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THE EXPERIENCE AND MAJOR CONSTRAINTS ON THE COMMERCIAL PRODUCTION OF SOYABEANS IN GUYANA

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Introduction

Soyabean, *Glycine max* (Merrill), is considered one of the world's most important sources of vegetable oil and protein. The plant which originated in China [1] has been cultivated in Eastern countries for several centuries and still remains the staple food of the mainly vegetable diets of China, Japan and Indonesia.

In the early twentieth century soyabean assumed importance in the Western Hemisphere - notably the United States of America - with rapid development of the crop during the 1940's as a consequence of World War II which brought acute shortage of butter to the American consumer. This increase in acreage has continued through the decades so that the 4 million hectares (10 million acres) harvested in the U.S.A. in the mid 1940's has increased to 22.5 million hectares (56 million acres) in 1973 [2].

The U.S.A. is now the world's major producer of soyabean. Increases in U.S.A. acreage and production from the year 1950 onwards have borne a direct relationship to increases in world production and world trade. The other major producer - China - is only a minor participant in world trade. Brazil is developing very rapidly into a major producer and exporter of soyabean. Her industry has developed terrific inertia in the last five years and Brazilian soyabean farmers have been known to have experienced overnight prosperity in some instances. Current indications are that neighbouring Latin American countries (Columbia and Venezuela) will soon be producers of some importance and there is every likelihood that other countries in South and Central America and the Caribbean in the same latitudes and enjoying similar climatic conditions can develop soyabean as a major crop.

The Value of the Crop and Its Justification

The economic value of soyabean lies in its protein (40-45 per cent) and oil (18-20 per cent) composition of the dried seed. It is therefore equally as important as an oilseed crop as it is in high protein grain for both human and livestock use.

Vegetable Oil

A study [3] of the edible oil consumption in Guyana shows that in 1972 local production was 6,870 metric tons with a net deficit of 260 metric tons which was met by imports. Table 1 shows the consumption of vegetable oil in Guyana in 1974, and projections to 1976 and 1981.

The coconut industry (the major source of vegetable oil) which has been plagued by several problems and setbacks is not at this stage capable of satisfying the projected local demands. Oil palm production

Table 1. Consumption of Vegetable Oil in Guyana - Projections to 1981

(metric tons)

	1974	1976	1981
Production	6,818	7,730	9,090
Consumption	7,078	8,002	9,410
Deficit	260	272	320

appears economically feasible [4]; however, the time factor precludes substantial relief from this source before the end of the decade. Soyabean can quickly develop to fill the short-term gap in both local and regional short falls in vegetable oil production.

Protein

Soyabean protein which still holds a major place in stockfeed manufacture is now being used directly in place of animal protein which is 10 to 20 times as costly to produce on a per unit basis of protein. In Guyana and the Caribbean region the initial major role of soyabean protein would be in livestock feed production, however, it is envisaged that a parallel but less intensive development (initially) of systems for human utilisation will be considered.

The status of the stockfeed industry in the country and in the region justifies even more the case for the establishment of a soyabean industry. Importations into the region (Jamaica, Barbados, Trinidad and Tobago and Guyana) in 1972 approximated to 3,500 metric tons (7.5 million pounds) of beans and bean equivalents in the form of cake, meal and ready mixed feeds. It is also a well established fact that the future of the livestock industries in the region will depend very critically on the availability and cost of the two major inputs - corn and soyabean. Local and regional production of both commodities is therefore clearly justifiable.

The Guyana Experience

Adequate documented field trials with soyabean were done in Guyana in the early 1960's [5] in the Intermediate Savannah area. Interest in the crop developed and a University of Florida contract in 1968 covering research and development of crops in the Intermediate Savannahs included soyabean as one of the major areas of investigation. This arrangement proved quite useful in exposing many fundamental problems associated with the crop and devising plans for their solution. The single most outstanding achievement of the programme was the release of a new variety *Jupiter* which is especially adapted to tropical latitudes [6]. Agronomic and field production techniques were also investigated with University of Florida technical personnel and local counterparts.

At the end of the contract in 1972 a new agreement was immediately negotiated with University of Illinois for Guyana's participation in the INTSOY (International Soyabean) programme. It was fortunate that some key personnel from University of Florida programme were retained by INTSOY thus achieving a measure of continuity in the programme.

