GUYANA AGRI-PROGRAMME

PROCEEDINGS OF SEMINAR ON LARGE - SCALE CULTIVATION OF COWPEA (VIGNA UNGUICULATA)

SIMON BOLIVAR FUND

IICA
GUYANA OFFICE
INTER-AMERICAN INSTITUTE OF AGRICULTURAL SCIENCES

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PROCEEDINGS OF SEMINAR ON LARGE-SCALE CULTIVATION OF COWPEA (*Vigna unguiculata*)

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TABLE OF CONTENTS

ACKNOWLEDGEMENT

This bulletin, which consists of some of the main papers presented at a workshop on 'Largescale Production of Legumes' is part of IICA's contribution to the National Legume and Cassava Programme in Guyana, which was made possible through the Simon Bolivar Fund. Hopefully, this publication will be useful to workers involved in cowpea production.

It was hoped that the bulletin would have been available much earlier but this was not possible owing to the late submission of some of the papers. The contribution of the various persons who made presentations is gratefully acknowledged. The papers were edited mainly for clarity. The subject matter is therefore the responsibility of the writers.

REP (Ed.)

ADDRESS BY MINISTER OF AGRICULTURE
Comrade G.B. Kennard, CCH, MP

1979 has been designated the Year of the Child. The conscience and concern of the world will be focused on the child during this period. And justifiably so; because in many parts of this planet, millions of children have been neglected not only at the family level, but in national planning and in the services which Governments provide.

The well-being of children is of special concern to those of us who labour in the field of Agriculture. It was not surprising, therefore, that the 1974 World Food Conference sponsored by the United Nations Organisation, which I attended, resolved that: "All Governments should ... accept the goal that within a decade no child will go to bed hungry and that no family will fear for its next day's bread".

Lamentably, as I speak to you five years later, it seems certain that this goal of freedom from hunger will not be met in this decade. Indeed, it appears that it will not be achieved even by the end of this century. The reason is that food production has not increased to the extent desired. Thus, over the period 1968 to 1977 food production has risen by an average of only 2.95 per cent per annum in developing countries some of which recorded negative output growth rates. At the same time, their population have increased by an average of 2.6 per cent per annum, so that production was hardly enough to keep pace with the rise in population and the need to increase per caput consumption rates. As far as increasing the per caput consumption or intake of food, a recent FAO survey has disclosed that the daily caloric intake per head of population has actually declined in the developing world and is some 1,200 calories less than the per caput intake in the development industrialised democracies.

But these figures, horrifying though they are, do not reflect the full gravity of the situation. The list of people in the developing world contains significantly less protein - gram for gram - than that of the industrialised countries. Protein malnutrition is recognised, consequently, as a most serious problem in developing countries. Practically all of the 2,000 million people of these countries, who, it is estimated are continually undernourished suffer from protein malnutrition with resultant low vitality, vulnerability to disease and low life expectancy.

Looking closer home, Nutritionists have been disturbed about the presence of protein malnutrition in many of the countries of the Caribbean Community. They and their colleagues in agriculture have been advocating strongly and incessantly, therefore, that food production should be increased and particularly the production of protein foods such such as meat, fish and legumes.

Guyana, as is well-known, formulated its Feed, Clothe and House programme almost a decade ago. Success has attended our efforts especially in achieving the objective of feeding ourselves. We are, presently net exporters of starch rich foods. In fact, in this group, not only do we feed ourselves with foods such as rice but we supply most of Caricom's needs for this commodity. No longer do we import starchy root vegetables such as the white potato. We have replaced some 20 million pounds anrually of this item with indigeneous starchy root vegetables such as cassava, eddoes, sweet potatoes and yams. We are now anxiously exploring export markets for surpluses of some root crops in addition to plantains. We have succeeded also in replacing imports of all fruit and vegetables - both fresh and preserved and all types of fish, beef, poultry and pork - fresh, frozen and preserved.

However, we have a long way to go to achieve self-sufficiency in protein. Though we rely on local production for our requirements of beef, fish, poultry and pork we are still importing large quantities of milk products and a fair amount of legumes. Moreover, we need to increase the per caput daily intake of protein.

With respect to legumes, these protein rich foods have been accorded the highest priority in our present food production plan. The reasons for this emphasis on legumes are:-

<u>Firstly</u>: They represent a source of protein which is acceptable to the entire population. Unlike animal protein which is not eaten by some people, vegetable proteins such as peas and beans, are consumed by everyone irrespective of his or her religious, ethnic or cultural identity.

<u>Secondly</u>: Legumes, as a protein source, are substantially less expensive than other proteins particularly those of animal origin. For example, one pound of beef costs five times as much as a pound of black-eye peas. Vegetable proteins are also more readily digestible and chemically pure than some animal proteins.

<u>Thirdly</u>: Legumes are adaptable to the various soils and ecological situations of the country.

<u>Fourthly</u>: The culture of legumes is relatively simple and within the capability of our people; and

<u>Fifthly</u>: Legumes contribute to the efficiency of agricultural production and soil and fertility conservation.

The increased Legume Production Programme was launched two years ago and has met with satisfactory results. Thus in 1977, the nation imported some 12 million pounds of legumes of all sorts, notably - split-peas, chic-peas or channa, peanuts, black-eye peas and various other peas and beans - some canned, for example, green peas. At the end of 1978, these imports had fallen by more than 50%.

This was a noteworthy achievement in our agricultural thrust. State Organisations such as the Guyana Sugar Corporation, the Guyana National Service, the Guyana Rice Board, the Caricom Corn & Soyabean Company and, to a more modest degree, the Guyana Defence Force, Police and Schools have made historic contributions. At the same time, I wish to pay tribute to the thousands of small farmers and home gardners who produced for their only sustenance and for their communities and even for the urban markets.

In all these endeavours, the Ministry of Agriculture has received significant help in money, in kind and in technical assistance from the Inter-American Institute of Agricultural Sciences I.I.C.A. and from the Simon Bolivar Fund. I wish publicly to recognise this collaboration and to thank I.I.C.A. its directorate and professionals for the part which they have played in ensuring the success of our programme. Our wish is that the cooperation and friendship which have distinguished our relationships would continue long into the future both in respect of this programme and others.

For 1979, we shall continue our legume programme - but more vigorously. We shall encourage small farmers to expand and will enlist to their ranks - others who have not been involved so far. Concurrently, we shall launch this special campaign to foster large scale cultivation by State Agricultural Agencies, Cooperatives and large farmers. State Agencies such as Guysuco and the Guyana National Service have budgetted to produce millions of pounds of legumes in 1979 by employing mechanised and other advanced techniques. However, it is important that before we go into the field, we should share our knowledge and experiences. This is the purpose of this Seminar. It is vital that we use the most appropriate and up-to-date technology. This seminar should reveal the best tractor, the best combine, the best varieties, fertiliser combinations, weedicides , insect-icidies, etc. which should be used.

Our aim is to ensure that large scale cultivation of legumes result in a large increase in production - large enough to replace the remaining imports and yield a surplus for export and large enough to increase the per caput daily intake of protein of every man, woman and child. At the same time, our expectation will be that higher production would be reflected in reduced production costs and, therefore, lower prices to consumers.

I wish your deliberations and subsequent activities all success. Through your endeavours you would enable Guyana to achieve the aspirations of the Resolution of the 1974 World Food Conference whereby, as far as legumes are concerned, "no child would go to bed hungry and no family would fear for its next days's bread".

ROLE OF LEGUMES IN THE CARIBBEAN FARMING SYSTEMS

Antonio M. Pinchinat

1. INTRODUCTION

Legumes, which belong to the family of Leguminosae, constitute one of the most diverse groups of plants. They share with the Graminaeae (cereals and grasses) a leading importance in world agriculture (1). They have been cultivated for at least 6000 years and served manking in many useful ways (2).

The role of legumes in Tropical America was reviewed by Pinchinat (3). This paper undates that revision, focusing on the importance of legumes in the prevailing farming systems in the Caribbean.

2. SOIL FERTILITY AND CONSERVATION

Through the activity of their root nodules, in symbiosis with different strains of Rhizobium bacteria, legumes are able to fix atmospheric nitrogen and improve soil productivity (4). Soils which are either naturally poor or have been exhausted by continuous cropping are characteristically low in both nitrogen and organic matter. This negatively affects both the chemical and physical fitness of the soil to sustain high crop yields. Under such conditions, crops become yellowish, stunted, unproductive, and easily are oversome by weeds. Although the crops may respond to mineral nitrogen fertilizers, this does not give the lasting improvement in soil fertility which would follow organic enrichment and improved physical structure by including legumes in the farming system.

As a rule in the Caribbean legumes are not specifically planted to improve soil conditions and they are very rarely used as green manure or cover crops. This may be partially due to conditions of land tenure but a general lack of knowledge of the value of legumes in that respect is a major contributory factor. Moreover very little is known in the region about the comparative efficiency of nitrogen fixation by legumes. Similarly, the effect of legume genotype and husbandry on soil protection, physical structure and productivity has received scant attention. Grain legumes as they are currently grown and harvested seem to make no significant contribution to soil nitrogen and organic matter content.

3. CROP PROTECTION

In the Caribbean, two of the major plantation crops, namely coffee (Coffea arabica) and cacao (Theobroma cacao), are generally grown under shade. The shade plants reduce evapo-transpiration and protect the blossoms and young fruits from the direct impact of rain drops. They also provide ground mulch and suppress weed growth. For shading purposes, legume trees are preferred, mainly because of their capacity to fix atmospheric nitrogen and produce abundant leaf mulch. Among the legume trees used as shade in coffee and cacao are the corals (Erythrina sp) mother-of-cocoa (Gliricidia sp.) saman (Pitchecellobium saman), and various guamas (Inga edulis: I-vera: I. spectabilis, and others).

4. PASTURE IMPROVEMENT

The association of legumes and grasses is a standard recommendation to increase the carrying capacity of pastures (2). Both the legume and the grass benefit from the association: the grass prevents the legume from being overtaken by weeds and the legume sustains the nitrogen budget of the sward.

Many valuable forage legumes could be used to improve pastures in the Caribbean. They include genera such as Desmodium, Calopagonium, Phaseolus, Centrosema, Indigofera, Leucaena, Dolichos, Stylosanthes, among others. But little effort has been made by ranch men in the region to exploit legumes for grazing. They rarely, if ever, sow grass/legume mixtures to improve the nutritive value of pastures.

5. FOOD AND FEED

Among plant species, legumes as a group contain the highest levels of protein, which may be as much as 35% in the raw, harvested product. They are also important sources of carbohydrates, fats, minerals and vitamins (5). Legume-grain protein is a natural complement of cereal-grain protein: the legumes mostly contributes lysine and the cereals methionine, thereby improving the amino acid balance of the resulting diet. In feeding experiments with rats, Bressani (6) obtained maximum protein value when 50% of the protein in the diet had come from maize (72 g) and 50%, from dry beans (Phaseolus vulgaris) or cowpea (Vigna unguiculata).

Pulses (grain legumes) are the poor man's meat and their consumption tends to be higher in the marginal than in the affluent social classes. A unit of beef protein may cost 10 times or more than that of a unit of dry bean protein (7). No wonder that in many countries of the Caribbean the demand per capita per day for grain legumes is relatively high. In intensive animal production systems, such as the raising of hens, hogs and dairy cattle increasing use is being made of concentrated feeds based on legume meals. These generally are the by products of industrial processing of oil bearing legumes such as soyabean (Glycine max) and peanut (Arachis hypogaea).

Legumes are also consumed as green beans or peas, immature pods, and green leaves. The pulp of the fruit in some legumes may be eaten directly or used in the preparation of various kinds of beverages. Legume tubers, pods, leaves and seeds have found many other food uses.

6. CASH CROPPING

Food legumes are high-value cash crops which find ready outlets in the Caribbean. The most commercially important species are the common bean, cowpea, pigeon pea (Cajanus cajan) and Lima bean (Phaseolus lunatus). Small amounts of other legumes such as hyacinth bean (Lablab niger) are marketed. They are grown for the green pods, peas or beans or for the dry seeds. The product may be sold fresh, canned or frozen.

In Guyana (8), domestic production of peas (mostly cowpea) and beans grew from 80 metric tons (Mt) in 1966 to about 14 times that much in 1977. The country aims at producing by 1981 more than 5000 Mt of grain legumes, 75% of which would be cowpea. In most of the Caribbean, grain legumes are intercropped, principally with maize or cassava but in Guyana, on the other hand, most farmers grow them in pure stand. A number of studies have demonstrated that total food production and net income are higher when legumes are inter-cropped rather than grown along (9). Intercropping reduces production risks by diversifying income sources and increasing crop flexibility to the vagaries of the environment.

7. OTHER USES

A large number of legumes are good sources of timber. These include species in the genera Dalbergia, Platymiscium, and some legume shade trees. The same or other legumes are used for fuelwood or charcoal. Some legumes, such as the pigeon pea have found a place in folk medicine, and include various tropical ornamental plants, such as the flamboyant (Delonix regia), which serves to enhance the beauty of the Caribbean countryside.

CONCLUSION

Legumes are important to Caribbean agriculture. They are used in many ways, principally for food, feed, shelter and fuel. Yet their contribution to the region's farming systems could be greatly increased through better agronomic management. Pasture value particularly could be improved by growing grass/legume mixtures. Soil fertility could be maintained, restored or increased and soil erosion reduced by extending the practice of green manuring where this is economically and socially feasible. Improving grain legume yields could help alleviate protein malnutrition in the region, boost rural income, and strengthen trade balances. Diversifying agro-industrial uses of legumes could enlarge the contribution of the agricultural sector to the gross national product and open up new and more job opportunities for the increasing population.

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FOOD LEGUMES WITH POTENTIAL FOR LARGESCALE PRODUCTION IN THE CARIBBEAN

R.E. Pierre

1.0 INTRODUCTION

1.1 Legumes, which are members of the botanical family Leguminoseae, are among the most important plant groups in agriculture. The importance of legumes is perhaps superceded only by the Gramineae (cereals and grasses). Members of the legume family are used in agriculture for several purposes including forage, covercrops, green manures, grain and as green vegetables (edible pods and young leaves). Some legumes are good sourc^s of oil(peanut, soyabean) while others are excellent sources of vegetable proteins and are extensively used for human consumption and livestock feed. It should be pointed out that while legumes are rich in protein, this protein in sometimes daficient in certain essential amino acids such as methionine and cystine.

1.2 Legumes possess an additional advantage in that, because of their symbiotic relationship with nodule bacteria (Rhizobium sp.), they are able to convert elemental nitrogen from the atmosphere into plant food and are thus widely used for maintaining and improving soil fertility. They can also be grown on a wide range of soils often without supplemental nitrogen.

1.3 The importance of legumes in agriculture and nutrition can hardly be over-emphasized. Food 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 - a feature which facilitates their distribution and the wide range of available legume types makes them adaptable to various systems of cultivation ranging from backyard gardens and small farms to highly mechanized production systems.

1.4 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 levels of yield
- unfavourable systems of cultivation
- extreme susceptibility to various pests and diseases
- restrictions in utilization owing to consumer preference
- certain undersirable features e.g. flatulence factors, anti-metabolites (trypsin inhibitors), hemagglutinins (bean), cyanogenic glycosides (lima bean), poor digestibility and peculiar flavours (soyabean).

1.5 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

2.0 IMPORTANT FOOD LEGUMES IN THE CARIBBEAN

2.1 Of the several species that are grown and utilized in the region, five species appear to have development potential. These are pigeon pea (*Cajanus cajan*), bean (*Phaseolus vulgaris*), cowpea (*Vigna unguiculata*), peanut (*Arachis hypogaea*) and soyabean (*Glycine max*).

2.2 These species are:

- generally accepted and utilized in the region in one form or another
- amenable to largescale, mechanized cultivation, pigeon pea being the possible exception
- currently being studied intensively in national and international research programs in the tropics.

2.3 Other species of less importance in the region include lima bean (*Phaseolus lunatus*), seim or bonavist bean (*Dolichos lablab*), mung (*Vigna radiata*) and urdi (*Vigna mungo*).

2.4 There are three species which are utilized in the region which are unsuitable for domestic production. These are garden pea (*Pisum sativum*) which is used mainly as canned and split pea, lentils (*Lens esculenta*) and channa (*Cicer arietinum*).

3.0 SOME CHARACTERISTICS OF THE FOOD LEGUMES

3.1 Pigeon Pea:

3.1.1 The pigeon pea or gungo as it is known in Jamaica, is a short-lived woody perennial shrub which grows to heights of 1-4 m dependant on variety. The plant is slow-growing initially but eventually develops a deep taproot which makes it relatively drought resistant.

3.1.2 It is one of the most popular grain legumes in the Caribbean. Both mature green and dry seeds are utilized but it is preferred in the mature green stage in many territories. It is also processed by canning in Trinidad, Jamaica, Puerto Rico and the Dominican Republic.

3.1.3 Pigeon pea is widely grown throughout the region primarily by small farmers and is frequently intercropped with corn. There are several cultivars due mainly to an unusually high level of out-crossing (5 to 40%). Although this could be advantageous to the plant breeder, it creates practical problems for the farmer in relation to the maintenance of varietal purity.

3.1.4 The traditional varieties are tall, indeterminate types that are highly sensitive to photoperiod. They are difficult and expensive to harvest and the mature green pods are seasonally available. 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 severe defoliation in some varieties, is particularly serious on the determinate types which do not produce new leaves on the flowering branches after the onset of flowering.

3.1.5 It has been shown that by superimposing the effect of day length on the dwarf varieties by late planting (November-January), both plant size and maturation period can be reduced thus making it possible to grow pigeon pea as a row crop rather than a spaced crop - a feature which has opened up the possibility of largescale, mechanized cultivation.

3.1.6 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 at 670 kg/ha, but several experimental plantings averaged 1,900 kg/ha, the best plot producing over 16,000 kg/ha mature green pods equivalent to about 5,500 kg/ha dry seed. A yield of over 15,000 kg/ha green pods with a UWI variety (GI 54/3) has been obtained in an experimental planting in Guadeloupe.

3.2 Bean:

3.2.1 This legume, known in Jamaica as "Red Peas", is one of the most widely utilized in the region particularly in Belize, Jamaica and Trinidad and Tobago. It is considered to be less adapted to lowland tropical conditions than some of the other species. The main producing territories are Belize and Jamaica.

3.2.2 A very wide range of dry bean types exists. This is evident in the plant habit and in the seeds which vary in size, shape and colour which may be white, black, red, brown, gray 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 but in most Central and South American counrties the black-seeded types are preferred.

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

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

3.3 <u>Cowpea</u>:

3.3.1 Guyana is the chief producer of cowpea (blackeye) in the region but small quantities of various types are produced throughout the Caribbean. Compared to dry bean, cowpea is less susceptible to diseases and pests, less susceptible to soil moisture stress, and more ecologically adapted to the low humid tropics. It also appears to be quite free of antimetabolites and toxic agents. Its relatively limited demand may be attributable to its flavour but this may be overcome by adequate promotion.

3.3.2 Like bean, it is a very polymorphic species and has a wide range of seed types which vary in size, shape and colour (black, white, red, light and dark brown, black eye, brown eye, red eye, and various mottled types).

