m \bar{f}_{sj} v_s - E_j}{(u_j - \bar{m}_j - r_j)} = \frac{DC_j}{NVA_j} \quad (2.6)$$

DC_j = opportunity cost of domestic resources employed by the j th activity
(in domestic currency), and

NVA_j = net foreign exchange earned or saved (in foreign currency).

Equation 2.6 can be substituted into equation 2.4 to give:

$$\begin{aligned} NSP_j &= (v_I - DRC_j) (u_j - m_j - r_j) \\ &= (v_I - DRC_j) (NVA_j). \end{aligned} \quad (2.7)$$

Note that when NVA_j is negative then the border price of the output is less than the foreign cost per unit of output in border prices and, hence, activity j has no comparative advantage. In such a case there will be no need to calculate the DCR.

When NSP is zero, the DRC will be equal to the shadow price of foreign exchange. The DRC ratio indicates how many domestic resources are required to earn a unit of foreign

exchange by the activity in question (the exchange rate in that activity). The shadow exchange rate (SER), on the other hand, measures how many domestic resources a country is willing to give up to obtain a unit of foreign exchange (i.e., exchange rate of the entire economy). For NSP to be positive, the DRC must be less than the shadow exchange rate.

The relationship between the DRC and CA is established by rearranging the terms of equation 2.5:

$$CA_j = \frac{\sum_{s=2}^m f_{sj} v_s}{u_j - m_j - r_j} < v_1 \quad \text{or} \quad DRC_j < v_1. \quad (2.8)$$

In short:

$$\begin{array}{ccc} & > & < \\ NSP = 0 & \text{as } DRC = SER. & \\ & < & > \end{array}$$

Dividing each side of equation 2.8 by the shadow exchange rate (v_1) gives:

$$\frac{DRC_j}{v_1} < 1.$$

The left hand side of the equation is known as the resource cost ratio (RCR) and, hence, the criterion for evaluating comparative advantage is:

$$RCR < 1$$

There is comparative advantage if $RCR < 1$,
 neutrality if $RCR = 1$,
 disadvantage if $RCR > 1$.

For the analysis of a single commodity it is necessary to compare the DRC of its production activity with its SER. However for two or more commodities or regions, relative DRC can be compared effectively so long as the activities do not alter relative prices in the economy.

Underlying assumptions

The important assumptions that will make any empirical application of the DRC approach yield useful results are listed by Pearson et al. (1976) as:

- world price of the commodity is given exogenously or can be estimated;

- the true foreign exchange costs can be estimated;
- shadow prices of inputs and output can be calculated; and
- incremental cost of production, based on constant technology and relative factor prices is also constant due to supposed zero elasticity of input substitutes.

While these assumptions emphasise the static nature of the DRC approach, they do not compromise the validity of its use to measure comparative advantage, at least at the commodity level (Monke, Pearson and Akrasenee, 1976).

2.4.3 Issues on Method and Procedures

The most difficult problem about the analysis of comparative advantage in agriculture is the related issue of valuation of labour, land, capital employed and foreign exchange. Their opportunity costs are often difficult to estimate from available statistics. Typically the shadow price of a factor of production is the opportunity cost of income forgone by not using the factor in its best alternative employment. On the other hand, the shadow price of material outputs and imports are border prices (f.o.b. export price or c.i.f import of comparable imports).

The task is even worse when non-optimal tariffs and export taxes are applied as is the case in most developing countries. Under such circumstances the market prices differ from the first-best shadow prices which are calculated from a general equilibrium model under the assumption of optimal policies. If the first-best shadow prices are used together with the observed input coefficients, the result will depend on the number of stages of fabrication considered, and hence, total and direct DRCs are likely to differ (Balassa and Schydrowsky, 1972).

The equality of total and direct DRC measures under optimal resource allocation does not logically lead to the use of the former in a non-optimal situation. Balassa and Schydrowsky (1972) assert that in combining domestically produced and imported inputs in project evaluation, one implicitly assumes that inefficiently produced inputs will be used in the project. Under conditions of non-optimal policies, first-best shadow prices will reflect neither the marginal social cost of inputs nor the marginal social utility of its output. To the extent that non-optimal policies entail a bias in favour of import substitutes and against exports, the shadow price of foreign exchange derived from an optimal situation understates the marginal social cost. In effect, the net social benefits of saving or earning foreign exchange will be understated.