Emphasis is now being laid in three areas of developmental research:

(a) a soyabean breeding programme aimed at producing new varieties with plant characteristics even better than the established variety - Jupiter;

(b) microbiological studies of the symbiotic nitrogen fixing organism, *Rhizobium japonicum*, and development and testing of more efficient and adaptable strains of Rhizobia as well as production of commercial cultures of the bacteria for local use; and

(c) studies of the agronomy of the crop under specific micro environmental conditions.

These programmes have helped in developing a pool of local expertise trained in various aspects of the crop in the Guyana environment. This pool is now providing the necessary foundation for further development and expansion of the crop.

Commercial production of soyabean on a substantial acreage was initiated in Guyana in 1970. Since then, acreages cultivated have been increasing each year although these increases have been modest.

Production Potential

Climate

It has already been established that Guyana's climate will permit growth of soyabeans. In fact, in a normal year, adequacy and distribution of rainfall is such that two crops can be produced. (see Table 2). The two major day spells permit proper maturity and harvesting of good quality beans.

Table 2. Climatic Chart for Soyabean Production in Guyana

Dec.	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
plant		harvest		plant	plant			harvest				
Short days Daylength increasing					Long days Daylength decreasing							
-short rainy-		dry season			----Long rainy--					Dry season		
season					season							
Smaller acreages planted mainly for seed production					Major season for soyabean production							

Soyabean is sensitive to photo period, however the degree of sensitivity to specific conditions will determine the adaptability of the variety to the environment. Since photo period can have a direct effect on plant height it can also affect yields directly. The importance of selecting a well adapted variety can therefore be appreciated. Although there is very little variation in daylight hours so close to the equator, the slightly longer hours experienced during the May/

September season (Table 2) are sufficient to give adapted varieties the additional plant height which is so desirable. The short plant stature of the Jupiter variety during the November/March season is a disadvantage both in terms of field management and yields.

The soyabean breeding and varietal testing programme which was started under the Florida contract and continues now under the INTSOY programme is therefore of paramount importance in the search for well adapted varieties for commercial use.

Soils

There are several identifiable regions with large acreages of soils suited to soyabean cultivation in Guyana. There is a prerequisite of good drainage and well textured soil for the cultivation of the crop and on this basis the following regions have been identified for the crop

(a) The Intermediate Savannah Region: This area lies in the North East of the country in the County of Berbice and is represented by the Ebini, Ituni, Kwakwani triangle - an area with generally undulating relief, 20 - 65 metres (60-200 feet) above sea level, with soils which are for the most part free draining sands or sandy loams of low fertility [5]. An estimated 80,000 hectares (200,000 acres) of these Brown Sand soils under native savannah vegetation are available for cropping to corn, soyabean, blackeye peas, peanut, cotton and orchard crops. Land development costs are minimal and large scale mechanization is easily permissible. Inherently poor fertility of these soils however requires an extremely high fertilizer input.

(b) The North West District: Soils are steeper, however, texture and structure are ideal for the crop moreso in the Matthew's Ridge Arakaka Kaituma area. The heavy virgin forest cover makes land development and full scale mechanization of the crop rather costly, and a smaller scale of operations is envisaged.

(c) Coastal Areas: Small trial acreages of soyabean have been successfully grown on the coastal soils which, as a group, are the most fertile and most strategically located in terms of population location and access to markets and agro-industrial facilities. The flat, low lying and heavy textured nature of these soils would however demand elaborate land development and preparation to ensure adequate drainage. These soils also have, for the most part, been already committed to sugar and rice production for which they are well suited.

Production Levels

Table 3 indicates commercial acreages and average yields in various locations since 1970. The variability in yield data and the fluctuating acreages with respect to the Intermediate Savannahs where most experience has been developed, is an indication of the range of problems that have been encountered over the seasons. A study of the history of each crop on the Kibilibiri Project (Intermediate Savannahs) brings to light some of these problems (Table 4). The most significant observation is that several instances of crop failure or low yields occurred late in the crop through climatic or management/organizational problems. The major

Table 3. Commercial Soyabean Acreage, Guyana, 1971-1976

Year	Location							
	Intermediate Savannahs		North West District		Coastal Areas		Total	
	ha.	ac.	ha.	ac.	ha.	ac.	ha.	ac.
1971	94.5	(236)					95.5	(236)
1972	43	(105)					43	(105)
1973	110	(275)	4	(10)	2	(5)	116	(290)
1974	100	(250)	20	(50)	80	(200)	128	(320)
1975*	220	(550)	120	(300)	80	(205)	420	(1055)
1976*	440	(1100)	240	(600)	120	(300)	800	(2000)

*Projected figures.

