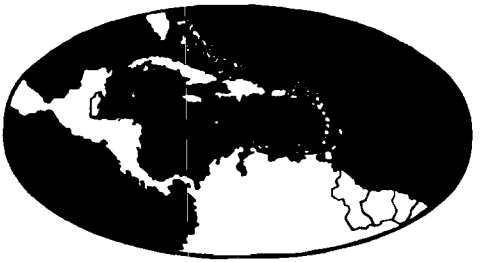
CARIBBEAN FOOD CROPS SOCIETY



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PROBLEMS ENCOUNTERED IN MECHANICAL HARVESTING OF BLACKEYE PEAS (COWPEAS) IN THE INTERMEDIATE SAVANNAHS OF GUYANA

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ABSTRACT

Efforts at large scale production of blackeye peas in Guyana have been centred around a system of mechanized farming in the Intermediate Savannah region of the country.

The crop is well adapted to savannah conditions and produced well. It has been possible to mechanize all field agronomic operations; however problems have been encountered with mechanical harvesting with combine harvester due to a complex of factors which in most cases are inter related.

The paper discusses the problems associated with the three major factors in the complex:-

(i) The plant
(ii) The harvesting machine
(iii) The micro climatic factor.

Timing of planting is important in relation to time of harvesting. Excessive rainfall during the maturity and harvesting periods can cause reduction in both yields and quality of harvested beans. Correct machine adjustment is also a significant consideration with regard to yield and quality.

Systems and methods for surmounting the problems described are discussed.

INTRODUCTION

Blackeye peas (*Vigna unguiculata* (L.) Walp) has traditionally been a small-farmer crop in Guyana with individual production units rarely in excess of 2 hectares. There exists in the country a high demand

for this commodity as a grain legume staple and recent efforts at achievement of local self sufficiency include large-scale mechanized production units in the Intermediate Savannahs of the Country (1).

This location with its vast tracts of infertile brown sand soils is new to crop production. The inherently poor fertility status of the soils (2) precludes the area from the normal crop production techniques traditionally practised by farmers in other agricultural locations, however, the area lends itself admirably to mechanization for row crop production. In addition technical and economic feasibility of large scale mechanized row crop production (3) makes farming of these soils justifiable with heavy capitalization.

A 1,000 hectare commercial pilot farm was started at Kibilibiri in 1971 on which grain crops - corn, sorghum, soybean and blackeye pea were grown with a system of complete mechanization. Black eye pea is especially adaptable to the location (4) and yields well. Harvesting has however posed specific problems, which in some seasons have resulted in significantly large losses of grain. Hand harvesting was initially attempted but this proved to be a highly labour intensive operation with attendant organizational and social problems, since labour had to be 'imported" into the area.

HAND PICKING VERSUS MECHANICAL HARVESTING

The hand picking operation permits selection of only sound mature pods especially where the plant may possess pods at various stages of development. These pods are subsequently threshed with a stationary thresher which, with the correct adjustments, produces good quality seed. Hand picking is however a slow and tedious operation especially when large cultivations are involved, and performance of workers is generally erratic and inconsistent because of the nature of the operation. In addition such a heavily labour intensive operation within an otherwise fully mechanized system causes imbalances in production organization.

The advantages of selected harvesting and the possibility of making a second picking from the standing plants are therefore not economically significant advantages under this system of cultivation.

Mechanical or combine harvesting requires that the entire plant be dry to facilitate the operation. Presence of green leaves, green stem or immature pods on the plant to be harvested results in staining of the seed with plant sap. Soil which is invariably picked up by the combine during

the harvesting operation could also stain the grain, especially if plant sap is present. Colour and appearance of the testa is an important factor in marketability of the beans, hence, stained or dirty seed coats reduce quality and acceptability of the grain commercially.

During the process of threshing the combine mechanism discriminates on size and relative density of the threshed components. It has been found that immature beans are generally chopped up during threshing into pieces with the average size of the seed and this material because it is heavier than the chaff, tends to pass through with the seed. This can cause a general increase in moisture of the harvested batch of seed and will incur additional drying costs.

VARIETAL ADAPTATION

The California No. 5 variety has been accepted as the standard for most blackeye pea cultivation in Guyana. A recent comparison (5) with other lines has indicated that for the purposes of mechanical harvesting this variety remains supreme in its agronomic properties (see Table 1). Major advantages can be summarised as follows:-

(i) Pods are borne well up among the leaves on the plant. Combine losses through high cutting are therefore minimal.

(ii) Plant height also permits easy combining.

(iii) Over 90% of the crop can be removed in a single harvest provided that the operation is well timed. This indicates the strong trend toward the determinate habit of the variety.