3.3.3 The world average yield 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 500 - 700 kg/ha.

3.4 <u>Peanut</u>:

3.4.1 This legume is rich in both oil (40%) and protein (25%) but the protein quality is somewhat poorer than most food legumes being low in lysine, threonine and methionine. One of the major factors limiting the extensive use of peanut meal in animal feed is its susceptibility to attack by a fungus, <u>Aspergillus flavus</u>, which produces a highly poisonous group of substances known as aflatoxins.

3.4.2 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, and in addition, soil adhesion to pods is greater in heavy soils.

3.4.3 Peanuts are classified into two broad groups as follows:

- Valencia/Spanish - Bunch or spreading bunch types
- Virginia - Runner or prostrate types

Valencia/Spanish	Virginia
Inflorescences on main stem	No inflorescences on main stem
Sequential branching	Alternate branching
Leaves light green	Leaves dark green
Susceptible to Cercospora leaf spot	Tolerant to Cercospora leaf spot
Small to medium seeds	Large seeds
Seeds 3-6 per pod	Seeds 2 per pod
Seed - no dormancy period	Dormancy period
Early maturing	Late maturing

3.4.4 Small quantities are produced in several Caribbean territories including Jamaica, St. Vincent, St. Kitts, Guyana and yields generally are in the order of 900 - 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 in excess of 3,000 kg/ha have been obtained in parts of the U.S.A.

3.5 Soyabean:

3.5.1 Soyabean also is an oil-seed legume which contains 18-20% oil and 36-40% protein. In the Caribbean region, soyabean is utilized mainly for oil and soyabean meal, the latter being one of the major components of livestock feed. 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.

3.5.2 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.

3.5.3. One of the major factors limiting the development of this crop is the need for processing. Recently, a processing plant was established in Jamaica and it is anticipated that there will be some local production in the future. Already, the CARICOM Corn/Soyabean Company a tri-Government largescale production enterprise, is producing some soyabeans in Guyana, small quantities are produced in Trinidad and there are plans for a joint venture between Jamaica and Belize for production in the latter country.

3.5.4 Soyabean has a fairly plastic morphology and lateral branching is influenced by plant spacing. Since pods are borne virtually all along the branches and main stem the plant density/yield relationship is less critical in this species than most other legumes.

3.5.5 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 more 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 yields in excess of 3,000 kg/ha have been obtained in Jamaica.

3.6 Lima Bean:

3.6.1 Both annual and perennial types are known and in growth habit, they range from erect bush to climbing or pole types. The seeds vary in size and colour (white, red, brown, purple, black and various mottled types). Both short day and day neutral varieties are known.

3.7 Seim on Bonavist Bean:

3.7.1 The varieties used in the region are prolific, vining short-lived perennials which bear over a relatively long period. This species is hardy, drought resistant and tolerant to poor but well-drained soils. Both short day and long day varieties are known.

3.8 Mung (green gram) and Urdi (black gram):

3.8.1 Both are short term, drought resistant species which produce rather small seeds. They are used mainly in the preparation of dahl and as sprouted beans.

3.8.2 Mung has spreading or reflexed pods with short hairs and the seeds, which may be green, yellow or brown, are globose with a flat hilum. Urdi has erect to sub-erect pods with long hairs and the seeds are brown or black, and oblong with a concave hilum . Both species are rather prone to shattering.

4.0 SOME CRITICAL MANAGEMENT FACTORS IN THE PRODUCTION OF FOOD LEGUMES

4.1 Soils Conditions:

4.1.1 Although legumes can grow reasonablywell in a wide range of soils, well-drained, fertile loams are ideal. Heavy clays are much more difficult to manage especially in regard to drainage and timing of cultivation operations. Good legume-growing soils should be at about pH 6.5 with adequate levels of phosphate, calcium and micronutrients such as boron and molybdenum which are essential for Rhizobium activity. Excess inorganic nitrogen tends to suppress nodulation and large amounts of aluminum and manganese do likewise. There is evidence which indicates that some legumes (peanut) respond best to residual fertilizers, and most of the work on pigeon pea has shown no yield response to fertilizer application in that crop. Peanut has a high calcium requirement for pod and seed development. Good drainage is essential as most legumes cannot withstand water-logging. Good soil/seed contact, a non-crusted soil surface and adequate light also are essential for good growth of legumes.

4.2 Inoculation:

4.2.1 Inoculation is essential when a legume crop is to be planted in a new area. The nodule bacterial (Rhizobium sp.) are fairly specific although some species are rather broad-spectrumed in terms of the species with which they are associated. For example, R. japonicum is specific for soyabean and R. phaseoli is specific for bean (Phaseolus vulgaris), but the cowpea Rhizobium appears to be associated with cowpea, pigeon pea, peanut and a number of wild legume species. In addition, certain strains of Rhizobium are more effective than others and a number of strain/variety inter-actions are known to occur.

4.2.2 Better and more effective nodulation occurs in soils which are close to neutral, devoid of toxic levels of Aluminum and Manganese, and have adequate amounts of Phosphate and micronutrients especially Boron and Molybdenum. Active nodules are red inside due to the presence of a pigment leghaemoglobin. In contrast, inactive nodules are hard and greenish in colour and these tend to drain plant nitrogen rather than provide same. Care should also be taken to avoid confusing root knot nematode infections for Rhizobium nodules. The latter are borne on the side of the roots and are easily detached whereas with root knot the entire section of the root is enlarged.

4.3 Planting material:

4.3.1 The food legumes generally are propagated by seed. They are largely self-pollinated and because of this it is relatively easy to maintain varietal purity. There are some exceptions e.g. pigeon pea in which up to 40% out crossing has been reported - a feature which is likely to be responsible for the large number of cultivars which exist in the Caribbean. Some species are cleistogamous (peanut, urdi).

4.3.2 The ease of varietal maintenance is offset somewhat by the susceptibility of some legumes to seed-borne diseases e.g. angular leaf spot, anthracnose, bacterial blight, bean common mosaic in Phaseolus vulgaris, cowpea mosaic virus on cowpea. A key requirement for efficient legume production, therefore, is the availability of good quality certified disease-free seeds. If seeds are to be produced locally, particularly bean, efforts should be made to produce these during the dry season with surface irrigation and adequate attention to roguing and disease and pest control.

4.3.3 Seeds preferably should be treated with an insecticide - fungicide mixture such as captan or thiram and dieldrin prior to planting. Use of mercurial seed dressings should be avoided as these tend to suppress nodulation in newly inoculated seeds.

4.4 Time of planting:

4.4.1 Proper timing of planting is one of the most critical operations in the production of grain legumes under rain-fed conditions. Legumes need adequate moisture for growth and development and a dry period for maturation and harvest. Excessive rainfall during the maturing period results in pod rots and seed discolouration and deterioration by fungal pathogens. In some species the seeds begin to germinate while still in the pods. High temperatures and hot dry winds cause flower drop and fertilization failure with consequent reduction in yield. Because of their sensitivity to adverse weather conditions, the production of legumes under rain-fed conditions is regarded by farmers as a high risk.

4.4.2 Most economically important legumes have marked moisture - sensitive stages of growth if seed yield is taken as a criterion of plant response. They are particularly sensitive to moisture stress during the flowering period and irrigation at this stage has been shown most widely to give maximum yield increases. Legumes also are very sensitive during the period of pod and seed development. There is some indication that the beneficial effects of irrigation at the onset of flowering result in part from an increased number of seeds/pod, while moisture at the pod/seed development stage exerts its influence mainly through increased seed weight.

4.5 Photoperiodism:

4.5.1 Many food legumes are photoperiodic but considerable variation in varietal reaction exists. Soyabean is one of the most sensitive to photoperiod and the crop is actually classified into ten maturity groups based on the latitude in which specific varieties can grow and yield satisfactorily. A variety which is planted outside its latitudinal range either enters into the reproductive phase too early with resultant stunting and poor yield or the plant may remain in the vegetative phase and fail to flower and set fruit.

4.5.2 In the Caribbean we are perhaps more familiar with the photoperiodic response of pigeon pea in which the traditional tall, indeterminate types are known to flower and fruit towards the end of the year when days are short. Considerable attention is now being given to the development of day neutral varieties of many legumes the advantages of which are obvious, particularly in multiple cropping systems.

4.6 **Weed Control:**

4.6.1 Food legumes in general are weak competitors and some are rather slow growing initially. Good weed control for the first 33% of the crops life is essential in order to avoid yield suppression and efforts should be made to manipulate inter-row spacing so that the crop canopy closes just about this stage and suppresses further weed growth.

4.6.2 Many of the legume species are quite sensitive to herbicides such as 2,4D, the triazines and substituted ureas. Some of the more effective and potentially useful pre-emergence herbicides include diphenamid, prometryne, maloran, preforan, alachlor and dacthal. Gramoxone as a directed spray is a very useful post-emergence herbicide.

4.7 **Disease and Pest Control:**

4.7.1 The control of diseases and pests both in the field and in storage is one of the most critical requirements for successful production of food legumes. A list of the most important diseases and pests is given in Table 1. Most of the diseases are species specific but several of the pests e.g. leaf hoppers, leaf webbers, leaf rollers, stink bugs, beetles attack more than one legume crop.

In general, it is better to use broad-spectrumed pesticide mixtures during the early stages of crop growth and less toxic insecticides in the more advanced stages of crop growth. The choice of chemical should be determined by the dominant pest at the time control measures are to be taken.

Some legumes are quite sensitive to certain pesticides. For example, pigeon pea is extremely sensitive to sevin, as is soyabean although somewhat less so.

5.0 PLANT CHARACTERISTICS ESSENTIAL FOR LARGESCALE CULTIVATION.

5.1 In largescale production of grain legumes one of the most critical operations is harvesting. For most species that are amenable to mechanised harvesting, this is done by a combine harvesters. For efficient combine harvesting certain plant characteristics are essential in those species in which the economic product is above-ground. These are as follows:

- Vigorous, erect plant growth 18-24 inches (45-60 cm) tall with pods borne well above ground level. Plants that are too tall tend to lodge,weak plants tend to be pushed over especially on light soils and plants that are too stunted are missed by the combine's pick-up reel. In addition, stunted crop growth may result in incomplete threshing because of insufficient bulk of material.

- Determinate growth habit in which nearly all pods tend to mature at the same time so that over 90% of the marketable product can be obtained in a single harvest.

- Leaf senesence and leaf fall at maturity and no immediate re-growth since the presence of green foliage at time of harvest results in seed discolouration. Failing that, it maybe necessary to use defoliants.

- Resistance to shattering to prevent excessive seed loss especially on hot dry days.

6.0 CONCLUSION:

6.1 Five food legumes, pigeon pea, bean, cowpea, peanut, and soyabean are considered to have development potential in the region. Other species of less importance include lima bean, seim, mung and urdi. The important species are generally accepted and utilized in one form or another in the region, they include plant types that are amenable to largescale, mechanized production systems, and currently they are being intensively studied in research programmes in the tropics.

6.2 A number of critical management factors in the production of food legumes require attention. These include soil conditions, Rhizobium inoculation, planting material particularly in regard to seed borne diseases, time of planting in relation to rainfall pattern and photoperiod response, and the control of pests, diseases and weeds. Successful production is heavily dependant on the level of attention given to these factors.

TABLE 1. Main diseases and pests of food 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	Virus	Leaf beetles	C. ruficornis
Charcoal rot	Macrophomina phaseoli		Diabrotica balteata
Golden mosaic	Virus		Homophaeta cyanipennis
Powdery mildew	Erysiphe polygoni	Leaf hoppers	Empoasca fabae
Root knot	Meloidogyne sp.	Leaf rollers	Goniurus proteus
Root rot	Rhizoctonia solani	Leaf webbers	Lamprosema indicata
Rust	Uromyces phaseoli v. typica	Mites	Tetranychus sp.
Southern blight	Sclerotium rolfsii	Stink Bugs	Nezara viridula
Web blight	Corticium solani (Thanatephorus cucumeris)	White flies	Bemisia tabaci
PIGEON PEA (*Cajanus cajan*)			
Anthracnose	Colletotrichum cajani	Bruchids	Callosobruchus sp.
Collar & stem canker	Phoma cajani	Leaf hoppers	Empoasca fabae
Leafspot	Cercospora cajani	Podborers	Ancylostomia stercorea
Leafspot	Phyllosticta cajani		Fundella cistipennis
Rhynchosia mosaic	Virus		Heliothis virescens
Rust	Uredo cajani		Heliothis zea

TABLE 1. (Continued)

Diseases		Pests	
Southern blight	Sclerotium rolfisii		
Web blight	Corticium solani (Thanatephorus cucumeris)		
Wilt	Unidentified		
Witches Broom	Mycoplasma		
COWPEA (Vigna unguiculata)			
Ashy stem blight	Macrophomina phaseoli	Aphids	Aphis sp.
Bacterial blight	Xanthomonas sp.	Beetles	Diabrotica balteata
Cowpea mosaic	Virus		Cerotoma ruficornis
Leafspot	Cercospora canescens		Homophaeta cyanipennis
Leafspot	Cercospora cruenta	Bruchids	Callosobruchus sp.
Pod Rot	Choanephora infundibulifera		Acanthoscelides obtectus
Powdery mildew	Erysiphe polygoni	Coreids	Leptoglossus phyllobus
Rust	Uromyces appendiculatus	Cowpea curculio	Chalcodermes sp.
Southern blight	Sclerotium rolfsii	Leaf hoppers	Empoasca fabae
Stem rot	Unidentified (Phytophthora/ Pythium)	Podborers	Fundella cistipennis
Target spot	Cornyespora cassiicola		Maruca testualis
			Heliothis sp.
		Stink bugs	Nezara viridula

TABLE 1. (Continued)

Diseases		Pests	
SOYABEAN (*Glycine max*)			
Rhynchosia mosaic	Virus	Beeltes	Diabrotica balteata
		Leaf hoppers	Empoasca fabae
		Leaf webbers	Lamprosema indicata
		Stink bugs	Nezara viridula
PEANUT (*Arachis hypogaea*)			
Leaf spots	Cercospora arachidicola	Leaf hoppers	Empoasca fabae
	Cercospora personata	Stem borers	Unidentified
Rust	Puccinia arachidis		
Southern Blight	Sclerotium rolfsii		
Web blotch	Ascochyta sp.		

LAND PREPARATION AND FIELD LAYOUT

by

P.F. Robinson

INTRODUCTION

The objective of land preparation is to provide a suitable soil environment for a crop to be planted and grown satisfactorily. This soil environment is termed a "seed bed" and it should be produced with the minimum number of tillage operations to keep costs down. A good seed bed can normally be achieved by using the correct tools and equipment and timing the operations to take maximum advantage of weather conditions.

FACTORS INFLUENCING TILLAGE OPERATIONS

How much tillage is required and the equipment needed to produce a suitable seed bed will depend on:

(a) Type of soil.
(b) Drainage needs.
(c) Crop to be grown.
(d) Timing of operations.

It is always advisable to have a soil test before land preparation is commenced. The analysis will provide information on the fertilizer requirements etc., but most important for land preparation it will supply information on the structure of the soil. If for example the layer of top soil is shallow, deep cultivation should not be carried out.

(a) Type of Soil

Soils in Guyana can be divided into the following four groups for the purposes of land preparation:

- Clays
- Loams
- Pegasse
- Sands

Clays:

These are very fine textured soils varying in colour from grey to brown. They are very difficult soils to cultivate, being very hard when dry and extremely sticky when wet. Timing of operations on this type of soil is vital if a seed bed has to be prepared with the minimum of operations and to obtain the best results. In addition, a suitable drainage system has to be installed to dispose of surface water.

Loams:

These soils consist mainly of mixtures of sand and clay and the texture will vary depending on the proportion of the two major components. These soils dry out quicker than the clays and a seed bed can be prepared with less effort. Timing is still important for best results but it is not as crucial as with clays. These are relatively free draining soils and there is generally some lateral movement of water. Drainage requirements will depend on the elevation of the land and the water table. Erosion is likely to present some problems.

Pegasse:

These soils can loosely be described as peat or decayed vegetation. The water table in areas where pegasse is present is very high and empoldering is necessary if drainage is to be controlled and the water table lowered to acceptable limits. Empoldering is an expensive operation and involves excavation of drainage canals that link up with a controlled outlet so that surplus water can be removed from the land to be cultivated.

Pegasse soils are highly organic, low in fertility in most cases, somewhat toxic due to high aluminium content and very acid. Mechanical operations are always difficult on this soil. Ground pressure of the equipment used must usually be below 5 lbs.per square inch. This means that light tractors with either tracks or high flotation tyres are most suitable.

Sands:

There are large areas of sandy soil under cultivation in the country at the moment. These are very free draining soils low in fertility. They can be worked at almost any time. Erosion is a problem and can cause loss of yield. Certain practices can be adopted to reduce erosion such as contour ploughing, strip ploughing and the use of herbicide sprays to reduce the need for soil disturbance by inter-row cultivation.

(b) **Drainage needs:**

Good drainage is necessary before preparing land for cultivation. Apart from the need to remove excess water from the soil, it helps to leach out toxic substances and so improves the soil environment. Aeration of the soil is essential for good plant growth. This process is mainly brought about by the movement of water in and out of the soil. Rain water soaks into the soil filling the pore spaces and driving out the air. Then, as the water drains away, fresh air is drawn into the soil to refill these spaces. Aeration will vary from clays to sandy soils but good aeration is necessary for seed germination and growth.

Most of Guyana's coastline is below sea level, and a network of wide drainage canals carry away water channelled into them from in-field drains. Pumps strategically placed along the coast are designed to cope with the average rainfall that is collected in the drainage canal system.

In-field drains will vary according to soil type and generally are two feet open drains spaced at distances ranging from twelve to sixty feet. Open drains of this type are most effective on pegasse and loams soils. On clays a ridge and furrow lay-out can be installed running in the direction of land slope. Either system should link up with a fairly deep open drain (referred to as a four-foot) to carry away all excess water. Mole drainage can also be used effectively on clays. This is a cheap drainage method. An implement known as a Mole Plough which has a torpedo or bullet shaped "mole" attached to a steel coulter is drawn through the fields to form cylindrical channels in the sub-soil.

It should be noted that drainage trenches considerably hamper the movement of machinery and care must be taken in their design. Remember effective drainage plays an important role in crop management.

Poor drainage will result in the following:

- Pools of water lying on surface
- Excessive weed growth
- Young plants that are pale green or yellow in colour and stunted
- Machinery easily bogs down

Good drainage results in:

- Better weed control
- Better soil aeration
- Soil that is easier to work
- Easier Inter-row cultivation and harvesting operations
- More vigorous crop growth and better results from fertilizers.

(c) Crops to be grown:

Tilth is a term used to describe the condition of the soil in a seed bed. For example, the soil may be in a finely divided state or may be lumpy. In general, small seeds require a finer tilth than large seeds. The seed bed is the place where the seed germinates, and suitable conditions must be created to allow the seed to grow and produce a satisfactory crop.

(d) Timing of operations:

Timing of operations in regard to weather conditions is of vital importance in land preparation, particularly on heavy clay soils. This is more of an art than a science and is largely based on experience. Considerable damage can occur if untimely land preparation operations are carried out and these invariably result in a poor seed bed, low yields and high land preparation costs.

OPERATIONS

<u>Ploughing</u>: Ploughing is the first operation in seed bed preparation and is likely to remain so for some time yet, although rotary cultivators, heavy cultivators with fixed or spring tines plus mechanically driven pulverizing machines are being used as alternatives to the plough in some countries. Good ploughing is probably the best method of burying weeds and exposes the soil in preparation for further refinement.