Balassa and Schydrowsky, (1972) also indicate that in evaluating projects under non-optimal policies, analysts should ideally use second-best shadow prices reflecting marginal social costs and utilities under existing policies with adjustments made for prospective policy changes. It requires first the construction of time-series values of marginal social costs and utilities and then deriving the shadow prices corresponding to them. The requirement of substantial data and estimation difficulty make the procedure unattractive for developing country applications.

For that reason, Balassa and Schydrowsky (1972) suggest further that in the absence of appropriate shadow prices, a project should be evaluated using the direct DRC. It involves evaluating the primary factors other than foreign exchange at their market prices. This alternative is, however, based on the assumption that non-optimal measures of production do not affect the relative prices of primary factors other than foreign exchange. The nonfulfilment of this assumption, according to Balassa and Schydrowsky (1972), will introduce errors in the estimates.

Another issue is that on the division of non-tradable input costs into tradable inputs and primary domestic factor costs. Problems are likely to arise in the classification of tradable and non-tradable materials and services. Moreover, the disaggregation of inputs classified as non-tradable into direct and indirect tradable input and primary domestic factor costs, even when an input-output table is available, can be troublesome.

In addition, the inability to correctly classify locally produced input as tradable or non-tradable causes an inherent bias in the estimated DRC coefficient. Tradable inputs are defined as goods which would (or would not) be traded if the country were implementing optimal economic policies, and hence, has market prices equal to social prices. In the absence of optimal policies, as is the case in all countries, one cannot be sure whether an input produced locally under existing policy will continue to be produced under optimal policy. As indicated by Pearson et al. (1976), a strong presumption exists that given optimal policy, fully traded local inputs will be traded. But it is not clear if non-fully traded inputs will be tradables or nontradables. Pearson et al. (1976) suggest that in the absence of information, non-fully tradable inputs be treated as if they were non-tradables. To the extent that they are not, a bias is introduced because some tradable input costs are incorrectly counted as primary domestic factor costs.

A major criticism levelled against the DRC approach is related to its static nature. The assumptions of constant cost technology and zero elasticity of input substitutes

emphasise the short-run nature of both the DRC concept and comparative advantage itself. Empirically it is only possible to identify comparative advantage at a given point in time.

It is worth noting that DRC does not capture the effects of technological changes. Rather, technological changes determine the pattern of comparative advantage (and DRC coefficients) in the future. Thus, DRC should not be expected to determine the trend in comparative advantage. Monke et al. (1976, p. 278) argue in support of the DRC concept in the following words:

The DRC technique compares technologies within and across countries at a given point in time. Accordingly, the assumptions of constant costs and fixed production coefficients emphasise that comparisons of DRC coefficients and the determination of comparative advantage are valid in the dynamic sense only if production technologies and growth patterns do not substantially alter input mix and domestic factor costs.

A dynamic estimation of comparative advantage is a more complex and speculative task. In a dynamic context, the comparative advantage of production depends on the process of technological change which alters input mix and output yields. It also depends on the pattern of economic development which changes the opportunity cost of domestic factors of production as well as on the interaction of the two processes. Hence, the consideration of dynamic comparative advantage involves movement along the production function as well as shifts of the production function itself. This requires the adoption of a more sophisticated mathematical programming approach.

Recent literature points to the development of dynamic comparative advantage models, e.g., Haley and Abbott (1986). Their model identifies resource availability and allocation, relative agricultural prices, and income and savings behaviour as key components in the cross-sectional study of agricultural trade. Changes in trade mix are attributed to changes in production and consumption behaviour. The formulation of the model suggests that initial conditions can have substantial impact on the direction and magnitude of the changes.

In the absence of data required for a programming approach, sensitivity analyses can be undertaken on major variables in an effort to approximate the effect of dynamic changes. Variables which might usefully be subjected to sensitivity analysis include the world price of the commodity, the input-output coefficients (to reflect possible changes

in technology), and the shadow price of foreign exchange resulting from possible changes in comparative advantage (Pearson et al., 1976).

2.5 Review of Previous Studies Using the DRC Approach

There have been several studies using the DRC approach to determine the economic efficiency, or an economically efficient system, of producing a commodity. A few of such studies are mentioned below.

The DRC approach has a long history of practical use in Israel where it has been applied extensively by government planners as a means of evaluation under conditions in which the official exchange rate and prices of tradables were distorted (Bruno, 1972).

Akrasanee and Wattananukit (1976) conducted studies to assess the comparative advantage of rice production in Thailand. They estimated the private and social profitability of the export expansion of rice in Thailand using the Policy Analysis Matrix (PAM) and the DRC approach.

