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GROUP IV:

"DEVELOPING THE REGION'S GRAIN/LEGUME AND OTHER PROTEIN SOURCES"

GRAIN LEGUMES WITH DEVELOPMENT POTENTIAL FOR THE CARIBBEAN REGION

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Introduction

Grain legumes, by virtue of their high protein content and relatively low cost, are potentially capable of alleviating protein malnutrition among millions of people particularly in developing countries. One or more grain legume finds ready acceptance among the inhabitants of practically every country. The storage, handling and transportation of these commodities present comparatively few problems owing to their low moisture content, thus facilitating distribution.

The wide range of grain legume types makes them adaptable to various systems of cultivation ranging from backyard and small farm production to highly mechanised production systems. Because of their symbiotic relationship with root-nodule bacteria (*Rhizobium* sp.) they can be grown on many soils without supplemental nitrogen - a feature which cannot be over-emphasized owing to the ever increasing cost of fertilizers.

In spite of these major attributes, certain constraints so far have restricted the capability of grain legumes to provide the deficient protein. These include their overall low level of yield, unfavourable systems of cultivation, extreme susceptibility to various pests and diseases (see Table 1) restrictions in utilization owing to consumer preferences and certain undesirable features, e.g., flatulence factors, antimetabolites (trypsin inhibitors, hemaglutinins and associated toxic factors, cyanogenic glycosides, goiterogenic factors), poor digestibility and peculiar flavours. Fortunately, most of the antimetabolites are heat labile so that with proper cooking or heat processing the dangers associated with high levels of consumption can be almost totally eliminated. Legume proteins generally are deficient in sulphur amino acids particularly methionine and cystine.

Table 1. Major Diseases and Pests of Grain Legumes in the Caribbean

Diseases	Pests
Dry bean *(Phaseolus vulgaris)*:	
Angular leaf spot *(Isariopsis griseola)*	Aphids *(Aphis* sp.*)*
Anthracnose *(Colletotrichum lindemuthianum)*	Bruchids *(Callosobruchus* sp.*)*
Bacterial blight *(Xanthomonas phaseoli)*	Leaf beetles *(Ceratoma arcuata)*
Bean common mosaic	*(C. ruficornis)*
Golden mosaic	*(Diabrotica balteata)*
Powdery mildew *(Erysiphe polygoni)*	*(Diabrotica* sp.*)*
Root knot *(Meloidogyne* sp.*)*	Leaf hoppers *(Empoasca fabae)*
Root rot *(Rhizoctonia solani)*	Leaf rollers *(Goniurus proteus)*
Rust *(Uromyces phaseoli typica)*	Leaf webbers *(Lamprosema indicata)*
Southern blight *(Sclerotium rolfsii)*	Mites *(Tetranychus* sp.*)*
	Stink bugs *(Nezara viridula)*
	White flies *(Bemisia tabaci)*
Pigeon pea *(Cajanus cajan)*:	
Collar & stem canker *(Phoma cajani)*	Bruchids *(Callosobruchus* sp.*)*
Leafspot *(Cereospora cajani)*	Leaf hoppers *(Empoasca fabae)*
Rhynchosia mosaic	Podborers *(Ancylostomia stercorea)*
Rust *(Uredo cajani)*	*(Fundella cistipennis)*
Southern blight *(Sclerotium rolfsii)*	*(Heliothis virescens)*
Wilt *(Fusarium* sp.*)*	*(H. zea)*
Witches broom *(Mycoplasma)?*	
Cowpea *(Vigna unguiculata)*:	
Cowpea mosaic	Aphids *(Aphis* sp.*)*
Leafspot *(Cercospora canescens)*	Beetles *(Diabrotica balteata)*
(C. cruenta)	Bruchids *(Callosobruchus* sp.*)*
Powdery mildew *(Erysiphe polygoni)*	Leaf hoppers *(Empoasca fabae)*
	Podborer *(Fundella cistipennis)*
	Stink bugs *(Nezara viridula)*
Soyabean *(Glycine max)*:	
Rhynchosia mosaic	Beetles *(Diabrotica balteata)*
	Leaf hoppers *(Empoasca fabae)*
	Leaf webber *(Lamprosema indicata)*
	Stink bug *(Nezara viridula)*
Peanut *(Archis hypogaea)*:	
(Aspergillus flavus)	Leaf hoppers *(Empoasca fabae)*
Leaf spot *(Cercospora arachidicola)*	Stem borer *(unidentified)*
(C. personata)	
Rust *(Puccinia arachidis)*	
Southern blight *(Sclerotium rolfsii)*	