In spite of the marked determinate characteristics of California No. 5 variety it will continue flowering under persistently wet conditions at maturity. Under normal dry conditions maturity will spread over a period of 10 to 14 days however, deterioration of the earliest set pods can occur if plants are left standing for longer periods than specified.

Near - simultaneous maturity of all pods borne on the plant is an important coefficient in determination of adaptability to mechanical harvesting. Unlike hand-picking where it is possible to select only mature pods and to make two or three pickings, the combine harvester reaps the entire plant. A variety such as California No. 5 which, as indicated in Table 1 matures over 90% of its pods within a short period of time is therefore well adapted to mechanized harvesting.

TABLE 1. A comparison of agronomic characteristics of some promising lines of black-eye peas in relation to adaptability for mechanical harvesting (5).

Line	Yield of dry seed kg/ha	No. of pickings	% harvested at first picking	Plant height (cm)	Lowest pod (cm)
69F32	1528	2	63	53	28
69F184	1783	2	60	53	30
69F102	1306	2	79	38	20
California No. 5	1377	2	92	48	28

CLIMATIC CONSIDERATIONS

The objective of producing a uniform crop for mechanical harvesting is heavily dependent on the weather pattern. The Intermediate Savannah location, like several other areas in Guyana, experiences two cropping seasons as illustrated in Table 2. Planting dates must be timed very precisely so that maturity and harvesting occur in scheduled dry seasons. Continued rainfall during scheduled dry seasons while the crop is maturing can result in the following problems:-

(i) **Incidence of Pod Rot or Fusarium Rot:**

This disease which is caused by *Fusarium* sp. is associated with a moisture/humidity/temperature complex. The disease becomes apparent and can sometimes reach epidemic proportions during spells of hot humid weather accompanied by intermittent showers (Table 3).

Pods are attacked usually at their point of attachment with the stem or at their distal ends. The causal organism invades the tissue of the pod resulting in degeneration into a watery slimy mass. Seed affected by the disease is discoloured and quality of the grain is adversely affected. Mechanical combining does not discriminate against these pods, hence the problem exists of separation of infected or discoloured seed after harvest. This is not possible with available equipment.

TABLE 2. Climatic chart indicating ideal planting and harvesting times for blackeye peas in the Intermediate Savannahs of Guyana.

Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
- Short wet season		- Dry season -			- Long wet season -				- Dry season -		
Plant		Harvest			Plant				Harvest		

TABLE 3. Effect of precipitation during the maturity period of blackeye peas planted in various seasons at Kibilibiri on incidence of Fusarium rot and marketable quality of seed.

CROPPING SEASON	PRECIPITATION - 5 day intervals (cm)							Fusarium rot rating*	Seed Quality rating
	1	2	3	4	5	6	Total		
1971/72	2.82	1.80	2.13	1.24	2.13	0.00	10.12	n.a.	Fair
1972	0.00	1.57	0.00	0.00	2.23	0.43	4.23	0	Good
1972/73	0.89	0.00	0.00	0.71	0.00	2.87	4.47	0	Good
1973	4.06	1.40	4.42	4.39	3.28	7.26	24.81	4	Poor
1973/74	0.63	8.58	3.81	2.39	1.32	0.13	16.86	2	Fair
1974	2.23	2.89	3.12	0.00	2.69	1.78	12.71	3	Poor
1974/75	0.43	1.04	1.24	0.08	0.20	0.20	3.19	1	Good

* Rating: 0 (negligible) to 4 (severe)

The use of Dithane M45 at 0.75 kg active/ha per application has been successful in supression of Fusarium rot. The frequency and intensity of the rainfall will determine the number of applications necessary to control the disease during the period of maturity.

(ii) **Persistence of green vegetation at maturity:**

With appreciable rains, plants do not dry out naturally at maturity. Stems remain green and new flushes of leaves and flowers are produced. This presents the problem of discoloured on mud-stained seed and a higher moisture content of the harvested product.

(iii) **Increased weed growth:**

Similarly heavy rains encourage late weed growth. The effects on the quality of harvested seed is the same if green weed material is harvested during combining.

(iv) **Lodging of plants in the field:**

Persistent rains at maturity can cause lodging of plants. Harvesting losses are higher among lodged plants and quality can possibly be reduced when pods remain in contact with the soil for protracted periods.

(v) **Staining of seeds in pod:**

The pericarp or shell of the dry fruit is not very water resistant and saturates very easily when wet. Pink stains usually develop on the testa of the seed on contact with the wet pericarp. Marketable quality is therefore reduced.

THE PLANT FACTOR

The state of the plant at maturity and the moisture status bear a significant relationship to combine harvesting efficiency. Once physiological maturity is attained the crop must dry out as rapidly as possible to ensure a good quality product. A continuous spell of hot dry days (2 weeks) will satisfy this condition. Intermittent wet spells would necessitate artificial desiccation of plants before harvest.