In Guyana, the disc plough is preferred. It requires less maintenance and on rough land will ride over obstructions and avoid damage. Under adverse conditions they show improved performance over mould board and other types of plough.

Ground speed influences both the quality of work and the levelness of the finish. On heavy clay soils exposure of the ploughed land to the weather for about ten days is advisable. On lighter soils such as loams and pegasse exposure for a day or so is sufficient before proceeding with further refinement of the seed bed.

If limestone is needed, this should be applied as soon as the land is considered dry enough after ploughing and before further cultivation. This will ensure that the limestone will be well incorporated into the finished seed bed.

<u>Harrowing</u>: On heavy clay soils disc harrows arethe most popularly used piece of equipment after ploughing. The weight of the implement is matched with the size of its discs to achieve good penetration. By careful adjustment of the discs either a level surface or a camber can be obtained. The angling of the discs may be controlled hydraulically or manually. Apart from the disc harrow, there is now available on the market a rangeof equipment such as spiked harrows, spring-tine harrows and power harrows, all of which are capable of preparing seed beds in varying soils and conditions.

<u>Cultivation</u>:This is another area where machinery manufacturers have been able to produce a wide range of equipment. The rigid tine cultivator is probably the most commonly used and as the name suggests it comprises a number of fixed or rigid tines mounted on a robust frame. The tines are staggered to achieve intensive cultivation and avoid choking by clods of soils or trash. These tines can sometimes be arranged in pairs for row-crop cultivation.

Other types of cultivators include the spring-tine and spring-loaded cultivators, which are designed for use in areas where hidden obstructions such as roots or stones are a problem. The powered rotary cultivator is commonly used, particularly in corn growing areas and is considered excellent for forcing a tilth in stubborn soil. It should also be realised that soil structure can be damaged by over-cultivation with a machine of this type.

Other Operations:

Under certain conditions it may be necessary to use land levellers or graders before planting certain crops. Th can range from very big towed machines which can only be operated on large acreages, to simple structures that can usually be made without much outlay. Levelling operation is particularly important on heavy clay soils where the crop to be grown is susceptible to water logging.

For particularly refined seed beds, there are available a range of light harrows that are often trailed behind cultivators or seeding drills. Zig-zag and chain harrows fall into this category.

FIELD LAY-OUT

On coastal lands of the country where drainage systems are installed the best type of field lay-out depends mainly on the soils and water table in that particular area. For instance in areas with heavy clays the removal of surface water is more of a problem because of the impervious nature of the clays.

Four types of field layout are used as follows:

- Cambered beds
- Five-foot beds
- Ridge & Furrow
- Flat, mole-drained fields

These lay-outs are most suited to clay and loam soils. Pegasse and sandy soils because of their susceptibility to erosion, are best left flat with in-field drains suitably spaced to remove surplus water.

Cambered Beds:

The cambered bed was the traditionally accepted practice before the introduction of mechanisation. The beds are normally 2-3 rods (7-11m) wide and range from 50-150 rods (183-550m) in length. The general layout is shown in Fig. 1.

The cambered bed provides excellent drainage for the crop but it makes mechanization difficult. Serious efforts have been made in recent years to design lay-outs that can provide sufficient drainage for the crop and at the same time permit movement of the type of heavy machinery necessary for mechanisation. As a result the lay-outs shown in Figures 2, 3 and 4 have been introduced. These require more care and attention in preparation in order to obtain the desired results.

<u>Five-Foot Beds</u>:

The general layout of this system is shown in <u>Fig.2</u>. In-field drains are spaced wider apart to assist the movement of machinery. Distances vary from 5-10 rods (18.30 - 36.6m) and the beds are graded with a slope in the direction of the outlet drain. Smaller beds of about 5-feet are then formed by mechanical means with the furrow equivalent to the wheel spacing of the tractors. The furrows provide additional surface drainage which is normally tracked off into the in-field drains by shallow cross-drains referred to as quarter drains. These in no way impede the movement of machinery and it is possible to extend the beds and so reduce the number of turns per acre of land of the equipment.

<u>Ridge & Furrow</u>:

Preparation of this lay-out is almost identical to the five-foot bed except that ridges about 20 inches (51 cm) wide replace the wider beds. Surface water is also removed via the furrows and quarter drains. The length of these beds can also be extended considerably.

<u>Flat Bed (mole drained)</u>:

This lay-out has been designed to provide large areas of land free from obstacles such as in-field drains for full mechanization and it will provide adequate surface drainage to successfully grow a crop. The spacing of in-field drains is extended up to 85' (26m) and the length of the beds to as much as 300 rods (1089m). Mole drains 2'0" (60m) deep are pulled at right angles to the in-field drains and spaced at 12'0" (3.6m) apart. The success of this lay-out depends very much on the effectiveness and the life span of the mode drains, and is best suited to clay soils.

CONCLUSION:

In most cases land preparation represents the ~~most costly~~ single item in the budget of an arable farmer and is part of the business of farming that remains almost entirely an art. No definite rules can be laid down as to what implements are necessary to produce the best results because soils and conditions vary. Machinery that has been properly serviced and well-maintained pay dividends and contribute considerably to good land preparation.

FIG: 1. CAMBERED BED

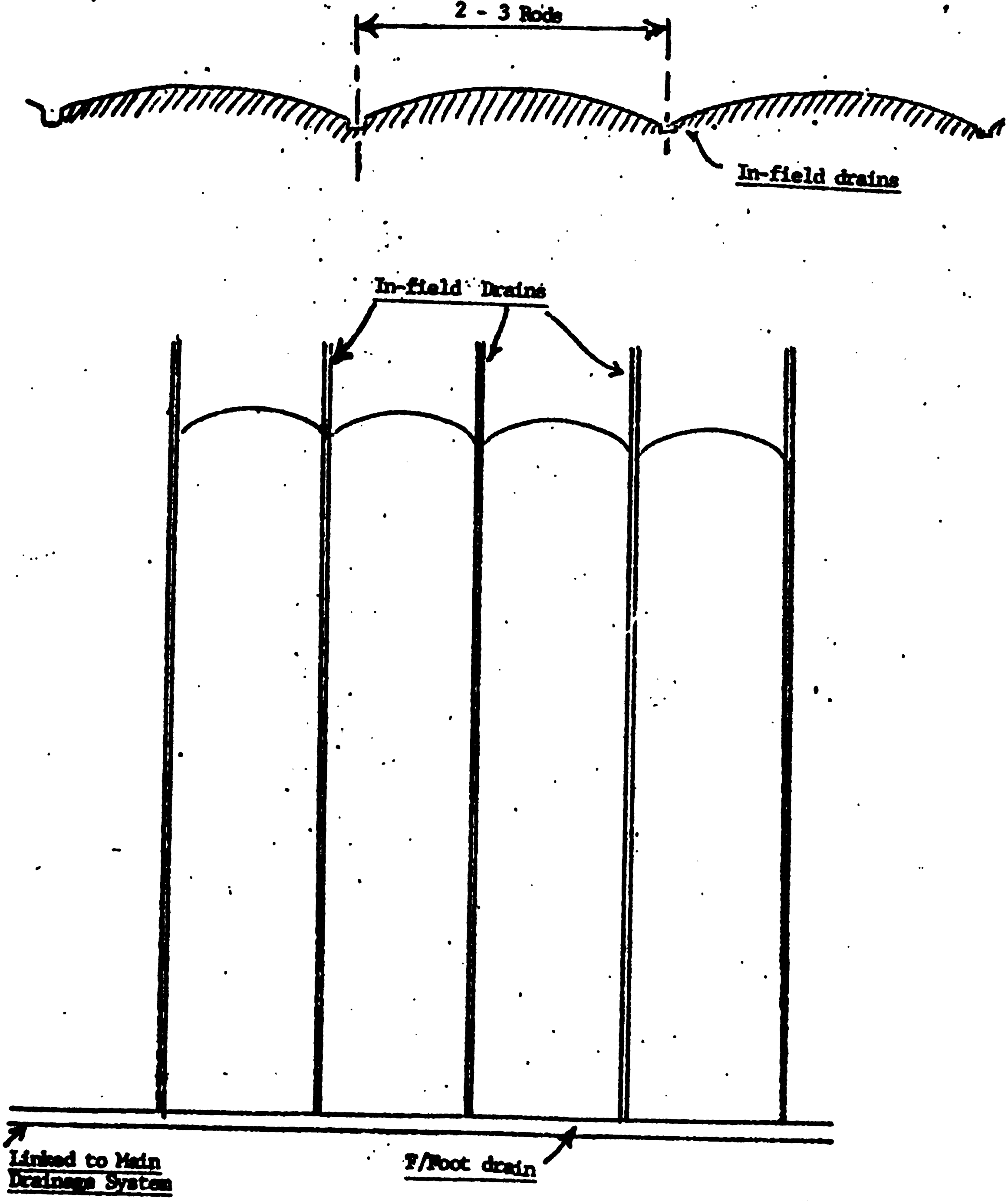


FIG: 2. FLAT WITH 5' BEDS

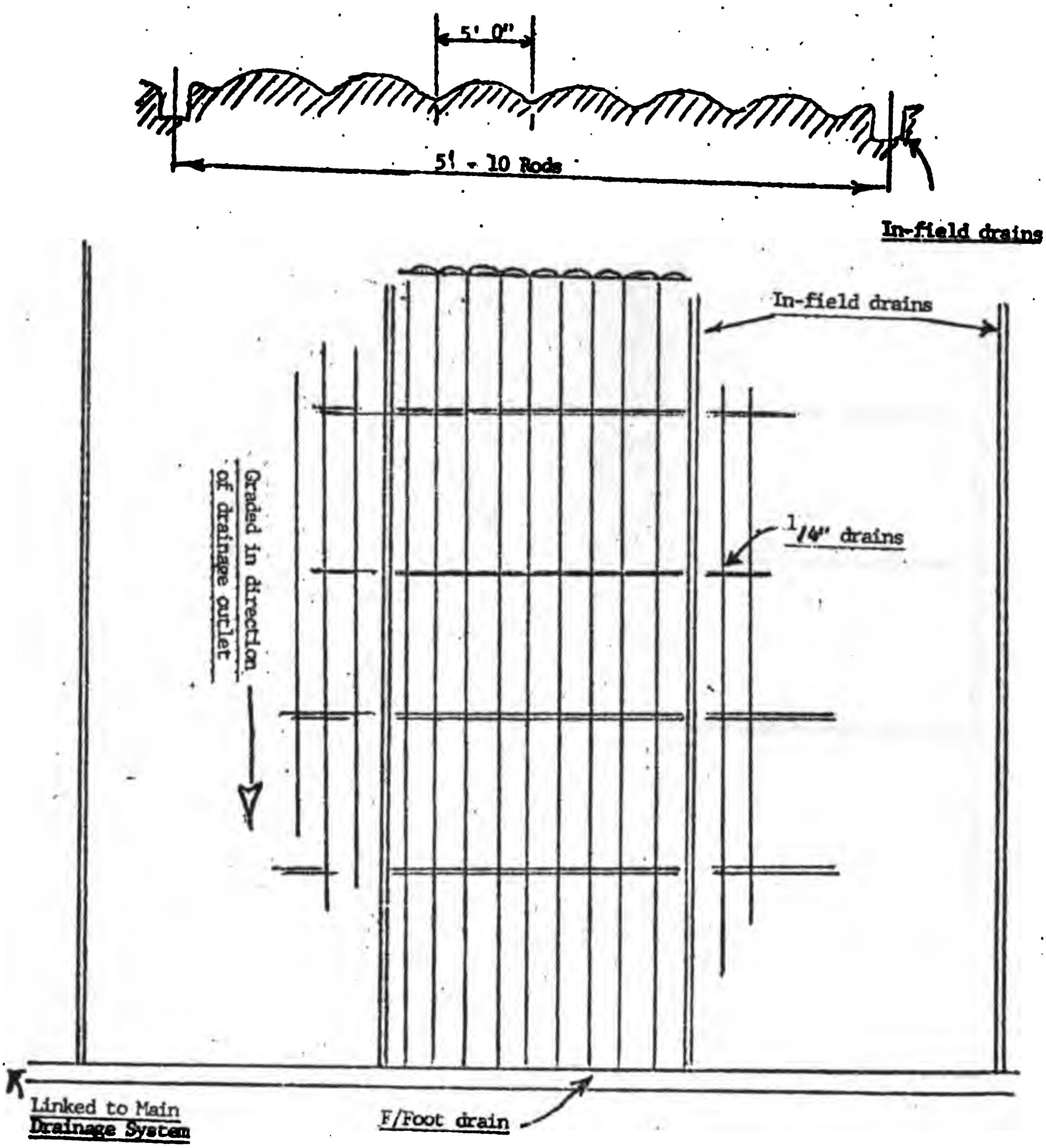


FIG: 3. RIDGE & FURROW

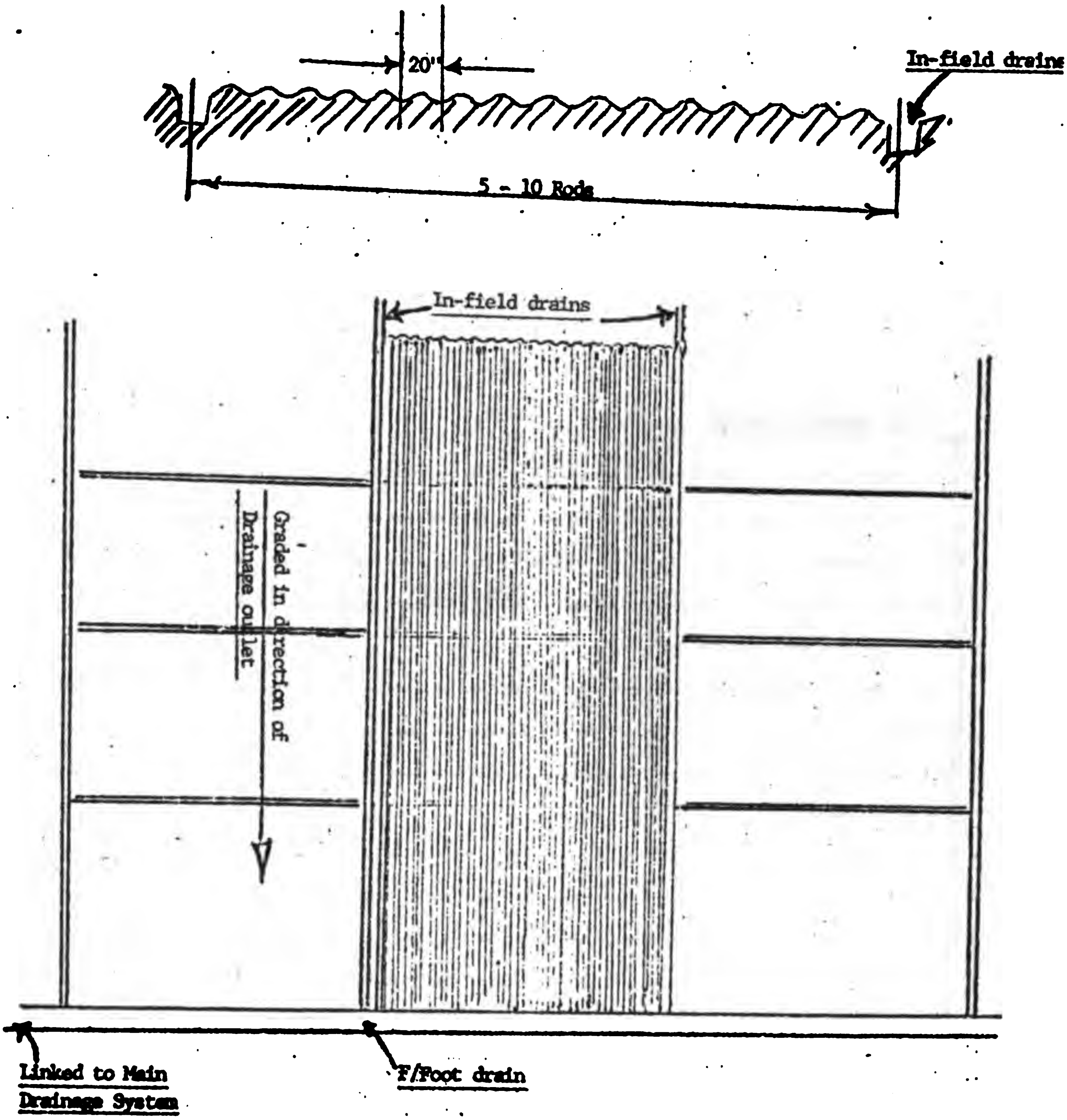
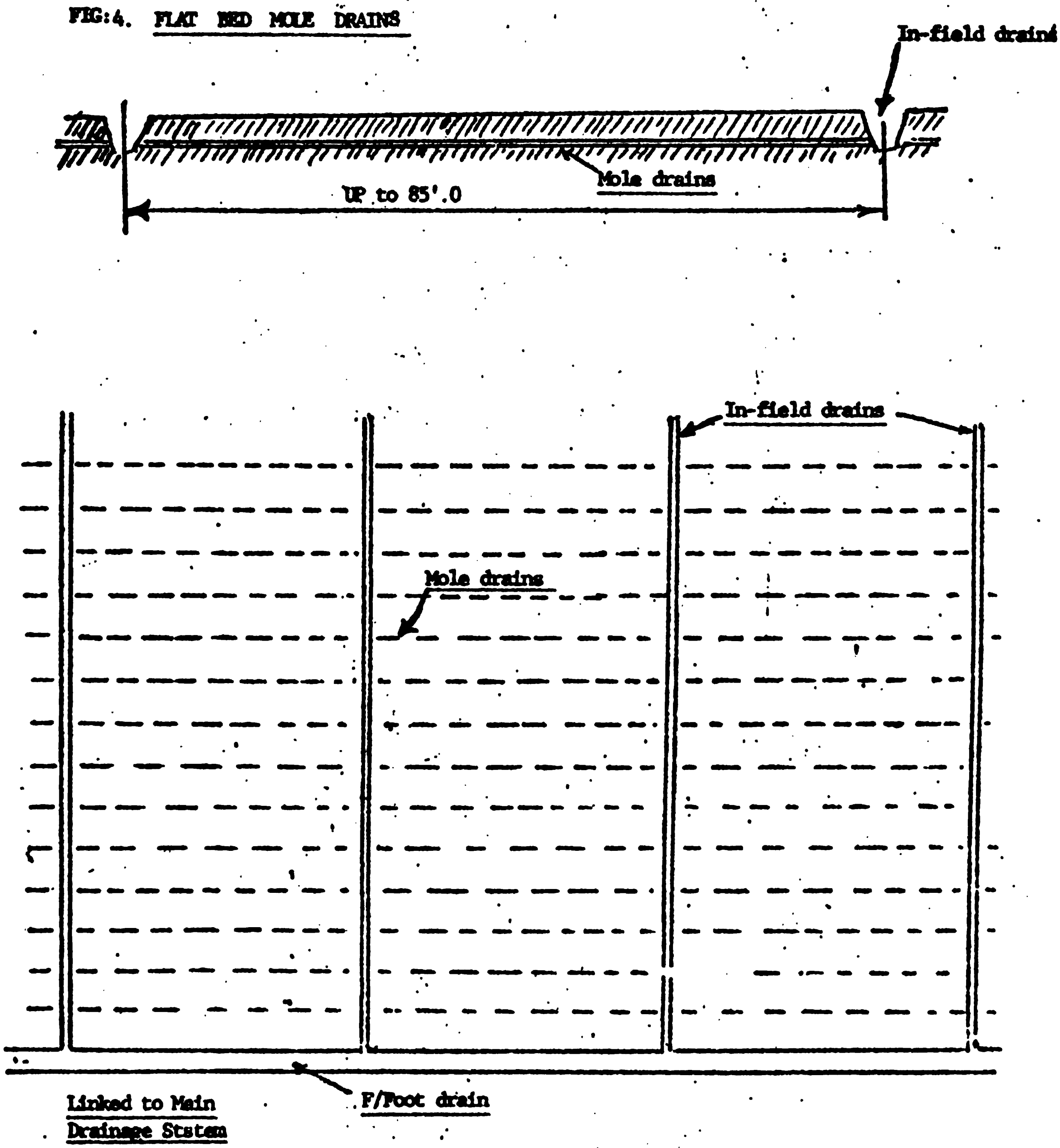


FIG:4. FLAT BED MOLE DRAINS



VARIETAL SELECTION AND PLANTING OF COWPEA (Vigna unguiculata)

J. Ross, H. Admas & P.F. Robinson

INTRODUCTION

Blackeye pea, which contains about 23.4% protein, is an important component of food in Guyana. Because local production has not kept pace with demand, importation of substantial amounts of peas and beans continues. Low yields from large scale production operations is one of the main factors responsible for the failure to achieve the national production targets. In addition, the need for new varieties with superior features is undoubtedly crucial to the improvement of this situation.