Potentially Important Grain Legumes in the Caribbean

Although several species of grain legumes are grown and utilized in various parts of the world, relatively few species are economically important. There are five species which appear to have developed potential in the Caribbean region. These are pigeon pea (*Cajanus cajan* (L.) Millsp.), dry bean (*Phaseolus vulgaris* L.), soyabean (*Glycine max* (L.) Mer.), peanut (*Arachis hypogaea* L.), and cowpea (*Vigna unguiculata* (L.) Walp.).

These species have development potential because they generally are accepted and utilized in one form or another in the region; with the possible exception of pigeon pea they are amenable to large scale, mechanised cultivation, and they all are currently being studied quite intensively both in national and international research programmes in various areas in the tropics.

Pigeon pea

This is one of the most popular grain legume used for direct human consumption in the Caribbean region. Both mature green and dry seeds are utilized but it is generally preferred in the mature green stage. It is also processed by canning in Trinidad, Jamaica and other parts of the Caribbean, e.g., Puerto Rico and the Dominican Republic.

Pigeon pea is widely grown throughout the region primarily by small farmers. There are several cultivars within the region due mainly to an unusually high level of out crossing in this legume. Although this could be advantageous to the plant breeder, it creates practical problems in relation to the maintenance of varietal purity.

The traditional varieties are tall, indeterminate types that are highly sensitive to photoperiod. Their tall and indeterminate nature make harvesting difficult and expensive, and their photoperiodicity results in seasonal availability of the fresh, mature green pods.

Several dwarf, relatively determinate, early bearing cultivars have been developed by the University of the West Indies (UWI) but these are highly susceptible to pigeon pea rust. This disease, which causes defoliation of the affected plant, is particularly serious on the dwarf determinate varieties since these varieties do not produce new leaves after the onset of flowering.

It has been shown that by superimposing the effect of day length on the dwaft varieties by late planting (November-January), both plant size and maturation period can be reduced [1,5] thus making it possible to grow pigeon pea as a row crop instead of a spaced crop. This has opened up the possibility of large scale mechanised cultivation of pigeon pea and experiments are now in progress at UWI in an effort to develop a mechanical

harvester for green pigeon pea. Tremendous progress already has been made at the same institution in developing a small sheller for green pigeon pea.

The world average yield is 630 kg/ha. but yields as high as 5,000 kg/ha. have been obtained in experimental plantings in India. In Jamaica the average yield is estimated as 670 kg/ha. but the average yield from several experimental plantings was 1,900 kg/ha. Our best plot produced over 16,000 kg/ha. mature green pods equivalent to about 5,500 kg/ha. dry seed. Sallette and Courbois [4] have reported a yield of over 15,000 kg/ha. green pods with a UWI variety, GI 54/3, from an experimental planting.

Dry Bean

This legume is one of the most widely utilized in the Caribbean particularly in Belize, Jamaica and Trinidad. The main producing territories are Belize and Jamaica.

A very wide range of dry bean types exists. This is evident mainly in the seeds which vary in size, shape and colour which may be white, black, red, brown, grey or mottled. With the exception of the small white-seeded 'pea' beans that are used in the preparation of pork and beans, Caribbean consumers prefer the red-seeded types, particularly the Red Kidney varieties. In most Central and South American countries, however, the black-seeded types are preferred.

Dry beans contain about 22 per cent protein which has a relatively high lysine content but is low in sulphur - containing amino acids. They are also reported to be high in anti-metabolites, haemaglutinins, trypsin inhibitors and flatus-producing factors.

Disease and pest problems are among the most important limiting factors to dry bean production particularly in the tropics. In addition, high temperatures and moisture stress during critical periods of the growing season are reported to reduce pod set and yield.