ARTIFICIAL DESICCATION OF THE CROP

The herbicide Gramoxone (Paraquat) has been successfully used in the dessication of the maturing blackeye pea crop at Kibilibiri. Complete drying of green leaves and stems and immature poods has been achieved on application of Paraquat at 0.29 kg active/ha at 2 to 3 days after application. Application is by boom sprayers with 340 litres of water per hectare as a carrier for the chemical. Since action of Gramoxone is one of contact, care is necessary to reduce drift during application to a minimum and to ensure satisfactory coverage.

In heavily weed infested fields a single application of Paraquat will dessicate both weeds and crop.

Once dessication is effected it is necessary to harvest within one week because of rapid deterioration of the plant.

THE COMBINE HARVESTER OPERATION

The efficiency of the combining operation is dependent on both machine and micro-climatic factors.

(i) **Machnie Factors:-**

For high recovery of good quality whole grain the combine must be well adjusted and carefully operated.

(a) The spead of the cylinder (threshing mechanism):

Slow threshing speeds yield a high proportion of whole undamaged grain but threshing is usually imcomplete. High cylinder speeds give complete threshing but also a high incidence of damaged (split) grain. Inadequate machine adjustment can result in either a high percentage of split grain (20%) or losses through improper threshing (15%).

The total harvested weight of the crop is therefore not a final indication of the marketable yields. The additional operation of cleaning or separation is necessary to eliminate splits and brokens which are not marketable.

(b) The height adjustment and efficiency of the cutter bar:-

The cutter bar on the header of the combine must be adjusted at a height low enough to cut the plant below the lower-most pods. However, this low position can result in the picking up of excessive quantities of dirt, moreso over uneven terrain, and subsequently staining of seed during threshing. The operator must therefore compromise by operational adjustment (raising and lowering) during combining.

Efficiency of the cutter bar depends on the sharpness of the knives. Blunt knives grab rather than cut the plants and can precipitate header shattering especially under hot dry conditions.

(c) The ground speed of the combine:-

Cutter bar losses can result from excessively fast or slow travelling speeds. Ground speed must be moderated to permit efficient cutting and gathering by the pick-up reel.

(ii) Micro Climatic Factors:-

The dried pod demonstrates a certain degree of hygroscopicity in response to variation in atmospheric temperature and humidity throughout the day. This fluctuation in moisture content has been found to be directly related to harvesting efficiency. Table 4 summarises this relationship between time of day and combining efficiency. Significant precipitation would annul the micro climatic effect exerted at any time during the day.

Field experience indicates that the most ideal harvesting periods are the early part of the day and during the evening. In the late morning/early afternoon period or the height of the working day excessive header losses can result and the seed tends to be damaged during threshing.

TABLE 4. Relationship between time of day and combining efficiency for day standing blackeye crop.

Time of day	State of plant (Moisture status of pods)	Remarks (Combine harvester efficiency)
Morning 7.00 a.m. - 11.00 a.m.	Medium moisture 23% - 26% plants losing	Ideal time for combine harvesting. Threshing clean and efficient. Low incidence of splits and broken grains.
Late Morning/early afternoon 11.00 a.m. - 5.00 p.m.	Low moisture (18 - 22%) plants losing moisture rapidly under hot dry conditions.	Shattering and header losses increase during harvesting. Higher incidence of splits and broken grains due to brittleness of grain.
Late afternoon/evening 5.00 p.m. - 11.00 p.m.	Moisture increasing slowly.	Ideal time for combine harvesting.
Late evening 11.00 p.m. - 7.00 a.m.	Moisture at peak.	With high R.H. moisture in seed may be too high for efficient threshing.

CONCLUSION

It is clear that there exists an interrelationship of several agronomic environmental and mechanical factors that all contribute to the feasibility of mechanical harvesting of blackeye peas. At the Kibilibiri Project in the Intermediate Savannahs some of these factors have been identified by a system of trial and error. It is however necessary with the established base of experience to examine in depth the more vital factors e.g. varietal characteristics use of desiccants, and combine harvester adjustments.

Harvested yield and marketable quality of the peas are naturally the final considerations in terms of commercial production. The speed and efficiency with which combine harvesting can be achieved would be worthless if for instance the peas standing in the field have started deteriorating or if a poor quality of product enters the combine bin as a consequence of improper adjustment on operation of the machine.

As the various factors and their interrelationships are more clearly understood the ensuing modifications and improvements will result in the development of blackeye pea into a truly well adapted crop for large scale mechanized production in the Intermediate Savannah area where a virtually untapped potential exists for massive increases in crop production.