VARIETIES

California No. 5 is the blackeye pea variety used in large scale production in Guyana. Early agronomic trials and easy availability of seeds from reputable sources have led to the choice of this variety (3). Ninety percent of its pods mature within short period (1) and can therefore be harvested in one operation. The advantage to mechanical harvesting is obvious. Despite this and other favourable traits (plant height and pods displayed high up among the leaves) California No. 5 is not totally suitable for large scale cultivation. It is susceptible to powdery mildew, mosaic and pod rot diseases and grain yields are low. In the mid-1977 planting, for example yields on sugar estates on the coastal areas ranged from 218-767 lbs/ac with an average of 474 lbs/ac (2). The yield average over eight seasons was 700 lbs/ac in the intermediate savannahs (4). Cowpea lines of higher yield potential are existant and some yields reported by IITA (5) were as high as 1317 kg/ha.

The National Grain Legume Project envisages a total of 8.3 million pounds of blackeye pea from 11,110 acres by 1981. This means an anticipated National average yield of 746 lb/ac (2). Increased yields can be achieved inter alia by improving cultural practices and better production planning with respect to the different seasons. But efforts in these directions would not be fully effective unless high yielding varieties with favourable morphological and physiological characters are found and popularised. For this reason, one of the major aspects of the research programme of the Ministry of Agriculture in collaboration with IICA is the evaluation of cowpea varieties.

EVALUATION

In a variety evaluation programme, it is necessary to compare available local varieties with imported selections, and already a number of varieties have been imported from the World Germplasm Collection maintained at IITA in Nigeria and from some other cowpea-producing countries. Selected trials sites also should be representative of a given production region in as many environmental factors as possible, and evaluation should be extended for at least three seasons in an effort to compensate for seasonal variations.

Potentially useful varieties obtained from these trials preferably should then be subjected to consumer acceptance tests including organoleptic tests, cooking quality and nutritional value. Plantings should then be carried out to multiply seeds of the selected varieties and to evaluate their performance in commercial production systems. In conducting such trials, a multi-disciplinary approach is most desirable.

SELECTION PARAMETERS

In selecting varieties for mechanised production attention should be paid to determinacy , crop duration, ability to withstand high population density, high nodulating ability, high yield potential, erected growth habit and non-shattering. Pods should be borne in a position that facilitates mechanical harvesting and varieties should be erected and tolerant to pests and diseases. For example, in some recent trials it was observed that varieties such as Pinkeye Purple Hull, Brown Crowder and Purple Hull Crowder appeared to be tolerant to certain fungal diseases which attack the pods under humid conditions and this resulted in a decrease in the incidence of poor quality seeds. Further testing is being done on this important parameter.

PLANTING

Seasonal Considerations:

Because of the susceptibility of the grain legumes to pod and seed damage during adverse weather proper scheduling of field operations is important. Planting must be done at such a time as to allow adequate moisture up to the pod-setting stage and to permit harvesting in the dry season.

Cowpea variety California No. 5 is a crop of short duration (65-75days) and in the short rainy season (mid-November to mid-January) planting should begin at the onset of the rains. The available soil moisture in this season is likely to sustain cowpea production on the clays and the crop will be ready for harvest in the ensuing dry, sunny period. However, because of rapid internal drainage and subsequent drying off, it is doubtful whether the moisture available during this season will permit the cowpea to achieve optimum pod set in the intermediate savannahs. Production on the brown sands during this season is risky unless drought resistant varieties are found.

In the long wet season rain falls from May to July. On the clays, if cowpea is planted at beginning of the rains the crop matures during the wet season when mechanised harvesting is not possible and the crop becomes a prey to pod rot and other diseases. Machine planting later in the season is difficult as the clays cannot be worked at a high moisture content. A very late variety, resistant to pod rot may be the answer to production on the clays during this season. On the other hand, because of good internal drainage the sands can be worked during the rainy season so that planting can be done in June and harvesting in August/September when it is reasonably dry.

So far, timing of planting was discussed under rainfed systems. However, if cheap methods of irrigation can be found, production can become more efficient and controlled. It would be possible to plant even towards the end of the rainy seasons and irrigate to ensure successful production but the economics of irrigation is the critical factor here.

Planting Equipment

There is a range of equipment on the market for the planting of row-crops such as legumes and corn that require accurate seed and row spacings. Among the most popular types are the precision drills. A choice of dispenser elements in the feed unit enables the drill to be adapted for sowing seeds of a wide range of size and at different row and intra-row spacings. Best results are obtained if the seeds are graded prior to planting.

Essentially each drill unit has a seed hopper and some mechanism for opening a furrow in the soil and covering the seed after its discharge. Adjustments can be made to regulate the depth of planting. After the seed has been delivered into the furrow it is covered by deflectors and the press wheel performs the final operation of lightly compacting the soil around the seed.

Some seeder units are driven from the tractor PTO to give a more positive drive and ensure regular seed delivery when seedbed and soil conditions are somewhat unfavourable. Other manufacturers rely on the front land-wheel of the seed unit to provide the drive to the feed mechanism. Some seeder units can be attached to the standard three-point linkage tool-bar while others are designed for a specific tool-bar which has provision for quick and easy change of row spacings. Although positively attached to the tool-bar the seeder units are free to follow the contour of the ground.

For large scale production eight or possibly more units can be attached to the tool-bar thus permitting greater output per day.

Ground speed is an important factor in the efficiency of precision seeder units. Generally tractor speed has to be kept down to about 3 miles per hour although this depends greatly on the conditions of the seedbed and the required precision of seed placement. The seeder units when used in series are provided with a marker at either side so that accurate spacing can be maintained to facilitate any subsequent inter-row operations.

Most manufacturers offer a range of attachments in the form of furrowers, coverers, bed levellers and press wheels to suit most conditions. In addition, fertilizer and spraying attachments are also available, thus making it possible to plant, fertilize and apply pre-emergence herbicide or other pesticide in a single operation.

When granular fertilizers are applied as part of the planting operation care must be taken in calibrating the attachment to dispense the correct rate of fertiliser. It is very important to adjust the outlets to discharge on one or both sides of the row, 2" - 3" to the side of and below the seed as fertilisers placed directly on the seed can adversely affect germination.

Regular maintenance of equipment and careful checks during the operations are essential if efficient performance is to be obtained.

SPACING/POPULATION

On clay soils a population of 110,000 plants/ha should be aimed at. This would require a spacing of 60 cms x 15 cms. On sandy soils a population of 130,000 plants/ha is recommended. This could be achieved with a spacing of 50 cms x 15 cms. Seeds should be planted at a depth of 4 cms.

CONCLUSION

California No. 5 is not well suited to large scale production in Guyana. This cultivar is low-yielding and susceptible to a number of serious diseases. Efforts should be made to select strains with suitable morphological and physiological traits that are more adapted to the ecosystems of Guyana's main production regions.

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SOIL CONDITIONS AND FERTILIZER REQUIREMENTS

M. Forrester

INTRODUCTION

During this presentation it is assumed that a large scale holding consists of more than one hundred acres and all husbandry practices are mechanized. This assumption is based on the principle that the entire operation is geared for surplus and by using machines, labour costs will be less and output of work/day will be more. This will result in a larger quantity of produce reaching the consumer at a cheaper price. It is also assumed that no irrigation is available.

Presently largescale production of legumes (cowpea) in Guyana is concentrated on the brown sands of the Intermediate Savannahs and coastal soils which consist of clays and organic clays (Pegasse).

With regards to the topic I will like to stress mainly soil conditions, since a basic fertilizer recommendation has been suggested by the Ministry of Agriculture (4) for both the clays and sands. There has been no further investigation so that a more precise and specific fertilizer recommendation is not possible at this time.

Because of the variation in depth, plant nutrients, acidity and content of toxic substances in pegasse soils, no generalised fertilizer or management recommendations have been made.

Soil conditions with respect to moisture relations differ tremendously within these two areas. The coastal clays have high water holding capacities, are extremely sticky when wet and it is difficult for machines to work under such conditions.

If drainage is inadequate, anaerobic conditions result which reduce nitrogen fixation and also provide conditions (water-logged) to which cowpea is very susceptible.

The brown sands on the other hand have low water holding capacities, are not sticky when wet and are easy to work. However, after numerous croppings compaction from heavy duty machinery and increased organic matter content from crop residues, generally make it necessary for the time interval between rains and land preparation to be increased.

LAND PREPARATION

If the desired land preparation is to be achieved timing of operations in relation to rainfall is critical. If, on the clays the land is ploughed before the rains come then large clods result and this is undesirable. If on the other hand the land is ploughed when the rains have already begun then the soil becomes puddled and this also is unsuitable for legume production.

On the sands if ploughing is attempted before the rains, penetration by the plough is difficult and may result in damage to the equipment.

FERTILIZING

Fertilizers could either be applied as mixtures or as individual elements. Mixed fertilizers may either be compounded e.g. 15: 15: 15 or individual fertilizer elements mixed on site. In the latter case an additional problem arises since different particle sizes tend to segregate i.e. the smaller particles pass through the outlet first. Thus, thorough mixing is essential. Also some mixed fertilizers become very sticky and interfere with the smooth operation of the machine by causing blockage. This could be eliminated by choosing types of fertilizers which do not absorb moisture rapidly e.g. (Sulphate of Ammonia Vs Urea) and by mixing quantities that are sufficient for immediate use. Compound fertilizers are recommended since they are physically as well as chemically mixed i.e. each particle contains almost equal quantities of the specified nutrient elements.

Fertilizers could be applied either as a single application or split applications. It is recommended that split applications be made at planting and 3 - 4 weeks after, but this will depend on the area being cultivated.

/the Application of fertilizers at planting as opposed to later in/life of the crop has been shown to increase yield and vegetative development and caused earlier flowering (3).

On the coast the second application of fertilizers will prove extremely difficult since the soils will have become excessively wet and machines will tend to stick and/or slide.

The inherent fertility of the coastal clays have been depleted over the years by continuous cropping and leaching of its original high content of soluble salts. At present these soils are acid and liming once every three years at 2 tons/ac is recommended (4).

Recommended fertilizer rates are as follows:

100/100/100 lb/ac Sulphate of Ammonia, Triple Superphosphate and Muriate of Potash respectively at planting and at 3 - 4 weeks a second application of 100 lb/ac Muriate of Potash.

If seeds are inoculated with <u>Rhizobium</u> (symbotic N-fixing bacteria) then a smaller quantity of N-fertilizer is required (10 - 15 lb/ac.).

On the better clay soils there is some residual effect of previous fertilizer applications and this should be taken into consideration.

In the Intermediate Savannahs, the sandy soils have low inherent fertility, are highly leached, acid and contain large quantities of oxides of Iron and Aluminium. Chesney (1) reported that phosphate fixation on these soils is very rapid. Because of the excessive drainage which is characteristic of the sands, fertilizers are lost by leaching when applied prior to heavy showers. A possible area of research could involve investigating the effects on yield of slow release fertilizers.

A fertilizer programme for cowpea on these soils (5) should include:

Lime	2,000 lbs/ac
Urea	50 " "
TSP	200 " "
MP	100 " "
Kieserite	50 " "

Application of trace elements also is essential and may be applied as Fritted Trace Elements (40 lb/ac F.T.E. 503). Trace element should be applied at planting. Molybdenum which is important to the efficiency of the inoculum may be applied as seed dressing.

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WEED CONTROL IN COWPEA

Merle E. Robertson

INTRODUCTION

In all areas of agriculture weeds, if allowed to grow with a crop can hinder production. Weeds affect crop yield by competing for water, competing for nutrients, and shading crop plants thus reducing their photosynthetic ability.

If water and nutrients are adequate the crop may not be so badly affected, but in developing countries where fertilizers are costly crops are often inadequately supplied with nutrients. Adequate supplies of water and nutrients also encourage the growth of weeds. It is important therefore that weed competition should be kept to a minimum.

EFFECT ON YIELD

In general, when weeds are allowed to shade a crop, the plants grow spindly and are poorly developed, flowering and fruiting are delayed and fruit size is reduced.

In cowpea production weeds must be controlled in order to obtain satisfactory yields. The yield potential of this crop and practically all crops can be realised only if adequate weed control measures are taken in conjunction with other necessary agronomic practices.

In Colombia, cassava fields which were unweeded for the first 60 days showed a 50% yield reduction as compared to plots which were kept weed-free for an equivalent period. In Guyana cassava weeded 2 - 3 times per year yielded 27,000 lb per acre whereas under poorly managed conditions yields did not exceed 10,000 lb.*

Sweet potato also requires a weed-free environment until the vines have covered the ground and according to Kasasian and Seeyave (1), if no weeding is done within the first four weeks yield is reduced.

Weeds can also encourage disease and insect damage to the crops with which they are associated. Moody and Witney (2) have shown that failure to weed soyabean and cowpea plots resulted in yield reduction of 13% and 15.8% respectively, due to insect damage.

In Guyana most farmers do their weeding by hand and the high cost of labour often prevents effective control. Additional losses also are incurred owing to delayed weeding. There is, however, heavy dependence on herbicides for control of weeds in the rice and sugar industries where some 80% of the total expenditure on pesticide is for herbicides. If other farming sectors can recognize the need for judicious and timely weed control measures the level of production is bound to rise.

*Personal Communication - B. Forde

Age of infestation, weed species, soil fertility, type of soil and depth of water table all influence the effectiveness of weed control measures. In lighter soils if water and nutrients are limited weeds are deeper rooting and more difficult to eradicate. In fertile soils where growth is vigorous, root reserves can be easily exhausted by repeated removal of top growth and eradication is thus possible. A similar strategy has been used for reducing the weed seed population inspite of the ability of these seeds to maintain viability in the soil for long periods.

It is evident that weed control must be an integrated system. In the developing countries, high cost and unavailability preclude the use of herbicides only and the high cost of fuel also limits the number of cultivations which would be necessary to obtain weed free conditions.

The aim therefore is to control weeds to the point where the deleterious effects on the crop are kept to a minimum. Efficient weed control can be obtained by adoption of a systematic combination of mechanical and chemical methods.

HERBICIDE APPLICATION

Herbicides may be applied to a crop pre-plant, pre-emergence or post-emergence.

Pre-plant herbicides are usually dinitro anilines e.g. trifluralin which give good control of grass weed seeds. They are applied after the land has been prepared but before planting and must be incorporated into the soil to prevent loss by photo-decomposition and volatilization.

Pre-emergence herbicides are soil acting materials which inhibit the growth of weed seeds and a number of herbicides groups have this function. These herbicides e.g. gesagard are applied after the crop has been sown but before the weed or crop seeds have emerged. Their activity is selective and this is enhanced by placing the herbicide in the zone where the weed seeds occur. In some cases the crop may be able to metabolise the herbicide e.g. gesaprim/corn and is thus unaffected by it.

Post-emergence herbicides act on the foliage of plants. They have contact action and are applied to weeds after the crop has been established. They are directed only on the weeds and a spray shield should be used to prevent crop injury.

The choice of herbicide depends on the economics of the situation. For example, a pre-plant incorporated herbicide may significantly increase the cost of production of a crop because of the additional tillage operation. This however may have advantages over the pre-emergence herbicide where there is a time lapse between land preparation and planting.

HERBICIDES USED ON LEGUMES IN GUYANA

Herbicide screening has been done to determine the effectiveness of several herbicides, since weed flora changes with continuous use of a particular herbicide.

The writer has found that planavin (1.5 kg/ha) effectively controls grasses and some broadleaf weeds. This is extensively used for weed control in cowpea on the coastal clays and sandy soils of the intermediate savannahs in Guyana.

At high rates gesagard (3 kg/ha) controls Phaseolus latyroides and other broad-leaf weeds to some extent but grass weeds are not adequately controlled. With adequate land preparation however, this herbicide can be quite effective on the clay soils. Both Gesagard (1.5 kg/ha) and Treflan (1 kg/ha) gave fairly good weed control in the intermediate savannahs. Amex 820 (dibutalin) (7.5 pt/ha) gave effective weed control in soyabean on both clay and sandy soils. Dual (metolachlor) (1.0 & 2.8 lt/ha) controlled all weeds including grasses such as Echinochlao colonum, Ischaeum rogosum, Digitaria sp. and broad-leaf weeds such as Phaseolus lathyroides and Caperonia palustris. At the higher rate mild phytotoxic effects were observed on soyabean. Probe (3 kg/ha) gave good control of weeds. Sencor (Metribizin) (2 and 4 kg/ha) gave good control of weeds with mild phytotoxicity at the higher rate on soyabean. Prowl (Penoxal) (2.8 and 5.6 lt/ha) controlled broad-leaf weeds but grasses e.g. Echinochlao colonum were not well controlled.

APPLYING HERBICIDES

Herbicides are applied either to follage or via the roots. Foliage application can be by spraying or dusting whereas sprays, dusts or pellets are applied to the soil and may or may not be followed by incorporation. In some cases rainfall may be sufficient to effect movement of the herbicides into the effective zone. Other methods of application include injection and spray blade application. In Guyana application of herbicides by spraying is the most frequently used method. Although knapsack sprayers (3-4 gallon capacity) can be used on large acreages by trained operators, the large, tractor-drawn, boom-type sprayers are much more satisfactory. Boom lengths vary between 16 - 50 feet (5 - 17 metres). The choice of boom would depend on the area to be sprayed, the number of working hours available and the tractor speed. The boom should be adjusted to compensate for the height of the weeds and/or crop in cases of post-emergence application.

The flat fan type nozzle is best suited for herbicide application. These operate with low pressure and discharge large quantities of liquid (300 lt/ha) so as to give adequate wetting of target, uniform coverage and to reduce drift. The boom height from the ground and width of the spray swath are important factors to be considered. If too high, the wind could cause drift resulting in uneven distribution and possible injury to nearby crops. If too low, distribution is uneven and one tends to apply excessive quantities.