An appreciable amount of research currently is being conducted on this crop in various parts of the world. A number of Central and South American countries have national bean improvement programmes and both the Centro International de Agricultura Tropical (CIAT) in Colombia and the Instituto Interamericano de Ciencias Agricolas de la OEA (IICA) in Costa Rica have fairly extensive programmes for the improvement of dry bean.

Average yields range from 300 kg/ha in Asia and Africa to 1,500 kg/ha in North America. Yield of 3,000 to 4,000 kg/ha. have been obtained by efficient farmers in North America and in experimental plots in Jamaica on a number of cultivars have yielded 2,000 to 3,000 kg/ha. [2].

Cowpea

Of the legumes utilized directly for human consumption, this crop is the least popular in the Caribbean. Small quantities of either black-eye, gub-gub or other types of cowpea are grown in various areas throughout the Caribbean.

Compared to dry bean, cowpea is less susceptible to disease and

pests, less susceptible to stresses in soil moisture, and more ecologically adapted to the low humid tropical climate. It also appears to be quite free of antimetabolites and toxic agents. Its limited demand may be attributable to its flavour but this may be overcome by adequate promotion. The major factors limiting economic production are low yield potential coupled with the predominance of agronomically undesirable prostrate and vining plant types which are not suited to large scale production.

Cowpea is the legume which until recently has received only minimal attention in terms of research inputs although some improved varieties have been developed in the U.S.A.

The world average yields is 385 kg/ha. but yields in excess of 2,000 kg/ha. have been obtained in experiments in Iran and Nigeria. Yields in the region appear to be in the order of 800 to 1,000 kg/ha.

Soyabean

Soyabean is an oil-seed legume which contains 18 to 20 per cent oil and 36 to 40 per cent protein. In the Caribbean region, soyabean is utilized mainly for oil and soyabean meal, the latter being one of the major components of livestock feeds. Small quantities are utilized in the processing industry in the preparation of soy sauce etc. and in Jamaica, the Food Technology Division of the Ministry of Trade and Industry has processed soyabean into several forms ranging from baby foods to various whole soyabean preparations.

There is a high regional demand for soyabean and soyabean products. In 1972, Jamaica imported 18,000 tons of soyabean, 4,500 tons of soyabean oil and 6,000 tons of oil seed cake and meal of which soyabean meal constitutes the major portion. In the same year, Trinidad imported 23,500 tons of soyabean meal.

Soyabean is an extremely photoperiodic crop but it has been shown that a number of varieties can be grown in the region with reasonably good results. However, one of the major factors limiting the development of this crop is the need for processing. Except for experimental plots and a few small scale plantings, soyabean has not been grown in the region. Recently, however, there has been some measure of interest in growing soyabean in several territories including Guyana, Trinidad, Jamaica and Belize.

Of the food legumes, soyabean so far has shown the highest yield potential and it is not altogether insignificant that it is the legume which has received most attention in terms of research inputs. The world average yield is 1,300 kg/ha. and yields in excess of 6,000 kg/ha. have been obtained in North America. In experimental plots we have obtained yields in excess of 3,000 kg/ha. in Jamaica.

Peanut

Like soyabean, peanut is rich in both oil (40 per cent) and protein (25 per cent) and can be similarly utilized although the protein quality is somewhat poorer than most food legumes being low in lysine and threonine in addition to methionine. One of the major limiting

factors to the extensive use of peanut meal in animal feeds is its susceptibility to attack by a fungus, *Aspergillus flavus*, which produces a highly poisonous group of substances known in aflatoxins.

Unlike the other grain legumes, the economic product of the peanut is produced underground. This tends to increase harvesting losses which generally are higher in heavy soils.

In the Caribbean, peanuts are utilized to an appreciable extent for direct human consumption as roasted peanuts, in confectionery, peanut butter etc.

Small quantities are produced in several Caribbean territories including Jamaica, St. Vincent, St. Kitts, Guyana and yields generally are in the order of 900 to 1,100 kg/ha.

In experimental plots in Jamaica yields in excess of 2,500 kg/ha. have been obtained. The world average yield is 850 kg/ha. but yields up to 3,000 kg/ha. have been obtained in parts of U.S.A.