Herd and Lacsina (1976) used the DRC approach to evaluate several apparently feasible methods of increasing rice production in the Philippines. They tested the sensitivity of results to changes in opportunity costs of land and of capital, and in the world prices of rice and fertiliser. They used data from 1974 and made adjustments where data were not reported in some studies as in the case of land preparation by animal and family labour contributions. These data were obtained by adjusting similar data for an earlier year, examining studies from other areas, or making educated guesses.

According to Herdt and Lacsina (1976), the technique for adjusting for price changes makes it possible to generalise the analysis for other price configurations. In their study, inputs that were produced domestically but traded were treated as domestic costs because their incremental output is imported; nontraded inputs and added local costs of traded inputs were divided into domestic and foreign costs; government input subsidies embodying real goods and services were treated as domestic costs and were treated as a traded or non-traded input according to the foreign or domestic cost of the fixed capital asset.

Available input-output tables for the Philippines did not deal with all agricultural inputs adequately to permit division into domestic and foreign costs. For that reason, Herdt and

Lacsina (1976) employed a technique where, by careful accounting, identification of the origin of cost as either domestic or foreign was made. Where domestic costs included imported inputs, they accounted for those inputs as indirect foreign costs. The shadow price of family labour was set equal to the market rate of labour, while the shadow price of land was derived from actual rental rates, earnings in alternative crops and personal judgment. The opportunity cost of capital was calculated at three alternative rates.

To evaluate the sensitivity of DRCs to the assumptions, Herdt and Lacsina (1976) calculated elasticities of DRC with respect to various parameters by assuming 10 percent changes in the specific parameters. The DRCs were observed to be highly sensitive to changes in the world price of rice, and hence, had serious policy implications, especially in reference to food self-sufficiency.

Mears (1976) estimated the social and financial rice export costs along with the DRCs for major rice producing areas in the United States (US). He analysed the sensitivity of his results to alternative yields and to alternative prices of land, labour, fertiliser and capital.

The only shadow-price adjustments considered necessary for the US were those for land and capital. Since the numeraire for all DRC calculation was the US dollar, an adjustment for foreign exchange rate was ruled out. The shadow price of land was estimated by calculating the social profitability of the next best alternative use, excluding the land costs. Instead of estimating the shadow price for capital, Mears (1976) used the prime loan rate. Sensitivity analysis was then employed in order to evaluate the effect of other rates with the assumption that the long-run rates of capital could vary between five and ten percent. Sensitivity analyses revealed a high level of sensitivity of DRC coefficients to world prices and to yields.

The Asian Development Bank, in recent years, has conducted case studies on the rice economy in Korea, Malaysia, Bangladesh, India and Indonesia. All the studies used the DRC approach. The Indonesian case study was implicitly concerned with the question of comparative advantage. The other studies focused on the question of rice market intervention policies although indications of revealed comparative advantage were obvious from data concerning differences between domestic and border prices in those countries. An interesting conclusion of the Indonesian study was that, although the country's remarkable success in increasing rice production had been achieved through deliberate government intervention, there was a downward trend in its comparative

advantage as a result of the promotion of inefficient paddy production by the government (Brown and Goldin, 1992).

Longmire (1985) also used the DRC approach in an analysis of comparative advantage and research opportunities for wheat on small holdings in Kenya. Hermanto, Zulham and Suhartini (1992) analysed the comparative advantage of soybean production in the East Java province of Indonesia. They provided an insight into using PAM as an approach to determine national and local comparative advantage. They estimated the DRC ratio from their PAM.

The theoretical and empirical estimations of the DRC ratio using the PAM approach are discussed in Chapters 4 and 5 respectively.

3 The Soybean Commodity System in Ghana

3.1 Introduction

In a short span of three or four decades, soybean has become a pre-eminent source of protein for animal diets and has gained popularity, world wide, for human nutrition. Unfortunately, until recently, no serious effort has been devoted to improving the crops performance in the tropics. Most soybeans in the tropics yield little, produce seeds with short viability, nodulate poorly so cannot fix nitrogen effectively, and shatter easily when ripe. These factors, among others, restrict the cultivation and utilisation of the crop in many developing countries that are incidentally in the tropics (Singh et al., 1987).