Usually the manufacturers supply tables from which the proper nozzle size and pump pressure can be determined for any combination of tractor speed and quantity of liquid to be applied.

SPRAYER CALIBRATION

Usually, it is recommended that herbicides be applied at certain rates per acre. Since most herbicides are applied as sprays, in order to apply the correct amount it is necessary to determine the application rate in gallons per acre for the particular equipment being used, hence the need for sprayer calibration.

Sprayers can be calibrated by using the tank-refill method or the nozzle-volume method, both of which are described below.

Tank-refill method:

1. Set two stakes, 330 feet apart, in a field that is similar to the field to be sprayed. The sprayer is to be operated in both directions between these stakes, a distance of 660 feet.

2. Fill the sprayer tank with clean water and operate the sprayer unit to see that all parts are operating properly. Adjust the pressure regulator to achieve the desired pressure with the engine turning at the RPM to be used while spraying. Shut off the sprayer.

3. Refill the sprayer tank or fill to some measurable point with water.

4. Begining 20 to 30 feet from the first stake, drive the tractor towards this stake at the desired speed with the sprayer off. Upon passing the first stake, turn the sprayer "on" and on passing the second stake turn the sprayer "off". Turn the tractor around and spray the area again on the return trip. Be sure to maintain uniform speed and pressure throughout the operation and keep boom at the desired height.

5. Measure, to the nearest quarter, the amount of water required to refill the tank or to restore it to the original level, say 30 quarts or 7.5 gallons. Be sure that the sprayer is level when filling to avoid possible error.

6. Measure width of spray swath - say 20 feet.

7. Determine application rate by calculation as follows:

   Area sprayed = Distance travelled x Spray width

   i.e. 660 ft. X 20 ft. = 13,200 sq. ft.

   Volumed sprayed = 7.5 gallon

   $\therefore$ Gallons per acre (GPA) $= \dfrac{43560 \times 7.5}{13200} = 24.75$

The Nozzle-Volume Method:

1. Select containers to be used in collecting spray discharge. Some farmers use plastic bags for this purpose. The discharge from several nozzles collected separately and then pooled, gives a more accurate result than collecting from a single nozzle.

2. In the field to be sprayed or a similar field set 2 stakes 220 feet apart.

3. Fill the tank with clean water. Operate the sprayer unit, check all parts for proper operation, adjust the pressure regulator to achieve the desired pressure with the engine turning at the RPM to be used while spraying, and keep boom at the required height. Shut off the sprayer and then measure spray width - say 20 feet.

4. Drive tractor and sprayer unit to a position 20 - 30 feet back of and facing the stake at the begining of the course marked out.

5. Attach containers for collecting spray discharge to nozzles, then drive the tractor towards the first stake at the desired speed with the spray pump operating at the desirable pressure but with the sprayer "off".

6. Turn the sprayer "on" as the boom passes the first stake and proceed towards the second stake, maintaining uniform speed and pressure throughout the course. When the boom reaches the second stake turn the sprayer "off".

7. Accurately measure the total amount of water collected, say 10 quarts.

8. Determine application rate by calculation as follows:

   Area sprayed = Distance travelled x Spray width

   i.e. 220 ft. x 20 ft = 4,400 sq. ft.

   Volume sprayed = 10 quarts or 2.5 gallon

   $$\therefore \text{Gallons per acre} = \frac{43560 \times 2.5}{4400} = 24.75$$

FIELD OPERATION

Items to Check Before Field Operation

1. Ensure that the sprayer is properly mounted to the tractor.
2. Clean the supply tank and fill it with clean water. Silt or sand particles will cause excessive wear of pump and nozzles and clogging of screens.
3. Clean suction and line strainers.
4. Remove all nozzle tips, nozzle strainers and boom endcaps.
5. Start the sprayer and flush the hoses and boom with plenty of clean water.
6. Inspect nozzle tips and strainers for defects and cleanliness and make sure all tips are of the same type and size. Mixed nozzle tips along the boom will give uneven spray distribution.
7. Replace the nozzles and strainers and check for proper operation and alignment.
8. Check all connections for leaks.
9. Adjust the pressure regulator to desired operating pressure. Operate sprayer with water and check nozzle discharge for uniformity. This can be done by placing containers under each nozzle, operating sprayer for a few minutes, and then checking to see if the same amount of water is in each container. This will detect worn, defective or incorrect nozzles.
10. Calibrate sprayer if necessary.
11. Add chemical to tank in correct ratio for desired rate of application.

Field Operation

The following information and rules should be used as a guide for operating a sprayer in the field.

1. Check wind. Excessive wind will affect the uniformity of spray application.
2. Operate the tractor at a uniform speed. This must be the same speed and gear that were used in calibrating the sprayer.
3. Strive to keep the spray boom parallel to surface being sprayed.

4. Maintain proper height of boom. The height of the nozzle above the spray surface determines the width of the spray pattern at the surface. On a boom sprayer, with nozzles spaced for complete broadcast coverage, the nozzle must be at the correct height to obtain uniform coverage across the boom width. Manufacturers' data sheets list the correct height for each type of nozzle.

5. Make regular observations of the operation pressure while spraying and maintain pressure as determined by calibration.

6. Observe nozzle patterns continuously to detect clogged nozzles or changes in nozzle position. Clogged nozzles or nozzle strainers are common problems affecting spray distribution. By using only clean water, selecting and using proper nozzle strainers and cleaning nozzles and strainers before use, this problem will be reduced to a minimum. A toothbrush is excellent for cleaning nozzles.

7. Stop the pump immediately the liquid is finished. Pumps can be seriously damaged when operated dry.

8. Always completely flush the entire system with clean water after completing the spraying job.

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POTENTIAL PESTS OF COWPEA IN GUYANA

K. Croal

INTRODUCTION

Cowpea must be regarded as one of several new crops which is being introduced into Guyana for large scale production. Comparatively it is a low priced crop, and consequently individual farm cultivations averaged between 0.25 and 1.25 acres. In 1976 total area under cultivation was 841 acres. With the advent of corporations such as Guyana Rice Board, GUYSUCO, Guymine and institutions such as the National Service, Guyana Defence Force, Police and Caricom Corn Soya-bean Company, projected acreages for 1979 are in the vicinity of 5,060 acres for state agencies and 4,600 acres for the private farmers.

Because of the previous low production acreage of legumes in general, and cowpea in particular, there has been no intensive study of economic pests of cowpea. At low levels of production, cost of pest control makes cowpea production unprofitable. The large acreages of cowpea now being contemplated tips the balance in favour of pest control. Establishment of a number of economic pests, hithero ignored, is almost a certainty. Resulting economic losses will be greater thus making the use of pesticides feasible.

A number of pests of pluses are reported from South America (Table 2). Lacking more specific information, these have been considered as potential pests of cowpea. Very few specific pests of cowpea are reported from Guyana.

Accepting the fact that there is a paucity of information on cowpea pests, a number of lines of action suggest themselves:-

(1) Monitoring by the production agencies separately or collectively of the pest spectrum over the entire growth period.

(2) Screening of available chemicals against pests as they occur to provide immediate short term control recommendations.

(3) Assessment of the economic loss produced by specific pests.

(4) Establishment of a suitable pest management system to control the various pest species.

PESTS OF PULSES

Nematodes, particularly the root knot nematode Meloidogyne, are suspected of being a possible limiting factor in legume production. Although susceptibility of cowpea to nematode damage has been reported by F.D. McDonald (1971-1976) as low, with continuous cropping on the same areas, these organisms might well develop into serious pests necessitating use of nematicides. Other pests reported locally have been presented in Table 1.

Rodents, several species of crickets (Gryllus sp., Scapteriscus Vicinus) and cutworms (Agrotis sp.) may cause severe loss either by devouring sown seed, or cutting the stems of seedlings at ground level. Extensive re-seeding may be necessary in extreme cases.

Between seedling stage and pod initiation a number of pests appear:

1. Leaf feeding beetles (Diabrotica sp.) are highly mobile general feeders which are difficult to control. Circular holes are cut in the young leaf, but the damage only becomes conspicuous as these holes enlarge with leaf development.

2. The leaf miner (Liriomyza trifolii) has been the most frequently reported pest locally. The larva tunnels between the epidermal tissues. A meandering white tracing can be clearly seen on the leaf lamina. Although they are quite numerous, their economic significance is uncertain.

3. Aphids (Aphis gossypii) are important because they are transmitters of cowpea mosaic virus. These sucking insects remove sap from the plant causing reduced vigor and yellowing of the leaves.

4. Stink bugs (Nazara viridula) attack both leaf and pods of cowpea. Shrivelled seed as well as pod shedding may result. Severe discolouration of harvested seed during storage is due to secondary fungus invasion.

5. Leaf hoppers (Empoasca sp., Eucheuopa concolor) produce curling and yellowing of leaves with resultant leaf drop. This group is also important with respect to disease transmission.

6. Mites (Tetranychus sp.) produce similar symptoms. Outbreaks of mites are sporadic, and seem to be controlled by weather conditions. They are most abundant in the dry season when plants are under severe water stress.

7. Leaf rollers and webbers (Lamprosema indica, Goniurus sp.) fold and web together several leaves. They seem to be minor pests at present.

From pod initiation to harvest, thrips and pod borers are very important.

1. Thrips (Franklinella insularis) sometimes damage flowers, reducing number of pods produced. They are mobile and will drop off the plant when disturbed.

2. A beetle (Ceratoma arcuata) and several lepidopterous larvae attack cowpea pods.

The major pest of stored cowpea is the Brucid (Callosobruchus maculatus). This beetle attacks drying pods in the field and the resulting infestation is carried over into storage bonds. Sitophilus zeamais but not S. oryzae, together with Corcyra cephalonica are specific to cowpea. The rest of pests listed in Table 1 have been identified in samples of cowpea collected countrywide from different locations. As such it is not certain whether they are specific on cowpea, or contaminants from the storage area.

Table 2 indicates those pests which are indigenous to South America but not reported from Guyana.

RECOMMENDED CONTROL MEASURES

Chemicals

The chemicals given in Table 3 have been applied to a range of legume crops for specific pests, and not necessarily to cowpea. This should be borne in mind when applications are made. Should phytotoxic effects appear, treatment should be discontinued.

Storage

Bond hygiene is very important. Building fabric and storage area should be cleaned and pre-treated with 0.8% phoxim or pirimiphos methyl at 5 litre spray fluid/100 m^2 surface area.

Stacking of bags should allow at least 60 cm between stacks, and between stacks and wall. If further treatment during storage is required, proper stacking facilitates carrying out necessary operations. Fumigation chemicals and dosages are given in Table 3.

Applications

Tractor mounted sprayers and motorised knapsack sprayers are more economical for large scale operations. Proper calibration of these machines will allow one to utilize the recommended rates economically.

Wherever possible, it is safer to have separate equipment for weedicide application as it is difficult to totally remove all traces of weedicide from spray equipment.

When using any insecticide the following rules should be observed.

1. Wear rubber gloves when handling concentrates.
2. Wash gloves after use, especially the insides.
3. Wash concentrate from skin or eyes immediately.
4. Avoid working in spray mist.
5. Wash hands and exposed skin after work, and before meals.
6. Avoid all contact by mouth.
7. Do not smoke during apraying.

Where special teams are used for chemical application, regular medical examinations are advisable to check the effects of exposure on the operator. Personnel should be trained in proper use of equipment and safe use of various pesticides.

Table 1. PESTS OF PULSES IN GUYANA

Class	Genus and Species	Order Family	Part Attacked/Crop
Field Pests	Agrotis sp.	Lep: Noctuidaé	Seedlings (General)
	Ancylastomia stercorea (Zeller)	Lep: Pyralidae	Pod borer (Peas)
	Anticarsia gemmatalis (Hub.)	Lep: Noctuidae	Leaf (Soyabean, Bora)
	Ceratoma arcuata*	Col: Galerucidae	Pod borer (Cowpeas)
	Diabrotica sp.	Col. Chrysomelidae	Leaf (General)
	Dysmicoccus brevipes (Skll.)	Het: Coccididae	Root (Soyabean)
	Eucheuopa concolar	Het: Hassidae	Leaf (Pigeon pea)
	Franklinella insularis Franklin	Thysan: Thripidae	Leaf, flowers (Peas)
	Gryillus sp. (Cricket)	Orthop:	Seedling (General)
	Hyalymenus tarsalus F.	Het: Coraidae	Bora
	Liriomyza trifolii (Burg.)*	Dip: Agromyzidae	Leafminer (Bora, cowpea)
	Nezara viridula (L)*	Het: Pentatomidae	Leaf/Pod (Soyabean, cowpea)
	Psyllobora confluens F.	Col: Coccinellidae	
	Scapteriscus vihinus	Orthop:	Seeding (General)
	Stephanoderes nr. nanulas (Schedl.)	Col: Scolytidae	Peas
	Syneoca surinama (F.)	Hymen: Vespidae	Pods (Pigeon pea)
Pests of Stored Seed	Callosobruchus maculatus (F.)*	Col: Bruchidae	Cowpea
	Coreyra cephabonics (Stainton)*	Lep: Pyralidae	Cowpea
	Lassioderma serricorne (F.)	Col: Anobiidae	Cowpea
	Oryzaephilus surinamensis (L.)	Col: Cucujidae	Cowpea
	Rhyzopertha dominica (F.)	Col: Bostrichidae	Cowpea
	Sitophilus zeamais (Motsch)*	Col: Curculionidae	Cowpea
	Stagobium panicum (L.)	Col: Anobiidae	Cowpea

Table 2. POTENTIAL PESTS* OF COWPEA

Class	Genus and Species	Order Family
Field Pests	*Acanthomia pisum*	Het: Aphididae
	Acrocercops sp.	Dip:
	Aphis fabae (Scopoli)	Het: Aphididae
	Aphis gossypii (Glover)	Het: Aphididae
	Apion spp.	Col: Curculionidae
	Ceretoma ruficornis	Col: Galerucidae
	Colaspis spp.	Col: Eumolpidae
	Ceroplastes spp.	Het: Coccidae
	Diabrotica balteata	Col: Chrysomelidae
	Empoasca spp.	Het: Cicadellidae
	Epicauta albovittata(Gestro)	Hymen: Meloidae
	Etiella zinckenella (Treit)	Lep: Pyralidae
	Ferrisia virgata (Ckll)	Het: Pseudococcidae
	Goniurus sp.	Lep:
	Graphognathus spp.	Col: Curculionidae
	Heliothis zea (Boddia)	Lep: Noctuidae
	Lamprosema indica	Lep:
	Maruca testulalis (Geyer)	Lep: Pyralidae
	Plagiodera inclusa (Stal.)	Col: Chrysomelidae
	Spodoptera sp.	Lep: Noctuidae
	Tetranychus cinnabarinus (Boisd)	Acarina: Tetranychidae
	Thrips tabaci (Lind.)	Thysan: Thripidae
Stored Seed	*Acanthoscelides obtectus* (Say)	Col: Bruchidae
	Cadra cautella (Walker)	Lep: Pyrelidae
	Callosobruchus chinensis (L.)	Col: Bruchidae
	Ephestia cautella (Hubner)	Lep: Pyralidae
	Plodia interpunctella (Hubner)	Lep: Pyralidae

* Pests indigenous to S. America but not yet reported from Guyana on Cowpea.

Table 3. RECOMMENDED CHEMICALS FOR CONTROL OF COWPEA PESTS

Chemicals	Rate of Application	Pests
Aldrin 5% dust	20 lb./acre	Crickets
Aldrin 40% WP	2 lb./acre (20 gln. spray) fluid/ac.)	Crickets
Carbaryl (sevin 85% WP)	1.5 lbs./acre	Pod borers(Hep)
Dimethoats (Rogor)	0.03% at 700 1/spray fluid/ha.	Pod borers
	0.05% at 700 1/ha.	Leaf miners aphids
Dichlorvos	0.1% spray	Mites, thrips,scales
Endosulfan	0.07% at 700 1/ha.	Jassids, pod borers
Fenitrothion 50% EC	14 fl. oz/ac.	Jassids, Pod borers
	0.05% spray	Leaf miners, aphids, mites, thrips, scales, leaf cater-pillars.
Malathion EC	0.1% spray	Leaf miners, aphids, mites, thrips,scales.
Methyl bromide	2 lb./1000 cu. ft./3-4 hrs.	All storage inscets.
Monocrotophos 60% EC	7 fl. oz/ac.	Jassids, pod borers.
Permethrin (Ambush)*	0.0015% spray	Leaf caterpillars
Phosphine	11.39 g/3 - 4m^3 / 3 days	All storage pests
	11.3 g/1 - 2 ton/3 days	All storage pests
Pirimiphos methyl *	0.03% spray	Leaf caterpillar
Tetrachlorvinphos *	0.03% spray	Leaf caterpillar

*not tested on cowpea.

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DISEASES OF COWPEA AND THEIR CONTROL

F.D. McDonald

INTRODUCTION

Cowpea production is rapidly gaining distinct importance in Guyana's Agriculture today. One of the major constraints to production both on small farms and in large scale operations is the problem of diseases. The diseases that might affect the cowpea crop vary with the general environmental conditions such as rainfall, soil type, cropping pattern etc.

This presentation is based in part on observations made in the field along with information and experience with the cowpea crop grown elsewhere. I would attempt to treat in a general way the diseases that are likely to affect production in Guyana.

VIRUS DISEASES:

There are four (4) common virus diseases of cowpea:

(i) Cowpea (Yellow) Mosaic Virus (CYMV)
(ii) Cowpea Mosaic Virus (CPMV)
(iii) Cowpea Mottle Virus (CMeV)
(iv) Cowpea Aphid-borne Mosaic Virus

Cowpea (Yellow Mosaic) Virus (CYMV) and Cowpea Mosaic Virus (CPMV)

There is an on-going controversy as to whether the cowpea yellow mosaic (CYMV) and the cowpea mosaic virus (CPMV) are different viruses or should be regarded as strains of the group of CPMV. It would suffice for this presentation to consider CYMV and CPMV as different strains rather than different viruses.

CYMV can cause yield reductions from 60-100%. The earlier the infection the greater is the yield reduction although significant yield reduction can occur even with infections as late as six weeks after planting.

Symptoms: Both viruses cause necrotic local lesions, chlorotic local lesions, mosaic-like symptoms, leaf distortion, reduction in plant size and in severe cases death of plants. Each symptom can vary in intensity and can occur singly or in various combinations. The degree of chlorosis with CYMV is very much more pronounced than with CPMV.

Transmission: Both viruses are seed-borne and also transmitted by the bean leaf beetles. Only recently it was found that there are other insect vectors of CYMV e.g. thrips, other beetles and grasshoppers. The incidence of CYMV as a seed-borne virus is generally low (1-5%). However, this percentage can be increased significantly by a large insect population.

Control: Control of insect vectors by insecticidal sprays, use of certified disease-free seeds, use of resistant varieties where available and improved cultural practices such as inter-cropping and roguing of infected plants, all contribute to the control of these diseases.

Cowpea Mottle Virus (CMeV)

This virus is mechanically transmitted and no natural vector has yet been found. CMeV reduces yield of susceptible varieties in about the same proportion as CYMV. This disease has not yet been reported in Guyana.

The main symptoms are leaf mottling and leaf distortion and control is effected mainly by use of resistant varieties.

Cowpea Aphid-borne Mosaic Virus:

This disease also has not yet been reported in Guyana. The virus is neither mechanically transmitted nor seed transmitted, but is known to be transmitted by aphids.