Table 4. An Analysis of Soyabean Yields at Kibilibiri and Major Problems Associated with Production.

Planting season	Acreage	Average yield (kg/ha	Forecast Yield (80 days)* (lb./ac.)	Constraints to achievement of estimated yield
1970/71	36	950	n.a.	-
1971	200	662	1000	Uneven ripening. Shattering in field. Combine losses at harvest.
1971/72	100	600	1000	Bad weather at harvest.
1972	5	1566	1700	Combine losses.
1972/73	15	700	1000	Dry spell at podding stage. Short plants.
1973	260	900	1600	Severe weed problem (about 80 acres unharvested). Some acres unharvested due to bad weather and spoilage in field.
1973/74	115	750	1200	Short plants. Combine losses.
1974	135	1000	1500	Dry spell at podding after late planting.
1974/75	50	n.a.	n.a.	-

*Based on visual field evaluations of the crop at 80 days (full pod stage).

agronomic factor contributing to low yields was use of poor seed and low plant populations in the field.

Seed

This is one of the major constraints to rapid increases of acreage under production of soyabean. All commercial acreages are grown from locally produced seed of the Jupiter variety. Soyabean seed is extremely perishable if not harvested, processed and stored under ideal conditions. The limited seed processing facilities that exist at Central Agricultural Station, Mon Repos, are inadequate to handle seed production for the large projected acreages in the Intermediate Savannahs and North West District.

In addition, efforts to establish seed production plots and seed processing units in major production areas have not progressed very far and specialised equipment is not yet available for harvesting fields for seed. Seed quality has therefore been invariably poor, resulting in low plant population and other adherent agronomic problems.

Varieties

There are two categories of soyabean varieties - the indeterminate types that continue flowering and fruiting over a protracted period resulting in pods at all stages of maturity at harvest time, and the determinate types which set pods and mature all about the same time.

The determinate variety *Jupiter* which was tested in Guyana and released in 1971 as a variety adapted for tropical latitudes [6] is the only commercially available variety at the moment. The major problem with Jupiter - despite its excellent qualities of resistance to lodging and shattering is the fact that it does not attain sufficient height in the short rainy season (November/March) making crop management difficult and resulting also in lower yields. As a result of the on-going breeding programme, the Crop Science Unit in the Ministry of Agriculture will release very shortly at least three new varieties which will make up the existing deficiency.

Seed is locally grown by the major commercial centres at Kibilibiri and Matthew's Ridge, processed by the Ministry of Agriculture and redistributed. A more improved seed production system will be implemented shortly on seed production unit or farms monitored by the seed processing unit of the Ministry of Agriculture. Despite the need for large increases in the quantity and availability of seed, rigorous control of the processing of the seed will be enforced to ensure good quality.

Production Agronomy

Land Development and Preparation

Recommendations for development and preparation of land for soyabean is similar to that for most other row crops [7]. Various land preparation techniques are being investigated in the Intermediate Savannahs in the light of high operational costs, heavy demand on machinery and equipment and the undesirable effects of conventional systems which have created serious soil erosion problems on the long rolling slopes [8].

Initial investigations [9] into the innovative techniques of *minimum tillage* or *no-tillage* are being investigated with the objective of reducing operational costs and the machinery/equipment input. Other agronomic advantages - improved weed control, erosion control, improved fertility - are also possible. Knowledge of soil conservation techniques is also a prerequisite to cultivating and laying out fields for planting of soyabeans both in the hilly North West region and on the long rolling slopes of the Intermediate Savannahs.

The flat coastal clays pose somewhat different problems in terms of land development for soyabeans. The possibility of soyabean being instituted as a *fallow crop* in both rice and sugar cane fields means that additional micro-environmental drainage works (e.g., narrow beds and ridging of land) will be necessary to avoid or eliminate the water logging factor. However, the additional problem of inaccessibility of wet fields by machines for long periods makes mechanization of the crop questionable and will therefore place a physical restriction on rapid development of acreage.

Husbandry

Certain basic field agronomic techniques must be strictly observed if good yields are to be realised. The local experience has indicated clearly that large losses or even complete failure of the crop can occur at any stage of production. Among these problems are:

(a) Availability of good quality seed - As previously noted, systems are now being developed to improve the situation with regard to quantity and quality of seed available for planting. Soyabean seed deteriorates very rapidly under substandard conditions of harvesting, processing or storage. At Kibilibiri and in other production areas where poor seed was responsible for sub-optimal plant populations, yield losses were amplified by other attendant factors, e.g., increased weed population, depression of plant height, greater combine losses.