The successful cultivation and utilisation of soybean in China, Japan, Korea, Indonesia and other South-East Asian countries has prompted many African countries to explore the benefits of the crop. Many national agricultural programs in Africa share the conviction that soybean can contribute significantly to African agriculture in various ways. Firstly, soybean production provides farmers with a new and beneficial option which has the advantages of high yield potential and fairly low incidence of disease and insect problems. It also has the potential of diversifying farming systems in the savannah that are characterised by nearly continuous cropping of cereals. A third benefit is that derived by consumers who are provided with a relatively inexpensive alternative to other protein sources (IITA, 1992). Furthermore, the oligosaccharides which cause flatulence are minimal compared with other grain legumes, so soybean is an ideal food for infants. Finally, it is a good source for calcium and phosphorus (Singh et al., 1987).

Soybean is still not widely cultivated in Africa even though there is no significant biological constraint to the production of the crop on family farms. There are, however, indications that production is expanding in Benin, Cameroun, Cote d'Ivoire, Ghana, Nigeria, Uganda, Zaire, Zambia and Zimbabwe (IITA, 1992).

3.2 The History of Soybean in Ghana

Though the production and utilisation of soybean in Africa seem to have been an issue during the past two and half decades, the production of the crop in Northern Ghana has

a much longer history. Published research on soybean in Ghana dates back to the 1950s (IITA, 1992).

In 1977, a four-member team of experts from the International Soybean Program (INTSOY) visited Ghana to assess the potential for soybean production, processing and utilisation in the country. Based on their recommendations, a five-year (1978-1982) soybean development program was launched by the Soybean Committee of the Ghana Grains and Legume Development Board (S.K.Dapaah, 1994, pers. comm.). Production was expected to be on both small and large farms. The projected acreage and production for the period is given in Table 3.1

Table 3.1: Proposed Acreage and Estimated Production of Soybeans in Ghana: 1978 -1982

	1978	1979	1980	1981	1982
Acreage	10 000	20 000	30 000	50 000	50 000
No of farmers involved	1000	1200	1400	1500	1500
Output in tonnes	5000	12 000	21 000	37 000	37 000
Direct human consumption	3000	7000	13 000	20 000	20 000
Soybean meal and oil	2000	5000	8000	17 500	17 500

Source: Ministry of Agriculture, Accra.

It was hoped that oil extraction and processing plant would provide a ready market for the crop and gradually reduce the importation of soybean oil and meal. The Ghanaian government spends about US\$5.7 million annually to import soybean-based products. Indeed, the program seemed appropriate in the light of the agro-ecological conditions and the fact that Ghana was a heavy importer of soybean oil.

Unfortunately, after the initial experiment by the vegetable-oil processing firms in Ghana, none of them continued with the venture for various economic reasons. Tema Food Complex, the only government-owned industry that processes vegetable oil was not attracted to the processing of soybean oil since domestic production of soybeans did not adequately satisfy the plant's capacity. Soybean farmers were then left with a marketing problem, and hence output did not expand as much as anticipated.

3.3 Soybean Production in Ghana

With the exception of the rainforest, soybeans can be grown in all the agro-ecological zones in Ghana. Please refer to a map in Figure 1.1 which shows the agro-ecological

zones. Soybean varieties grown in the various zones, together with their durations and yields, are presented in Table 3.2.

Table 3.2: Varieties, Duration and Yield per Hectare in Different Agro-ecological Zones

Agro-ecological zones	Varieties	Duration in days	Yields in Mt/ha
Sudan Savannah	TGX 813-6D	110	1.2 -1.5
	Salintuya	110	1.0
Guinea Savannah	Salintuya	125	2.5
Transitional zone	TXG 536-02D	103	1.3 - 2.1
Deciduous forest	TXG 888-49C	110	1.1 -2.2
Coastal Savannah	TXG 813-6D	113	1.2 -2.4
	TXG297-10F	110	1.2 -2.0

Source: Ministry of Agriculture, Accra.

The production of soybean fits tolerably well into the cropping systems of the various agro-ecological regions. Inter-cropping is the common form of crop husbandry practised in the savanna zones and soybean is inter-cropped with maize, millet or sorghum. In the deciduous forest and transitional zones, where mono-cropping is common, soybean is rotated with cereals (Korang-Amoakoh and Akpabi, 1989). In addition to the crops with which soybean is inter-cropped or rotated, the other crops that can be grown under similar conditions are cowpea, groundnut and bambara bean.

For practical reasons, this study will be limited to production in the Sudan and Guinea Savanna zones where the crop has gradually received popular acceptance and has therefore attracted most of the government's support for the crop. Another reason for concentrating the study in the two northern zones is that they are the region for which data are readily available.