International Centres and National Programmes Concerned with Development of Grain Legumes

Based largely on the recommendations of Roberts 3 a number of international centres for indepth research on grain legumes have been established. Each international research centre is located in a geographical area which is either a major producing area or close to the centre of origin of the particular legume crop. Thus the International Institute for Tropical Agriculture (IITA) in Nigeria is primarily responsible for work on cowpea; Centro Internacional de Agricultura Tropical (CIAT) in Colombia is responsible for work on dry bean, and the Institute for Crops Research and Improvement in the Semi-Arid Tropics (ICRISAT) in India is responsible for work on pigeon pea.

So far, no international centre has been given major responsibility for work on peanut and soyabean, but both IITA and CIAT have minor programmes on soyabean. In addition, the University of Illinois, in association with the University of Puerto Rico, has recently launched an international programme for evaluation of soyabean varieties in different tropical areas.

Peanut has had a relatively long history of research in the tropics. In Africa, the Institute for Agricultural Research in Nigeria, the Centre de Recherches Agronomique (IRAT) in Senegal and the Agricultural Research Council in Malawi have all been concerned with various aspects of peanut research and the Indian Agricultural Research Institute has been conducting research on peanuts for some time.

There are various other international and national programmes on legumes. In Puerto Rico there is a programme on dry bean and cowpea which is supported by the Agency for International Development (AID) in addition to which the University of Puerto Rico has an important programme on pigeon pea; there is an FAO supported programme on soyabean etc. in the Dominican Republic; the Instituto Interamericano de Ciencias Agricolas de la OEA (IICA) has a major programme on dry bean in Costa Rica and practically every country in central and northern South America has a national research programme on dry bean. At UWI there are programmes of varying magnitude on

all of these legumes, both in Trinidad and Jamaica. These programmes are to a large extent supported by the International Development Research Centre in Canada and the Overseas Development Agency (ODA) of the United Kingdom government.

In general, therefore, there is a fair amount of research currently in progress in tropical areas on the potentially important grain legumes. Much of this intensified research is of recent origin and it would be some time before these programmes make an impact on the productivity of these legumes.

Undoubtedly, there is a need to improve the technology of production of these legumes. One should aim at the development of a package of practices and systems of production which would make these crops more viable economically and it is here that national research programmes can make a major contribution. There is also a need for more long term research principally by international centres aimed at surmounting genetic constraints of one type or another in every legume crop. Improvement of plant architecture, increased photosynthetic efficiency, improvement in protein content and amino acid balance, resistance to diseases and pests, increased harvest index, legume/Rhizobia relationships under tropical conditions and day neutrality in photoperiodic species are some of the areas which require attention.

Strategy for the Development of Grain Legumes in the Caribbean

The strategy for development of the grain legumes in the Caribbean should revolve around the following:

1. large scale mechanised cultivation of these crops in areas where suitable climate and adequate lands are available;
2. construction of adequate storage (processing facilities where applicable) in the areas of production;
3. improvement in the marketing and distribution systems in the region; and
4. development of additional processed products where possible to increase the utilisation of these commodities.

It has been pointed out that most grain legumes are amenable to mecahnisation. All cultural operations including harvesting and threshing can be performed mechanically. This gives one the advantage of being able to cultivate large areas and keep production costs low - an essential feature since the yields of these legumes are not particularly high.

I am not suggesting that there is no place for the home gardener and small farmer in the production of legumes. In fact, certain cultivars e.g. runner types of bean and cowpea, the indeterminate types of pigeon pea, the vegetable types of soyabean, are admirably suited to the small family farm and home garden. But if it is hoped to achieve some semblance of self-sufficiency in legume production in the region at reasonable cost, then it should be made abundantly clear that this cannot be done under the systems of production that currently prevail.

In most parts of the Caribbean, grain legumes and other food crops are grown in small plots, often on hilly and marginal land, with hardly any inputs other than labour from the farmer and his family. Crop growth

is dependent on rainfall, and little use is made of pesticides and fertilizers either through lack of knowledge or because of insufficient financial resources. Often the legumes are intercropped with corn, yams etc. Under these conditions, the basically low yields of these crops are further suppressed and the risk of crop failure remains high.

It has been said that large scale mechanised cultivation will increase unemployment and provide unfair competition for the small farmers who traditionally have produced the food crops in the region. These points are debatable. However, if we are to grow legumes in the region in reasonable quantity and at realistic costs, production must be mechanised.

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