(b) Soil fertility - The use of the nitrogen fixing bacteria *Rhizobium japonicum* as a means of cheap supply nitrogen to the plant is under serious study at the moment. Specific strains of Rhizobium which are adaptable to local conditions have been identified and small quantities (up to 100 acres per batch) are being manufactured and made available for commerical use. The soyabean programme demands that all farmers or agencies involved in growing of the crop should adopt the standard procedure of seed inoculation with *Rhizobium japonicum*. It is estimated that effective nodulation can result in savings of up to 25 per cent of total fertilizer inputs in the infertile soils of the Intermediate Savannahs. Other areas may not indicate such profound effects; [10] however, its use is still recommended as a safeguard. Other soil fertility problems exist in all areas. The Intermediate Savannah soils, for example, are deficient in major, secondary and trace elements. Current fertilizer recommendations for this location [7,11] are of a temporary nature and are subject to modification as more is learnt of the soils.

(c) Plant protection - The major problem in the area of plant protection is weed control. Weeds compete strongly with the crop and can reduce yields considerably as indicated by the experience at Kibilibiri (see Table 4). Both chemical and mechanical control is employed, the system varying with the location. At Kibilibiri where control is fully

mechanized, a preemergent herbicide is followed by rotary hoes or tyne cultivators if necessary. Hand weeding of smaller acreages is done but this exercise, if not well planned and executed, can increase production costs out of proportion.

(d) Harvesting, Drying and Storage - Crop losses can be both excessive and costly during these operations for a multiplicity of reasons:

(i) delays in harvesting resulting in shattering and reduction in yield and quality;
(ii) bad weather at harvesting;
(iii) poor combining due to inexperience of operator or improper machine adjustment;
(iv) lack of proper or functional artificial drying facilities; and
(v) inadequate protection from storage pests.

This is the point at which Kibilibiri has lost as much as 30-40 per cent of the crop for one or a combination of the reasons listed in a single season [12]. These problems have all been experienced in major soyabean growing areas and it is known that careful field management can eliminate most of them.

At Kibilibiri where acreages are large the crop is combine harvested. Adjusting and operating the combine is indeed a skilled operation. If sufficient care is not exercised, header losses and threshing losses can be very high. Other associated factors like moisture content at harvesting, height of plants, etc., must also be considered.

Hand harvesting is practised in other areas of production. This is feasible and manageable for areas of up to about 2.0 hectares (5 acres); however, consideration must eventually be given to small/medium scale machinery to assist on a semi-mechanized basis.

Crop rotations

One of the major agronomic advantages of soyabean is the facility with which the crop fits into a crop rotation system. The ability of the plant to fix its own nitrogen and to utilise residual fertility when following heavily fertilized crops as corn, sorghum or cotton makes it ideal for the poor Intermediate Savannah soils. The rationale for coastal production of the crop is also based on this premise and in addition on the utilisation of lands which may have remained idle or fallow between crops of sugar and rice [13]. A rotational system has been instituted at Kibilibiri in which corn follows one or two crops of soyabean.

Organisation and Management Factor

Whether soyabean is grown by the farmer, the cooperative group or the large state-owned corporation, the management factor is the final determinant of success. Management in this context connotes the efficient and timely execution of field technology in so far as it is relevant to the crop. In this respect both the Guyanese farmer or field manager and the planners will need to realign attitudes toward the crop since it demands a finer degree of planning and organization when compared with other major established crops - sugar and rice - with which most farmers are intimately familiar.

Planning

Planning and the working out of logistics for the crop must be of a very precise nature. Failure to consider all eventualities can lead, and has in fact lead in the past, to disastrous effects. Vital factors that must be considered are:

(a) timeliness of all field operations and especially planting and harvesting;
(b) easy availability of all inputs - manpower, machinery, fertilizers and biocides when required; and
(c) a recourse to emergency services in the event of unforeseen circumstances, e.g., unusual climatic conditions, pest epidemics, machinery failures.