Soybean is grown by small holders generally, using little or no fertiliser. In spite of the nitrogen-fixing qualities of the crop, its initial growth in Ghana requires about 20 kg per hectare of nitrogen fertiliser (Korang-Amoakoh and Akpabi, 1989).

The Ministry of Agriculture, in 1994, estimated the cost of production of soybean to be 235 343 cedis per hectare. The average yield estimated in the same year was 1200 kg per hectare which was well above the potential of 450 kg per annum estimated by Kolavilli et al. (1987). With the current promotion, soybean production in Ghana is expanding rapidly.

Information from the Ghanaian Ministry of Agriculture indicate that on the average, production cost for cowpea and bambara bean is similar to that of soybean. However, private returns to soybean are currently lower than they are for the other two crops. Net returns are remarkably higher for groundnut than for soybean although the cost of production for the former is also higher.

3.4 Research, Development and Extension

Prior to IITA's research achievements, high-yielding soybean developed in the USA and elsewhere could not be grown in Africa without rhizobial inoculation — an expensive and technically complex treatment generally beyond the means of African small holders (IITA, 1988).

The main objective of the soybean research by IITA is to develop improved cultivars adapted to the lowland tropical environments of Africa. The research is designed to make soybean a more attractive and a more feasible cash crop for small farmers. Short-term efforts are aimed at making the crop nodulate freely with indigenous rhizobial complexes; have satisfactory levels of seed storageability; and grow over a large range of ecological conditions.

Soybean research in Ghana is principally steered by IITA. The IITA Grain Legume Program located a breeder in Ghana in 1985 to assist in the development of collaboration between IITA and the national Crop Research Institute (CRI). The aim was to expand the existing legume-breeding program and allow for the development of specific high-yielding varieties of cowpea and soybean. The program was designed to assist with training and manpower development of the staff working with the Ghana Grains and Legume Development Board.

With research, the initial problems of quick loss in seed viability in ambient temperatures, and the inability of most soybean varieties to form nodules with the rhizobia that are indigenous to African soils, were successfully overcome. Another development in Ghana is that several soybean lines have been developed with resistance to the crop's most important diseases. In addition, national soybean work has built a momentum for better soybean utilisation. In Northern Ghana soybean is substituted for cowpea, bambara bean or groundnut in popular breakfast dishes.

The current national cereal and legume program (1991-1995), which includes the promotion of soybean production and utilisation, makes provision for the training of

wokers in the Crop Services and Extention Services Departments as well as those in the unit of Women in Agricultural Development. The training is in aid of effective communication of research findings to farmers and providing feedback to researchers.

3.5 Soybean Marketing, Utilisation and Demand in Ghana

Most farmers sell some portion of their harvest in the local markets but also prepare and consume some at home. There are no formal marketing arrangements. And like most food crops in Ghana, distribution and pricing are controlled by market forces unlike in the case of cash crops.

Unlike other traditional African beans, soybean is unpalatable and requires more complicated processing and cooking. In addition, soybean may be toxic when raw or improperly processed. These inherent disadvantages of the crop constitute the major constraint to its utilisation in spite of the tremendous economic and nutritional benefits.

Although progress in food-processing technology has successfully overcome these problems, most Ghanaian households are still unfamiliar with acceptable uses of the crop. Local production of soybean oil has not been welcomed by the few producers of oils in the country, peharps due to the lack of proper choice of technology suitable to the local conditions.

Traditional processing methods do not adequately utilise the available soybeans for the known and acceptable products. Hence, the lack of effective demand (both domestic and external) for soybean in Ghana has not encouraged its production.

3.6 Government Policy and Support

Since soybean production and utilisation in Ghana is still relatively insignificant (i.e., in terms of its contribution to the national economy), there is currently no specified government policy for the crop. Policy guidelines have, however, been proposed for the marketing and utilisation of soybean in order to derive the full economic and nutritional benefits of the crop. There is every intention to promote the utilisation of domestically produced soybeans to reduce foreign dependence and improve the nutritional status of the people (S.K. Dapaah, 1994, pers. comm.).

The intended policy is to consolidate and strengthen existing infrastructure and expertise and to promote the development of new ones, where necessary, for the effective marketing and utilisation of the crop in Ghana. Thus the goals of the proposed policy are as follows:

- To strengthen the existing market units (both private and state owned) in terms of personnel and facilities to allow efficient procurement, storage and distribution of soybean and soybean products.
- To develop infrastructure and facilities for industrial processing of the crop.
- To ensure a proper choice and development of soybean-processing technologies appropriate to the local conditions.
- To support research in soybean production and utilisation.
- To generate desirable linkages among the stakeholders of research.
- To ensure adequate education of Ghanaians on the economic and nutritional benefits of soybean production and utilisation (S.K. Dapaah, 1994, pers. comm.).