The main symptoms are mottling of leaves, interveinal chlorosis, vein-banding, leaf cupping and distortion, necrotic lesions, stunted and bushy growth, retarded or inhibited flowering and finally death of plants.

Control: Insecticidal sprays and cultural practices e.g. inter-cropping.

FUNGAL DISEASES:

(i) Damping-off of seedlings
(ii) Powdery mildew
(iii) Root and stem rots
(iv) Pod rots
(v) Cercospora leaf spots

Damping-off of seedlings is prevalent in wet clay soils. Grain legumes are very susceptible to the damping-off fungi and the disease often is induced by poor land preparation and poor drainage. Damping-off can either be pre-emergence or post-emergence. Post-emergence damping-off can be considered the more important. The main fungi responsible are *Pythium* sp. and *Rhizoctonia solani*.

Symptoms: - Reddish brown lesions on the hypocotyl just above the soil line

- Toppling of seedlings just at the focus of infection. In some cases the hypocotyl appears grey-green and water-soaked prior to seedling collapse.

- General flacidity of the leaves and finally death of plants.

Control: - Good drainage and land preparation accompanied by seed treatment (Thiram at 4 oz/100 lb seed).

Powdery Mildew (Erysiphe polygoni)

A creamy to white superficial growth of the fungus can be seen on the leaves and other above ground parts. Infected leaves serve as inoculum sources for later infection of the pods.

Mildew can effect damage by reducing photosynthesis especially in the early stages of growth, and causing pre-mature yellowing and leaf fall.

Control: Two to three sprays at bi-weekly intervals of benomyl (0.5 - 1.0 lb/ac) or Dithane M45 (2 lb/ac) should be adequate.

Cercospora Leaf Spot (Cercospora canescens and C. cruenta)

Cercospora leaf spot is common in Guyana and of particular importance in seed production since the pathogen is seed borne. Under suitable environmental conditions this disease can cause serious losses in yield.

Symptoms: C. canescens produces roughly circular reddish lesions which when numerous cause premature yellowing and defoliation. Infection by C. cruenta first becomes evident as chlorotic spots which later turn brown and necrotic. On the under-surface of the leaf the lesions appear greyish owing to the presence of profuse reproductive structures of the fungus.

Control: - Treat seeds with a standard seed treatment fungicide such as Thiram. Other measures as for powdery mildew.

Root and Stem Rots

Pythium rot is common in adult cowpea plants in addition to causing damping-off of seedlings.

Symptoms: Pythium stem rot is characterised by grey-green water soaked girdle of the stem extending from soil level up to and sometimes including portions of the lower branches. The stem cortex becomes slimy and is easily stripped off. Infected plants rapidly wilt and die.

Control: Chemical control is generally uneconomic on a large-scale and one should resort to crop rotation. Spot spraying of localised infection areas with captan (4 lb/ac) may be helpful.

Sclerotium rot (Corticium rolfsii)

Sclerotium rot occurs at high humidity and at warm soil temperatures (28^{o} - $35^{o}C$). This disease has been frequently observed at the Kairuni experimental station on the brown sands and elsewhere.

Symptoms: Plants are attacked at any time from the seedling stage to maturity. The fungus attacks the main stem at the soil line and invades the cortical tissue rather rapidly causing wilting and yellowing of plants and subsequent death. Superficial white, cottony mycelium is usually /abundant fairly/and sclerotia (brown spore bodies which look like cabbage seeds) generally are present.

Control: This disease is very difficult to control. Fungicide application generally is uneconomical. The most important control measures involve crop rotation and avoidance of fields with large amounts of rotting vegetable matter (straw etc.) Spot spraying of localised areas with captan (4 lb/ac) maybe helpful.

Pod rots:

The pre-harvest period considered in this context is between 2 - 4 weeks before harvesting. The occurrence of pod rot and the damage done during this period are probably the major constraints to cowpea production in Guyana. After pods are formed rainfall and heavy condensation of dew can induce pod rots of varying intensity. Here again several fungi are involved in pod rots including *Mycosphaera* sp, *Erysiphe polygoni* *Fusarium* sp., *Pythium* sp., *Choanephora* sp.

Weakly parasitic fungi (*Penicillium* sp., *Aspergillus* sp., *Mucor* sp) also cause damage in their own right.

It is important to note that the virulent seed-borne organisms also can damage seeds and are commonly associated with seeds in storage.

Control: With an organised routine spray programme for foliar diseases the inoculum level of most of the pod rotting organisms will be greatly reduced. Under adverse weather conditions, however, an additional spray may be required after flowering has begun and Dithane M45 (3 lb/ac) could be used.

Varieties differ in their susceptibility to pod rots, the red pigmented types tending to be less susceptible.

Other fungal diseases include wilt of cowpea (*Fusarium oxysporum*), Anthracnose (*Colletotrichum lindemuthianum*) and Rust (*Uromyces vignae*).

BACTERIAL DISEASES:

Bacterial blight (*Xanthomonas vignicola*)

This disease occurs mostly in wet weather and spreads rapidly during heavy rains. Bacterial blight seems to occur more frequently in wet clay soils than in the sandy soils. In Guyana, bacterial blight has been sporadic in occurrence and because of this loss assessment due to the disease is difficult to ascertain.

Symptoms: - Water soaked spots appear on the under surface of the leaf which soon become necrotic and develop a tan to orange colouration with a yellow halo.

- stem cracking (canker) may occur
- water-soaked spots on pods from where the pathogen enters the seed.

Control: Use of certified disease free seeds and resistant varieties where available.

CONCLUSION

The cowpea crop is susceptible to attack by viruses, fungi and bacteria which cause diseases that are major constraints to production. Some of these diseases are very difficult if not impossible to control by chemical means. In addition, the high cost of pesticides coupled with the low overall yield potential of the crop make it essential for producers to take an enlightened view both in regard to agronomic practices and plant protection measures. An integrated pest management approach which combines chemical methods of control with proper cultural practices is desirable. Further, in order to keep costs down, spraying should not be carried out more frequently than necessary. Two or three well-timed routine sprays may be all that are essential, except under severe conditions, for effective control. However, to do this effectively it is essential that farmers be able to recognise the specific disease and pest problems so that appropriate remedial action can be taken if necessary during the intervening period between routine sprays.

COMBINE HARVESTING

P.F. Robinson

INTRODUCTION

The combine as we know it today, is a machine used to harvest and thresh all kinds of grain in a variety of crop and field conditions. The name "Combine" developed when the harvesting and threshing operations were combined into one complete machine.

Today's combine is a complex machine. Not only are the harvesting and threshing units complicated, but add to that the engine, power train, the electrical system, the hydraulic system and it becomes one of the most complex machines used in agriculture. To fully understand the operation of the combine look closely at each function of the machine and try to understand each operation separately and how they relate to each other to make the entire machine effective.

FUNCTIONS

All combines perform the following basic functions:

- Cutting & Feeding
- Threshing
- Separating
- Cleaning
- Handling

Cutting & Feeding

The mechanism which cuts or gathers the crop and feeds it into the separator is referred to as the header unit. The type of header unit can vary according to the crop and the condition of the crop and can be either a cutting platform, pick-up reel or corn head. The header unit is attached to the feed conveyor of the combine and a pivot device allows it to be raised or lowered hydraulically to give the desired height of cut.

Cutting Platform: The selection of the cutting platform will depend on the crop to be harvested. The regular or standard type of platform is suitable for most crops but in the case of corn or rice a draper platform may be used. This is similar in many respects to the regular platform except that it has a draper or conveyor belt between the cutter bar and the auger. Cutting widths vary from 8 - 24 feet.

Operation: As the combine moves forward in the field the dividers on the platform separate a swath from the rest of the crop. The reel which revolves at a controlled speed separates part of the swath and pushes it towards the cutter bar and continues to push the cut crop towards the spiralled auger. The auger then draws the material to the centre where the feeder conveyor moves it to the cylinder for threshing. The reel, cutter bar, auger and feeder conveyor must work in proper relationship to cut and feed the crop evenly to the threshing cylinder without losing kernels or pods.

Pick-up Reel: Two types of reel are available, the Bat or Slat-type, and the Standard Pick-up reel.

The Bat or Slat-type Reel consists of three to eight slats made of wood or other material. While rotating against a standing crop the reel holds the head of the crop in position for the cutter bar to effectively cut the crop. The Standard Pick-up Reel has several fingers attached to the slats which are intended to pick up crops which have blown down or become tangled. These are particularly useful for crops such as rice and barley.

Both types of reel are adjustable vertically and horizontally to ensure proper delivery of the crop to the cutter bar and auger. The reel must also rotate at the correct speed to minimise shattering and grain loss. This speed is usually slightly faster than the forward movement of the combine.

Cutter Bar: The cutter bar consists of a steel bed attached to the front of the platform. Secured firmly to this bed are fingers through which the sectional knife passes. The knife is made of several triangular blades which are riveted to a flat steel bar. One end of the knife is connected to a reciprocating drive mechanism causing the knife to move back and forth at speed, thus shearing the crop.

To cut smoothly the knife must be sharp and correctly set otherwise considerable losses will arise as a result of tearing or chewing action.

Platform Auger Action: After the crop has been cut by the cutter bar the reel lays the material on the floor of the platform where the spiral flights of the platform auger pull the crop towards the centre of the feeder conveyor. Most makes of combines have retractable fingers located in the centre of the auger to assist in transferring the crop to the threshing cylinder. Smooth even feeding of the material by the auger is essential for proper delivery to the feeder conveyor. Adjustments can be made to the auger to achieve correct feeding to the conveyor.

Corn Head: These can vary in size from two-row to twelve-row units. As the combine moves forward in the field the points of the gatherers are positioned between the rows of corn. The mechanism grabs the corn stalks and pulls them between rollers. This action removes the ears from the stalks. Gathering chains carrying the ears to the cross auger and then to the feeder conveyor and threshing cylinder.

Feeder Conveyor Operation: Material from the platform is conveyed to the threshing cylinder by the feeder conveyor unit. Most feeders are of a chain conveyor type and are allowed to float at the low end to permit smooth feeding of both small and large masses of material. The conveyor chain is adjustable to cope with various crop conditions.

Threshing

The threshing area of the combine is where in the case of corn the grain is separated from the husk and in the case of legumes the bean is separated from the pod. The components which make up the threshing mechanism consist of a cylinder and concave. There are three basic types of threshing cylinders and matching concaves.

- Rasp-Bar Cylinder and Concave
- Spike-Tooth Cylinder and Concave
- Angle-Bar Cylinder and Concave

The most popular design is the Rasp-Bar Cylinder and Concave because almost all crops can be threshed with it. The Spike-Tooth design is used almost exclusively for rice and edible beans. The Angle-Bar is used mostly for small seeds such as clover. Cylinder sizes vary according to the make and size of combine.

The Rasp-Bar Cylinder consists of a number of steel bars attached to the outer circumference of a series of hubs. The concave consists of a series of parallel steel bars held together by curved side bars and rods. The concave is mounted under and slightly to the rear of the cylinder.

Spike-Tooth Cylinder and Concave consists of a number of steel teeth attached to metal bars which are mounted to the outer circumference of a series of hubs.

Angle-Bar Cylinder and Concave The angle-bar cylinder consist of helically mounted angle iron bars attached to hubs. Both bars and concave have rubber faces. The basic mounting and drive mechanism is the same for all three types of cylinders and concaves.

Cylinder Stripper Most combines are equipped with a cylinder stripper which is usually located near the top of the cylinder and is used to prevent back feeding. Back feeding occurs when material is carried around the circumference of the cylinder and dropped in front of the cylinder again.

The stripper is usually adjustable although some manufacturers fix the stripper in a preset position and no adjustment is necessary.

Operation of Threshing Cylinder and Concave: The feeder conveyor delivers the crop to the threshing mechanism. The crop is fed into the opening between the cylinder and concave. As the cylinder rotates, the material comes into contact with the rapidly rotating cylinder and the impact shatters the grain or seed from the stem cob or pod.

Additional threshing occurs by a rubbing action as the speed of the material is accelerated while passing through the restriction between the cylinder and concave. Approximately 90% of the seeds should be separated during this process with the seeds dropping through the opening of the concave.

The amount of seperation that takes place here directly affects the overall capacity of the combine. For instance if the separation after passing through the cylinder and concave is low more of the grain is thrown onto the straw walkers which over taxes the capacity of this unit and a higher percentage of grain will be lost at the rear of the combine.

Adjustments: Two basic adjustments are provided for the threshing cylinder and concave.

- Cylinder speed (150 - 1500 RPM)
- Concave to cylinder spacing

Both cylinder speed and concave to cylinder spacing are usually controlled from the operators platform.

Separating

The beater or rotary deflector is located directly behind and usually slightly above the threshing cylinder. It is the same width as the threshing cylinder but is much smaller in diameter.

Up to 90% of the crop is separated at the cylinder and concave, the remaining 10% being separated by the beater, finger grate and straw walkers. At this stage only loose grains can be separated thus any unthreshed grains will remain in the straw and will be discharged from the rear of the combine and can be regarded as machine losses.

Beater: The beater deflects the straw coming off the cylinder onto the straw walkers, tears the straw apart and knocks out some of the loose grain. Some beaters have built-in retractable or inter-changeable teeth for use in viney crops to increase their aggressiveness.

Straw Walkers or Racks: Effective separation in a combine is determined by how the crop is shaken as it travels through the separating area. The straw walkers not only provide the agitation to remove any remaining grain but they also remove the straw or trash by "Walking" it out of the rear of the combine.

Different types of straw walkers are used under different crop conditions. The most common straw walker is the step type which provides excellent tumbling and walking action. Straw walkers have holes of different shapes and sizes to allow grains to fall through yet prevent straw and trash passing through. The most effective type of hole is the "Hooded or lip-type" which reduces plugging by stalks and trash.

Straw Walker Action: After the straw or trash has been deposited on the straw walkers, it is tumbled and tossed as it/propelled to the rear. The loose /is grain falls through the openings and is carried to the cleaning shoe. The straw continues to be agitated along the length of the straw walkers until it reaches the rear of the combine and falls to the ground. The straw walkers throw the straw in an upward and rear-ward direction during part of the agitation cycle. This leaves the straw momentarily in mid-air, and material then falls onto a section of the walker nearer to the discharge end. Each action 'walks' the straw or trash a little further towards the rear.

Each agitating cycle occurs 150 - 250 times per minute depending on the combine. If the speed is too fast or too slow, losses may occur. The speed of the straw walkers is usually not variable and is determined by the basic speed of the separator.

The straw or trash must be passed through the machine quickly enough for good material handling capacity and correct separation but not so fast that the grain cannot be separated from it. The separation capacity of a combine is usually reached before the straw handling capacity is reached. To obtain maximum grain separation the concave clearance and cylinder speed must be properly adjusted as most of the grain is separated by these components.

Cleaning

After the crop has been threshed and separated, the grain and chaff are delivered to the cleaning area of the combine. The basic methods for delivery of grain to the cleaning area are by gravity feed, conveyor belts or chains or multiple augers.

Grain threshed by the cylinder and concave falls directly into the cleaning unit. Grain and chaff separated by the straw walker are returned to the cleaning area by the return pan located underneath the straw walker.

Conveyor belts or chains are located underneath the cylinder and concave and deliver the threshed grains to the cleaning unit.

Multiple Augers, running the length of the threshing and separating area, move the grain to the cleaning unit.

Cleaning Unit: After threshing and separating, some chaff and straw are mixed with the grain. To remove this most combines have three basic components which make up the cleaning unit. These are fan, chaffer and sieve.

The fan has its own housing and the chaffer and sieve are in the unit usually known as the "Cleaning Shoe".

Cleaning Fan: The cleaning fan is a multiple-bladed fan mounted in front of the cleaning shoe. The air blast from the fan removes most of the chaff and straw from the grain. Fan speed is adjustable and vary from 250 - 1500 RPM depending on the crop and conditions. The amount of air can be controlled by shutters, wind boards or fan speed.

Shutters are used to control the amount of air taken in and delivered by the fan. These need to be partially closed when cleaning light seed and wide open when cleaning heavy seed.

Wind Boards, located in the fan throat, control the direction of the fan blast to the chaffer and sieve. Usually the fan blast is directed well to the front of the cleaning shoe in heavy crops and more to the rear of the shoe in light crops. In many combines the fan housing and fan throat are designed to direct the air to the shoe where it will do the most effective cleaning job and the need for wind boards and shutters are thus eliminated by effective equipment design.

Fan Speed: The fan speed is adjusted for maximum usable air volume without blowing the grain out of the combine. Slight adjustment is then necessary to obtain the most effective cleaning action.

Cleaning Shoe: The cleaning shoe, which contains the chaffer and sieve, is mounted under the main frame of the combine separator. The bottom of the shoe usually contains the lower tailings auger and the lower clean grain auger. The chaffer and sieve are suspended on hangers mounted on rubber bushings attached to the side of the cleaning shoe. The chaffer is mounted on to the upper shoe and the sieve is mounted to the lower shoe. The chaffer and seive are moved back and forth by a pitman-type drive attached to the hangers.

Chaffers are either adjustable or non-adjustable. The adjustable type is made up of a series of cross pieces of over-lapping metal louvers with lips or teeth. These louvers are mounted on rods and fastened together so that they may be adjusted together to the desired opening.

Non-adjustable chaffers are available in a number of designs. The openings and louvers have different shapes and sizes to meet various problems encountered in different crop conditions.

Chaffer Operation: The grain and chaff are delivered to the front of the chaffer over the finger bar. The finger bar holds the incoming layer of grain and chaff mixture over the front part of the chaffer and allows the relatively high velocity of air from the fan to break up the layers. The lighter chaff is blown out and the grain and heavier particles fall down on to the chaffer. The oscillating motion of the chaffer carries these materials towards the rear of the chaffer where the grain and small heavy particles fall through the chaffer louvers onto the sieve, and the lighter particles are carried rear-ward until they either fall through the chaffer extension into the tailings auger or to the ground.

Sieve: The sieve is similar to the chaffer except that the louvers and openings are smaller. The final job of cleaning is done here. There are several types of sieves but the most common are the adjustable louver type. The sieve is located below the chaffer and materials which fall through the chaffer fall directly onto the sieve. This oscillates with the chaffer and in some cases counter to the chaffer. The grain falls through the sieve to the clean grain auger and is carried to the grain tank. The unthreshed grain heads or tailings are carried to the tailings auger by the action of the sieve. The tailings are then carried back to the cylinder for re-threshing.

Handling

Handling the crop means moving the threshed separated and cleaned crop from the cleaning shoe to the grain tank and then from the grain tank to a waggon or truck for transporting.Equipment for handling the crop include the following components -

- Clean grain elevator and augers
- Tailings elevator and augers
- Grain tank
- Grain unloading auger

Clean grain elevator and augers: After the grain has been cleaned by the shoe, the lower clean grain auger delivers it to the clean grain elevator. The elevator carries the grain to the upper clean grain auger or grain tank loading auger which deposits the grain into the tank. The augers are usually 4 - 6 inches in diameter. The elevator has a series of rubber or steel paddles attached to a drive chain which move at about 350 feet per minute. The slow speed helps to prevent damage to the grain. In some crops such as edible beans metal buckets are used to ensure careful handling of crop.