Programming

The 1972-76 Development Programme for Guyana [14] indicates a target of 6,000 hectares (15,000 acres) of soyabean by 1976. This target will inevitably be revised downward to a figure that is more realistic and attainable - more in the region of 800-1000 hectares (2,000-2,500 acres). The need however, for rapid expansion of acreage is underlined by the fact that consideration is being given to the establishment of a Solvent Extraction plant for more efficient oil recovery as compared with the hydraulic press system now being used. This will in turn make available a low fat residue that could be processed in several different ways for human protein supplement - notably baby foods.

A more organized and efficient system of programming primary production aspect of the enterprise is therefore essential to its rapid and sustained growth.

Economics of Soyabean Production

Because of the infancy of the soyabean development programme cost analysis data for the crop in the various possible locations is not all available nor is it conclusive. A study of the economic potential of the crop in the Intermediate Savannahs was presented by Hooker in 1973 [15]; however, since the data has been collected technology has been improved and fixed and variable costs and the value of the bean has increased out of all proportions. At that time it was estimated that with a yield of 1500-1800 kg per hectares and an assumed price of 12.5 cents (G) per pound, a small profit margin seemed possible. A more recent analysis has however indicated that with current technology the attainable yield of 1200 kg per hectare will provide a margin of profit. Table 5 summarizes very briefly the variable cost factors involved in production in the Intermediate Savannahs based on current experience.

Cost analysis data for other areas is less reliable. It is however known that heavy capital costs for land clearing exist in the North West District while land preparation costs will tend to be higher on coastal soils. Fertilizer inputs which carry a significant proportion of the variable costs in the Savannahs are lower in other areas of production.

Table 5. Soyabean - Production Costs Per Acre; Intermediate Savannah Region.

Item	Cost/acre ($G)	Remarks
Land development	10	Basis on 20% of land under light scrub.
Land preparation	12	Ploughing, harrowing, planting.
Fertilizer and liming	230	Materials and application.
Seed preparation and planting	60	Materials and application.
Weed control	35	Chemical and mechanical control, materials and application.
Pest and disease control	20	Materials and application
Harvesting	15	Combine harvested.
Drying and storage	7	Artificially dried and bagged.
Total Cost/Acre (farm gate)	389	

Yield and gross revenue

1500 lb./ac. at 40¢/lb. = $600.

Conclusion

Future prospects

Future prospects for the long term expansion of soyabean in Guyana lies in the strategy of all countries of the region toward rapid development of their livestock industries. The country is making precise plans to develop soyabean to the stage of a commodity crop as is reflected in the following proposed developments:

(a) the establishment of the Guyana Agricultural Products Corporation which among other resposibilities will be involved in further developing the established soyabean enterprises in the Intermediate Savannahs and North West District;

(b) the proposed joint participation of Trinidad and Guyana through their respective Governments in the corn/soyabean project to be based in Guyana - initially 5000 acres and increasing to 50,000 in the long term;

(c) the current investigations into the value of the plant as a substitution for the flood-fallow system on sugar estates in coastal areas; and

(d) establishment of a solvent extraction unit for efficient processing, higher oil recovery and a good quality meal that can be used in formulation of human protein diets.

Naturally, participation at the primary production level must come from the farming community - most likely in the form of *satillite farms* which can efficiently utilise and capitalise on the limited facilities and technology available on the large state farms. Isolated and unorganized attempts to involve farmers in this crop can result in failure and frustration and an ultimate set-back to the development of the enterprise. To this end selected farmers and farming groups are being introduced to the crop and are being encouraged to produce small trial acreages under the strict supervision from Ministry of Agriculture technical personnel.

Summary

Marked interest in soyabean as an oilseed crop developed in Guyana during the 1960's. Later developments included a major thrust in the area of research and development of the crop with the assistance of University of Florida personnel working with local counterparts. This programme proved extremely beneficial and several major problems relating to the agronomy of the crop were resolved. Significant among these was the identification of the variety Jupiter suited to tropical latitudes which was tested in Guyana. In addition the value and importance of the symbiotic nitrogen fixing bacteria *(Rhizobium japonicum)* was recognised.

Commercial acreages of soyabean were grown in Guyana for the first time in 1970 in the Intermediate Savannhas. Shortly after smaller acreages were introduced into the heavily forested North West District and more recently on the flat low lands of the coast on a trial basis.

Problems and constraints to increased production and productivity have been encountered at every stage of field operation. Some have been resolved. Others, although understood are more difficult to handle and in fact are affecting production significantly.

There are plans for rapid expansion of acreage in all locations but particularly in the Intermediate Savannahs where large scale mechanization is possible. Farmers are also being introduced to the crop on a selective basis.

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