In pursuance of these goals, policies proposed include those on marketing, soybean-based products to be promoted, technology choice, manpower training and research development and extension.

The first proposed policy on marketing is to ensure that local use of domestically produced soybean is given a priority. However, where exportable surpluses exist, they will be transformed to value-added products. Second, no raw soybean, unlike other traditional beans, should be sold to individual consumers on the open market without being processed.

Depending on available funds, technical expertise and local needs, soybean products which are likely to have the desired socio-economic characteristics are to be promoted. The products identified are soybean oil, cake and lecithin by-products; soybean flour and protein concentrates; and soymilk and beverages.

Since Ghana's soybean output cannot satisfy the capacity requirements of solvent extraction units, popular in the advanced countries for their efficiency, the pressing and expelling method is the most appropriate under the circumstances. In this respect government is to promote cottage-type industry to be run by local entrepreneurs and organisations.

Government intends to encourage training for nutrition extension workers at the local level to promote the use of the crop in rural areas. Training for both high and medium level technicians will be encouraged too.

As part of the Medium-Term Agricultural Development Program (MTADP), a five-year (1991-1995) project for improvement in cereal and legume production is under way. The main objective of the project is to develop and propagate improved varieties of cereals and legumes, focusing on the development and use of hybrid seeds of maize, sorghum, millet, soybean and cowpea.

The project was estimated to cost the government about 189 million cedis (i.e., US\$ 513 894 at the 1991 exchange rate), with a foreign exchange component of US\$320 843. Planting material, chemicals and other inputs are made available to farmers. Funds allocated for soybean promotion in 1994 amounted to 37 million cedis (US\$ 41 110 at 1994 exchange rate)

3.7 Future Prospects

With farmers in developing countries giving priority to producing crops for household consumption and livestock feed before allocating resources to production for market, the choice of crop depends on farmers' assessment of their limited resources, and other factors such as risk and uncertainty. However, with the advancement of commercialisation of agriculture, comparative returns are likely to outweigh domestic requirements in making decisions on land use for different enterprises (Basaliah, 1986).

Fortunately, research to date has overcome all the important biological constraints to increased soybean production, thus, further improvements in the soybean industry in Ghana will depend on government policies for the crop and how the people respond to the policies.

Soybean is basically an industrial crop. Thus, success in its development depends on the purchase of raw soybean for commercial exploitation (Basaliah, 1986). Until this fact is realised and effective measures are implemented to increase the demand for locally produced soybean, the future of the crop in Ghana will remain gloomy.

3.8 Concluding Remarks

Since the traditional processing procedures cannot cope with current soybean output, let alone increased output, any move towards processing the bean into oil (for human consumption) and meal (for livestock) will certainly be in the right direction.

It is unfortunate that the private sector has not been attracted to the soybean processing industry in spite of the potential benefits that can be derived from the crop. This is probably the case because it is currently not economically viable to processors and those likely to gain most of the benefits are farmers and consumers. Perhaps another reason is the competition soybean faces from other oilseeds such as palmtree and groundnut.

To achieve its goal of improving the nutritional status of the population, the alternatives open to the government are as follows:

- Get directly involved in the processing, marketing and distribution of the crop, while promoting its production and utilisation through effective education.
- Keep promoting domestic production and utilisation of the crop through effective education and support services with the hope that the private sector will respond.
- Import the crop and promote its utilisation until such time as adequate demand will require local production.

With the current structural adjustment program in Ghana and the government reducing its involvement in direct production and distribution, the first option is in conflict with current policy objectives. A choice between the second and third options should ideally depend on the economic efficiency of the two approaches.

It is worth noting that if a crop is desired for farm-household consumption, it strengthens smallholders' incentives to produce. However, if the crop is produced on a commercial scale, then it must compete with other crops. The essential element in both cases is "effective demand" for the crop. "Effective demand" is, therefore, a major force determining the profitability (efficiency) of producing a crop.

A discussion of how the DRC approach is used to assess economic efficiency forms the content of the next chapter. It has been noted in Section 2.4 that the formulae for calculating the DRC and NSP are typically demand driven. Hence, the higher the demand for a product the higher its net social profitability and comparative advantage.