Tailings elevator and augers: Tailings are unthreshed or unseparated material which fall through the chaffer extension at the end of the chaffer and off the rear of the sieve. Here the lower tailings auger moves the material to the tailings elevator. The elevator then carries the material to the upper tailings auger which drops the tailings to the centre of the separator just above the threshing cylinder. Here the material is re-threshed and later separated and cleaned. The tailings elevator and auger are similar in construction to the clean grain components except that they are smaller because they do not carry as much material. An inspection door is provided so that the operator can examine the tailings to determine whether the combine is adjusted correctly. If the threshing cylinder and cleaning shoe are properly adjusted there should be very little material in the form of tailings.

Grain Tank: Grain tanks come in many shapes and sizes and may be located on top or on one or both sides of the machine depending on the make and size of the combine.

Grain unloading auger: An unloading auger system is normally used to unload the grain from the tank. This system usually consists of a larger auger across the bottom of the tank. Connected to it is an outer auger which unloads the grain from the tank to a truck or trailer. The outer auger is usually tilted at an angle to extend over the side of the receiving vehicle. In order to reduce unloading time to a minimum, augers up to 12 inches in diameter are used and are run at high speed.

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DRYING

Neville C. McAndrew

INTRODUCTION

A question frequently asked is "Why should grain be dried after being harvested?" The answer lies in the knowledge that grain when harvested is seldom, if ever, at a moisture content safe enough for proper storage. In grain, moisture levels closely control a number of physiological activities. For instance, at moisture levels about 45/60% germination (sprouting) can occur; in the range 18/20% to 45/60% respiration is high, micro-organisms develop profusely and heating is almost inescapable; mould (fungus) growth may occur at 14/20% and respiration is still sufficiently high to cause heating; below 12% moulds and heating are seldom problems, and insect infestation ceases to be a problem at moisture content below 8%.

ADVANTAGES OF DRYING

Grain spoilage involves insect activity, fungal growth and some bacterial action either separately or in combination. It is an established fact that the removal of moisture from grain in such a manner as to retain maximum grain quality, yet reach a level of moisture in the grain which will not allow the growth and development of spoilage organisms, will considerably reduce the rate of deterioration. Drying or dehydration refers to the process of moisture removal thus Presenting an unfavourable environment for the growth and development of spoilage organisms.

Apart from being the key to reducing storage losses, drying of food grains has a number of advantages some of which follow:

- Drying allows for earlier harvesting thus reducing chances of field loss as a result of adverse weather or insect attack.
- Drying permits harvesting at a higher moisture content thus reducing losses through shattering.
- Drying permits more harvesting hours per day resulting in fewer harvesting days per season.
- Earlier and speedier harvesting allows earlier land preparation for the succeeding crop and in some cases may even permit the planting of another short season crop between major seasons.

MECHANISM OF DRYING

Drying occurs when a product, grain in this instance, loses or gives up moisture to thesurrounding environment. This would only occur if the vapour pressure inside the grain is higher than that of the ambient air. This means that loss of moisture from the grain would proceed only if the relative humidity of the drying air at any given temperature is lower than that which would prevail in the grain if the grain was at the equilibrium moisture content for that particular temperature. Moisture loss will continue until the equilibrium moisture content at the particular temperature is reached. Note that the equilibrium moisture content is the moisture content at a given temperature when the vapor pressure in the grain equals that of the surrounding environment.

It might be sufficient to point out, however, that for practical purposes the relative humidity of the drying air must always be lower than that of the air which is known to be in equilibrium with the grain at the safe storage moisture level.

Grain drying occurs in stages. Firstly, the air in the spaces between the grains absorbs the moisture present on the surface of individual grains. Moisture within the grains is then transported from the interior of the grains to the surface from where it evaporates. This process continues until the equilibrium moisture content is reached and there is no further evaporation of moisture from the grain surface at the prevailing temperature. Further drying at the same temperature would take place if this moisture - laden air is now removed from around the grain and replaced with a fresh supply of air having a lower relative humidity. Alternatively further drying could be encouraged by raising the temperature (heating) of the air thus increasing its water-holding capacity and allowing additional moisture to evaporate from the grain surface.

SYSTEMS OF DRYING

Natural drying occurs as the grain loses moisture on the plant while the crop is still standing in the field. This usually occurs after the crop has reached maturity. The period of natural drying is affected by such considerations as crop type, prevailing environmental conditions, method of harvesting , availability of labour and machinery and the availability of facilities to further dry the harvested grain.

Two systems of drying - Sun Drying and Artificial Drying - are normally used to dry harvested food grains and there are several drying methods within each system. It should be noted, however, that different types of grain have individual and specific drying characteristics and the drying method used should always be the one that would give the highest quality product. In general food grains should not be dried at temperatures above 110°F.

Sun Drying

Sun Drying may be suitable for the small farmer but has limited practical application in large scale production. This system demands a high labour input to periodically agitate the grain on the drying floor to facilitate uniform drying. Sun drying also demands constant vigilance to protect the grain in the event of an unexpected shower of rain. The system is dependent on sunny days and requires an extensive drying area if substantial quantities of grain are to be dried. Grain being sun dried has to be stored under cover during rainy periods and at night time in order to avoid re-absorption of moisture.

Artificial Drying

It is known that by increasing the temperature the water holding capacity of a given volume of air is increased. The burners on hot air driers fulfill this role by heating up the incoming air. A fan,used either to force or to pull the heated air through the grain mass, serves to keep air of low relative humidity (high water holding capacity) constantly moving through the mass of grain and removing air that had already absorbed moisture. In this manner moisture is removed in a continuous cycle.

Hot air driers therefore require a source of power, usually electrical, to drive the fan and a source of energy (wood, charcoal, electricity or petroleum products) to supply the heat. Petroleum products are by far the most commonly used energy source. Hot air drying is only one of the many methods of artificially drying grain. Other methods include infra-red drying, freeze drying, use of dessicants, etc., all of which are designed to efficiently remove moisture from grain. But these would be of little practical application in our context at this time.

Hot air driers are of different types and sizes and each type has its advantages and disadvantages.

Sack or Bag Type Driers are well adapted for use when different grain crops or different varieties of the same crop are handled simultaneously as the threat of physical contamination with other grains is reduced since the grains are dried in bags. Available mobile models can be tractor drawn and used directly in the field.

Box Driers are modified bag type driers where boxes with perforated wire bottoms are used as grain containers. After the grain is dried the filled boxes are removed from the drying area and replaced with boxes containing a fresh lot of grain. By continually replacing boxes of dried grain a continuous drying process can be maintained.

Bin Driers are very practical for drying grain in lots that exceed five tons. The roof, side walls and perforated flooring are usually made of metal and the base wall, which serves as a plenum chamber upon which the bin is mounted, is usually constructed of concrete.

A drying system involving the use of bin driers would satisfy the needs of local large scale producers and drying bins in a multiple bin installation could be arranged in a number of different patterns,one of which is shown in Fig. 1.

Continuous Flow Driers have limited application and are usually associated with large grain handling complexes such as terminal elevators, etc.

CONCLUSION

It is important that serious consideration be given to the method of artificial drying to be employed both in regard to the level of grain production and the range of crop types to be handled. All driers or drying systems require commitment of capital which should be expended to give maximum returns and not necessarily for the purchase of the most sophisticated or modern equipment. For our large grain legume producers a well designed and sensibly laid out multiple bin drying system would suffice.

A multiple bin system apart from efficiently drying grain of different crop types would also facilitate storage and handling on the farm during peak harvesting periods. Packaging of grain for the market can then be done on off days e.g. rainy days or after the harvest is completed.

Since the purpose of drying is to lower the moisture content of the grain to a level safe enough for proper storage, there must be some reliable method of determining grain moisture content before, during and after drying. Traditional methods such as feeling, biting and cutting the grain have worked in the past and continue to be used on small farms. However, these methods are not sufficiently reliable for the large grain producers. Moisture testers are preferable. These are efficient and are fairly reliable for determining grain moisture content and a good portable moisture tester is an essential tool in any large scale grain production enterprise.

Finally it is essential to remember that high moisture levels in grain is the source of many of the problems associated with grain deterioration. Effective and efficient drying would not only mean a marketable product of higher quality but also reduced losses in storage and, in the final analysis, more food for all.

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CLEANING

Neville C. McAndrew

INTRODUCTION

Grain from the harvester is seldom in a condition suitable for use either as animal feed or for human consumption. Present marketing standards and consumer tastes demand that food grains be first separated from its contaminants and a product of acceptable quality be presented.

Contaminants in grain,apart from reducing the grain quality and/or its acceptability, are also contributory to increased in drying costs and to numerous storage problems. Harvested grain usually contains a number of typical contaminants. These include weed seeds, small, damaged, broken and shrivelled grain, straw, chaff, leaves, twigs, stones and soil particles, all of which contribute individually or collectively to the unsightly appearance of the product. It is further recognised that the presence of these and other foreign material in food grains accelerates the deteriorative process as at the same moisture content unclean grain is more likely to "heat" than sound grains. Furthermore it is believed that extraneous material harbour greater numbers of mould spores and bacteria, and that insects, grass and dust have a higher moisture content at the same relative humidity. The process of separating grain from its contaminants is referred to as cleaning, and this is usually done prior to final drying and storage.

OBJECTIVES OF CLEANING

The basic objectives of any efficient cleaning operation are as follows:

- To obtain a clean product that would satisfy domestic and international standards.
- To remove completely any seeds, the sale of which would contravene any existing legislation (Noxious Weeds Act).
- To avoid extensive loss of grain during the process.
- To add the minimum of processing charges to the sale price of the grain.
- To remove all contaminants which may damage subsequent processing machinery.

METHODS OF CLEANING

For effective cleaning, the grain and its contaminants must differ in one or more physical properties. These differences must be identifiable and are acted upon by machines used in the cleaning process. The properties most often recognised and used to effect cleaning are differences in geometric dimensions (length, width and thickness) and differences in rate of fall or float. Other recognisable differences include colour, specific gravity, resilience, etc. However, no single machine except perhaps the human eye if it can be so labelled, can successfully identify and act on all contaminants simultaneously. Grain cleaners usually identify differences in one property. For example sieves select on the basis of differences in geometric properties and may separate long grains from short grains or plump from shrivelled or undersized grains.

Perhaps one of the simplest methods of cleaning is by throwing grain into the wind to remove the lighter grains and chaff. This method, known as winnowing has been subjected to a number of variations and adaptations over the years. The main disadvantage of the method is that it allows stones, pieces of earth and a certain amount of extraneous seeds to remain with the grain and often requires some amount of hand selection to remove these contaminants.

Over the years there has been rapid development of machinery for grain cleaning. The ones most often used employ the air-screen system, which was the basis for the oldest cleaning machines and still is the easiest and most effective form of cleaning bulk grain. This system has also been built into numerous combine harvesters for initial field cleaning.

The cleaning process as carried out by a typical four screen cleaner is as follows.

Grain flows by gravity and the rate of flow is controlled by an adjustable feeder. The grain falls into an air stream which removes light, chaff material and the remaining grain is distributed evenly over the top screen. This process also aids in breaking up grain cohesion thus facilitating the subsequent screening process.

The grain then passes through the screens. The top screen scalps or removes the large material, the second screen grades or sizes the grain, the third screen scalps the grain more closely and the fourth screen performs a final grading. The graded grain then passes through an airstream which lifts and blows away light grains and chaff to waste.

Screens for air-screen cleaners are available with holes in four shapes - square, rectangular, round and triangular. In addition, the rectangular holes may have square or rounded ends. Also available are mesh sieves which are usually used for rougher cuts. A round hole screen should be the first choice for fairly rounded grains, the slotted screens are clearly superior for long material and since they hold anything wider than the slot size, they are the common choice for selecting undersized from round grains.

Air-screen cleaners are available in various sizes and models and use varying numbers and combinations of screens. Irrespective of their size, however, air-screen cleaners all use basically the same system to effect the cleaning process, that is an air flow which selects for differences in rate of fall (or float) and screens using the geometric properties of length, width and thickness. The type of cleaner to be used would depend primarily on the size of the enterprise and the level of precision required in the cleaning process.

Pre-cleaning operations might involve passing the grain between magnets to remove any metallic objects which may damage the cleaning equipment.

In the cleaning of food grains on a largescale, a two-, three-or four-screen cleaner could suffice, depending again on the desired quality of the final product. It should be remembered that a four screen cleaner would give a more precisely graded product.

CONCLUSION

The efficiency of the cleaning operation is dependent on the efficiency of the machine, the selection of appropriate screens for the particular task and the competence of the operator. It is recommended that during the cleaning process initial trial runs be made with variations in screen combination air flow, grain flow and screen slope. Inspection of both the final product and waste at each setting or combination of settings should be carried out to ensure firstly that the end product is of the desired quality, and secondly that as little good grain as possible is being lost during the cleaning operation. With experience, operators can easily select the right screen combinations etc. for the various food grains, but even so inspections should be made after trial runs since grain size, even in a particular variety is known to vary from season to season.

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STORAGE

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INTRODUCTION

Despite remarkable advances in crop production in areas such as plant breeding, farm management, pest and disease control, one unalterable fact to this day is that crop production is still seasonal in spite of a non-seasonal demand for plant products. This singular fact has led over the years to the development of marketing systems, often very complex in organisation, designed to ensure an unceasing supply of farm products to the ever demanding consumer. Processing and storing of agricultural commodities play major roles in the functioning of these marketing systems. Good grain storage practices aim at preserving grain quality and quantity at levels as high as possible, which basically means eliminating loss and damage by insects, fungi, mites, rodents and birds.

PRE-HARVEST STORAGE

It is somewhat erroneous to consider grain storage as commencing only after the grain has been harvested and taken to some special area or structure where it is to be held until marketed. There is in reality a pre-harvest storage period for dry grains and the food legumes are no exception.

Grain normally reaches functional and physiological maturity at the time of maximum weight accumulation. This usually occurs at a moisture content of about 30-35% in most grain legumes and this is too high for ordinary storage. The post maturity period which directly precedes harvesting is, in fact, a period of storage in the field during which the entire plant continually loses moisture until harvest. Conditions in the field are seldom if ever, suitable for efficient grain storage and substantial losses can be experienced there. Adverse weather conditions, characterised by high temperatures and high humidity or rainfall, acting singularly or in conjunction with pest and disease attacks, affect both the recoverable quantity and quality of the grain prior to harvest. Furthermore these initial problems in the field are recognised as the starting points of numerous subsequent problems that are experienced during post-harvest storage. Good crop management practices - that is effective control of weeds, pests and diseases and early harvesting followed by timely and efficient drying can help in minimising field storage problems.

POST-HARVEST STORAGE

(a) Pre-Cleaning & Drying

Another cycle of storage follows after the grain has been harvested and before it is cleaned and dried. Ideally grain should be rapidly and safely dried immediately after harvesting. However, a number of factors may cause delays in getting the drying done. The most common factors include unavailability of drying equipment, inadequate drying facilities and insufficient quantities of grain to commence the drying operation. Undue and prolonged delays prior to drying can cause serious problems as in that grain from the harvester is usually contaminated with leaves, straw, broken and damaged grains etc., which would be respiring rapidly and contributing to heating of the grain. Under these conditions spoilage would be rapid. If the facilities are available, grain that is harvested and could be immediately dried should be aerated by forcing unheated air through the grain mass in order to reduce the field heat and heat of respiration. Although a 1 - 2% reduction in the moisture content of the grain may occur during aeration, this process is not drying and should not be substituted for same.

(b) Post-Cleaning & Drying

By far the longest storage cycle occurs after the grain has been cleaned and dried until the time it is consumed. This cycle can be broken up into periods of bulk storage on the farm, bulk storage at a marketing agency or packaging plant, storage at the groceries and supermarkets and storage at the home of the consumer. Each period of storage throughout this cycle is characterised by the peculiar nature of its storage problems and the remedial steps employed. In general, as the product moves up the line to the consumer the unit price increases and the monetary value of any losses experienced increases as the product nears the consumer. The need for increasing care is therefore obvious.

On the farm, loose grain can be bulk-stored in concrete or metal silos or in metal bins of varying capacities. These bulk storage facilities should possess certain essential features as follows:

- they should allow for easy loading and unloading of grain
- they should allow for easy cleaning after all the grain has been removed
- they should not permit the easy passage of water through the walls or roof
- they should be constructed so as to permit easy fumigation
- storage bins especially in a multiple bin drying and storage operation should be designed and constructed to permit aeration and re-drying of the grain when necessary
- they should have facilities to permit periodic inspection of the grain so that trouble spots can be detected at an early stage.

On the farm and in warehouses grain can be packaged in jute bags of 100-200 lb. capacity and stored in stacks. If the farm is located in a dry area these stacks can be stored in the open, however, if frequent showers are the general pattern, the bags of grain should be stored under tarpaulin or plastic covers or under a shed. The pyramid shape is a frequently used method for stacking bags when manual labour is used. In warehouses bags can be palletised and stacked to desirable heights. As in bulk storing of grain, storage in bags should also be done in such a manner as to easily allow certain basic operations to be done. Some essential features of in-bag storage are as follows:

- bags should be of a close enough weave to retard movement of insect pests
- bags should be stacked in such a manner as to allow easy and unobstructed inspection at all points
- stacks of bags should be formed in such a manner as not to impede dusting or spraying activities
- bags should be stacked on pellets or dunnage to prevent moisture moving up through the floor and causing spoilage in the bottom layer

Efficient grain storage facilities therefore are characterised by certain essential features which may be summarised as follows:

- designs that facilitate loading and unloading of grain
- walls and floor without cracks and crevices which can serve as hiding places for insects
- corners designed to facilitate easy cleaning as debris remaining in inaccessible areas can be a potential breeding ground for storage pests
- rodent proofed by use of plastered concrete walls, aluminium sheeting and other methods
- structurally convenient to allow easy inspection, fumigation, aeration and re-drying when necessary
- water and leak proofing

(c) <u>Grain Spoilage</u>

The two most highly recognised contributors to grain spoilage are high temperatures and high relative humidity. Directly and indirectly they both affect the physiological processes of the organisms that are associated with grain spoilage. In general high temperatures signal an increase in metabolic activity of living organisms and the contributors to grain spoilage are no exception. High relative humidity within the storage environment invariably means high grain moisture and it is the level of available moisture which limit the physiological activity or organisms present on the grain surface or within the grain mass. It can be readily seen therefore that under conditions of both high temperatures and high levels of relative humidity there would be a significant increase in the rate of grain deterioration. However, should there be a choice between conditions which offer a combination of low temperature and high relative humidity, and high temperature and low relative humidity, the latter would be the better combination since the moisture content of the grain governs the type of activity whereas the temperature dictates the rate at which that activity progresses.

(d) Chemical control

Fumigants and/or insecticide dusts are used for the control of insect pests that attack the grain in storage. It is essential that the grain under fumigation be properly sealed to contain the fumigation gases and to protect workers from exposure. Popular fumigants such as Methyl Bromide and Phostoxin, when used as recommended by the manufacturers can kill insects even at the egg stage within the grain. Fumigants if received in the right dosage or for a long enough period also can kill humans. The need for care is obvious. Insecticide dusts e.g. Malathion, also have been used to protect storage grain from insect pests. However, the use of these powders has been associated with a number of unfortunate incidences of poisoning and death of humans.

CONCLUSION

In conclusion, storage of grain, whether short term, intermediate or long term is a necessary part of food grain production. While storage should be designed to maintain grain at as high a level of quality as is possible, the prime pre requisite of good storage is to start with top quality grain. The best of storage conditions have never improved grain quality, and what is taken out of storage is always lower in quality that what was put in. The deteriorative process is inexorable - it goes on regardless. We cannot stop deterioration we can only provide conditions within the storage environment that would slow down its rate.

POST-HARVEST LOSSES IN BLACKEYE PEA (*Vigna unguiculata*).

H. Barreyro

1. INTRODUCTION

The analysis and measurement of the losses that occur after harvest have the objective of establishing the best means to reduce the quantity of loss.

There are two ways in which more product can be made available to the consumer. One way is to increase the amount that is produced. This can be accomplished by either increasing the acreage devoted to production or by increasing the yield/acre. When the possibilities of increasing production by increasing the acreage devoted to production was curtailed because of the increasing cost of bringing new land into cultivation, emphasis was placed on what was called the "Green Revolution", whose main impact was through the introduction of higher yielding varieties and the massive application of fertilisers and chemicals in the production process. The 'green revolution' has been outdated for sometime now mainly because of the effect of the petroleum crisis on the chemical industries, but also because a plateau has been reached in the yield response of new varieties.

What was then the response to the increasing demand for food by an increasing population? This time attention was given to the amount of produce that was failing to reach the consumers for various reasons and it was proved after some research that it was cheaper to reduce these losses than to increase production per se.

In the case of Guyana the problem is also very great but for different reasons. The legume products which are now being introduced are expected to have an expanding production trend over the next few years, but this could be increased faster if the returns from the crop could be increased by reducing the losses of the produce and the risks involved in marketing. In most other parts of the world where grain legumes are commonly grown, they are considered to be non-perishables, i.e. that the grains can safely be stored for a long period. This fact, however, is not true in Guyana. The most that the grain can be stored here is two months with more or less minimum degree of deterioration. After that humidity, temperature and insects take a tremendous toll of the stored grain with the result that producers find it too risky to get involved in the crop on a largescale. The effect of this attitude is to slow down the increased production drive for grain legumes.

2. SOME ELEMENTS IN THE DEFINITION OF THE LOSSES

In general it is easier to talk about losses than to define them in a pragmatic way. Every product has its own characteristics and therefore the nature of losses is different for each of them.

A starting definition of the losses is as follows:

"Loss is all that product that becomes unacceptable to the consumer or that which never reaches him".

The interpretation of this definition is affected by consumer preference and more importantly, by his income. The lower the income of the consumer the more willing he would be to accept a product of lower quality. Therefore, a product that may be considered a loss for the higher income consumer would not be so for the lower income consumer. There is also the fact that in some cases people consume a product that is below acceptable food standards because of ignorance. These factors necessarily lead us to the need for a more precise definition of losses by establishing what type of product and minimum quality that can be sold to and accepted by the consumer. A proper grading standard is required and further studies should be done to identify the nature of the losses and its relations to human nutrition and health.

The approach used to determine losses in grain legumes was based on the existing possibilities of measuring losses rather than the ideal. The approach was to measure some of the characteristics of the grains that are indicative of seed deterioration. By knowing the evolution of the measure of these characteristics a relationship can be established with the different environs in which the grains were kept.

These relationships will in turn help to arrive at conclusions regarding the main factors governing the deterioration of the grain and determine the ones which could be changed or modified to reduce the losses or in fact to reduce the rate at which grains deteriorate.

The results of this study are summarised in Tables 1 through 8.

3. CAUSES OF LOSSES IN BLACKEYE PEA

The nature of the losses that occur in blackeye pea are of three types:

- Quantitative: These are the losses that are accounted for by weight.
- Qualitative: These are related to a grading system and its relation to the value of the product.
- Nutritional: These refer to the losses in terms of its nutritive value for human consumption.

For peas that are intended for seed purposes, the losses in germinating power are also important.

The losses in quantity are measured as spillage, or "leftover", i.e. what remains on the ground after the harvest is completed. Mechanical harvesting produces a sizable amount of this loss.

Harvesting can be a source of many problems. The major problem areas being the time of harvest and secondly, the method of harvest.

In blackeye the dry pea is the desired end product and it is the normal practice to allow the pods to dry on the plant before harvest. Some quantitative and qualitative losses occur here as a result of lodging, shattering, and pest and disease attacks.

The ideal method for blackeye pea is to harvest each pod by hand and subsequently shell them. This method ensures that each pod is harvested at the right time and shelled with such care as to preserve the quantity and quality which prevailed when the pods were removed from the plant. Spillage in the field would be minimal or even non-existant, and mechanical damage as experienced during machine threshing would not occur.

This method which is used by some small farmers is unsuitable for large acreages. It is highly labour-intensive and excessively time consuming and uneconomical although the grain quality obtained is excellent.

For large acreages we have total mechanical harvesting by self-propelled combines, which simultaneously harvest green and dry material. This method of harvest incurs varying levels of mechanical damage depending on the type of machine used, the skill of the operator, the adjustments and/or modifications to the machine and the moisture content of the grain being harvested. Since no machine is 100% efficient, some pods would remain unharvested or unthreshed, some shattering would take place and there would be some spillage.

Shelling is normally followed by cleaning, the process of removing the unwanted chaff from among the grain.

Both cleaning and grading are unavoidable,and while grading improves the quality of the product, the discarding of some amount of good material along with unwanted grains is inescapable.

Drying i.e. the removal of moisture, is a critical operation. High moisture is one of the major causes of qualitative loss which occurs in storage.

Losses in storage are the ones that are most readily observed since it is often the practice of inspecting and weighing the grain before and after storage and any changes in quantity and quality are usually reflected in the weight and condition of the product as it is marketed.

Quantitative loss in storage can be brought about through insect and rodent attack, spillage and larceny. Insects and rodents are also responsible for qualitative and nutritional loss. However, the majority of problems which arise during storage are often due to improper drying. Grain is hygroscopic, that is, it will absorb or give up moisture to the environment until a state of equilibrium with the environment is reached. All grain in storage should be inspected frequently for signs of damage.

From the analysis of the flows, it is clear that harvesting (mechanical), threshing, drying, storage and transportation are all critical points in the flow of the product.

MECHANICAL HARVESTING

Time of harvesting proved to be critical especially where mechanical harvesters are used. Pods that are too dry tend to shatter and those that are too green are easily crushed and damaged by the rollers.

Harvesting during or soon after the rainy season posed problems. Pod rot fungus affected large parts of the crop thus reducing severely the quality of beans realized.

For the farmer who harvests manually and dries naturally in the sun, it is important that the beans are harvested when "mature". Since sun-drying is usually a lengthy and sometimes uncertain process, the mature beans which contain less moisture, dry faster than beans harvested before maturity, thus reducing the possible occurrence of seed discoloration due to fungus infection.

TYPES OF HARVESTERS

The mechanical harvesters used in the cases of harvesting mechanically were rice combine harvesters adapted for use with blackeye pea. Losses during harvesting were very high indeed and could undoubtedely be attributed to mal-adjustments of the harvesters.

The latter needed to be adjusted and adapted for use with blackeye pea since both the size and texture of rice grains are different from those of blackeye peas. Losses due to spillage, peas left unharvested, crushing, spilts and broken grains all occurred.

THRESHING

Threshing operations were of three types:

- threshing combined with harvesting. (rice combine)
- threshing at storage bond in mechanical thresher
- threshing by hand - beating bags with a stick.

Of the three operations, the first one proved to be responsible for the most losses. The second operation, from observation was responsible for some losses due mainly to spillage plus split and broken peas to a lesser extent. Threshing by hand gave rise to very little losses but this exercise was time consuming.

DRYING

Another critical point in the flow is drying. Sun drying proved to be insufficient, especially if the product was held for a long period in storage. Sun drying could perhaps be improved by use of surfaces designed to trap the energy from the sun. Mechanical drying was efficient, but too harsh for peas to be used for seed purposes. It appears that more small portable dryers are needed to service adequately the number of blackeye farmers in production.

STORAGE

Of the factors responsible for post harvest losses, poor storage was very important. There were no storage facilities in use, either on or off-farm, that were especially designed for the storage of blackeye pea or any other grain. Most or all farmers (small or medium scale) used their homes (bottom house or kitchen) for storage. The two larger producers used a large, well enclosed bond in one case, and an open shed in the other. None of these facilities were temperature controlled, humidity controlled or rodent proof.

Off-farm storage presented the same picture with places used as bonds generally being quite unsuitable for storage. In a few cases, peas were put into cold storage where humidity was far too high, and the incidence of rodent attack alarming. The peas on removal from cold storage deteriorated rapidly and a high proportion was unfit for human consumption.

DELAYS

Delays between steps in the flow are critical only because of the poor storage and drying facilities in use at present. A delay between storage on farm and sale to a consumer for example, should present no real difficulties if the peas were properly dried and stored under proper conditions. Since peas can be classified as a non-perishable or stable food, then it is expected that shelf life should exceed a year if handled properly.

CONCLUSIONS

In the case of blackeye peas, it is assumed that the grain is at the peak of its condition when it leaves the plant at the moment of harvest. After this, a deteriorating process is started that is caused by environmental conditions (humidity and temperature) and seed conditions (moisture content mainly, and vital characteristics). These direct causes open the doors to attack by insects, fungi and other pests that alter the content of the seed and its appearance, by consuming part of it or by adding excreta or other foreign substances. Humidity and temperature also start the physiological processes of respiration, germination and aging.

Moisture content of the seed also affects the efficiency of harvest by giving rise either to broken grain, if it is too dry or crushed grains if it is too moist. Also in mechanical harvesting losses in quantity by unthreshed or unharvested pods, shattering, broken, split or crushed grain, are all directly related to the moisture content of the seed. In hand harvesting all of these factors are minimized because each pod is picked at its optimal state. However, the first level of losses start appearing in threshing which is usually done by beating the grain inside the bag followed by cleaning through sifting or winnowing of the grain.

It is clear that any improvement must relate to the farmer's practices and attitudes. While the emphasis here rests on post-harvest losses, it must be accepted that a number of factors which may occur prior to harvest can also result in serious losses. Factors such as time of planting, fertilizer management, pest and disease control, weed control, unfavourable weather etc., can have their adverse effects felt during harvest or still later at the post-harvest stage.

In Fig. 1 a sequential description of the hypothesis cf the causes of losses is presented. These deteriorating processes as reflected in the diagram are to be modified if losses are to be reduced.

The diagram stresses the inter-relationship between the several factors and also the cause-effect relations that exist among them. It is clear that there exists a chain of relations which affect the deterioration of the grain that is accelerated or not, depending on the environment in which the grain is kept.

On the other hand, it should be noted that every action to reduce losses have a cost and therefore, will influence not only the amount that actually reaches the consumer but the cost of the end product.

These are some of the most frequent avenues along which post-harvest losses occur. It is important to be aware of and be concerned about their existence. All too often, simple remedial actions such as use of proper machines, correct adjustment of machines (harvesters and threshers), efficient drying, general sanitation and constant watchfulness are overlooked.

Post-harvest losses are classified as such because these losses are observed during post-harvest operations. However, many of these problems have their roots in farmers attitudes and practices which prevail long before the harvest begins, and in the practices and attitudes of the people and institutions involved in the marketing of this and other products.

TABLE 1. Left-overs in the field by Farmer when hand-picking blackeye pea. (Pomeroon Farmer)

ITEM	MEASUREMENT
Weight of all samples	10 g.
No. of samples collected	3 of 1 sq. yard each
Estimated loss per acre	35.5 lb
Seed Analysis of left-overs	
Pure Seed	0
Damaged	13%
Splits	1%
Badly discoloured	84%
Small seeds (not matured)	2%
Amount of good grain harvested	140 lb.
Size of the yield	0.2 acre
Calculated yield/acre	700 lb.
Loss per acre	4.8%

TABLE 2 Left-overs in the field and Potential Yield - Combine harvested. (Intermediate Savannahs)

ITEM	MEASUREMENT
Weight of all samples	205 g.
No. of samples collected	5 of 1 sq. yard each
Estimated loss per acre	437.5 lb
Potential Yield:	
Weight of all samples	580 g.
No. of samples collected	5 of 1 sq. yard each
Estimated Potential Yield	1237.7 lb/acre
Proportion of grain left over	35.3%

TABLE 2b Seed Analysis of left-overs and harvested samples from Intermediate Savannahs

Category	Yield %	Left-over %
Pure Seed	77.92	58.8
Damaged	5.97	7.8
Splits	-	1.35
Badly discoloured	10.62	28.7
Moisture Content	18.1	18.1
Small Seeds	4.4	4.7

TABLE 3 Comparsion of rejected and clean peas[a].

Category	Clean Peas	Rejects or Sweepings	Before Cleaning
Pure Seed	67.07	20.02	43.50
Damaged	17.75	15.20	17.40
Splits	2.05	30.06	16.00
Badly discoloured	9.06	30.52	19.89
Small Seed	2.05	2.62	2.34
Foreign Matter	0.15	1.52	0.53
Moisture Content	13.90	11.10	12.54

[a] (Cleaning was done with a blower).

TABLE 4 Seed analysis of Blackeye peas produced at the Intermediate Savannahs and sold in Georgetown at retail markets[a].

Category	At production Site after cleaning (A)	At Whole-Saler (B)	Relative change (A to B)	At Retail Market (C)	Relative % change (A to C)
Pure Seed	67.07	65.26	-2.69	59.96	-8.12
Damaged	19.75	17.99	-8.91	25.57	42.13
Splits	2.05	2.31	12.68	1.9	17.74
Badly discoloured	9.26	11.05	19.33	9.13	17.37
Small Seed	2.05	1.61	21.46	-	-
Foreign matter	.15	.05	66.66	-	-
Moisture	13.9	15.44	11.08	15.93	3.17
Date sampled	12.10.77	19.11.77		19.11.77	

[a](A total of 12 samples were taken of the same lot of peas from production to retailing).

TABLE 5 Seed Analysis of rejects from cleaning operation at the market.

Category	Percentage
Pure Seed	0
Damaged	3.80
Splits	25.60
Badly discoloured	66.60
Foreign matter	3.80

TABLE 6 Seed Analysis of samples taken at Pomeroon and in Georgetown.

Category	At farmer's house (A)	At Wholesaler Georgetown (B)	Relative % change (A to B)
Pure Seed	68.70	67.75	-1.38
Damaged	18.40	16.70	-9.24
Splits	-	0.30	-
Badly discoloured	7.00	7.65	9.28
Small seed	5.10	4.85	4.90
Foreign matter	0.30	-	-
Moisture content	15.02	17.00	13.18
Date Sampled	22.10.77	5.11.77	14 days

TABLE 7 Results of Seed Analysis from several regions in Guyana.

Category	REGIONS				
	Pomeroon	Essequibo Coast	Corentyne	Parika	Intermediate Savannahs
Pure Seed	60.70	71.40	66.46	69.75	41.47
Damaged	18.40	11.50	20.62	13.35	18.86
Splits	-	7.33	.60	-	15.76
Badly discoloured	7.00	10.40	6.33	14.85	20.13
Small Seed	5.10	-	2.12	1.90	1.89
Foreign matter	3.00	-	.22	0.15	.59
Moisture content	15.20	n.a.	14.29	14.45	14.77

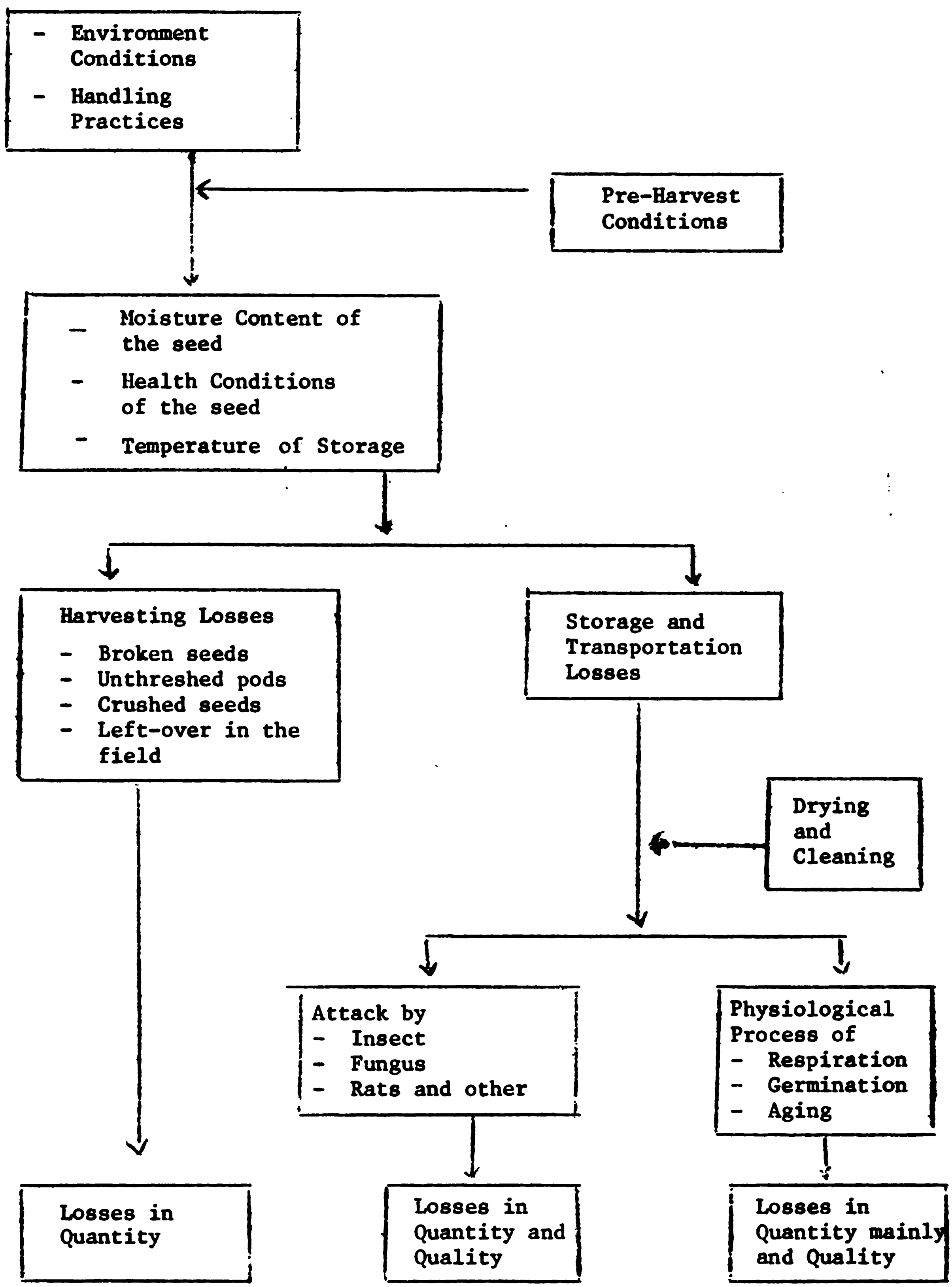
TABLE 8. Seed Analysis of samples taken from wholesalers, retailers and hucksters in Georgetown.

Category	Wholesalers	Hucksters	Retailers	Trend[a]
Pure Seed	65.26	50.25	57.6	-3.83
Damaged	17.99	25.31	27.53	4.77
Splits	2.31	3.42	1.53	-0.39
Badly discoloured	11.05	17.44	9.42	-0.815 6.39[b]
Moisture content	15.44	15.30	15.50	0.03

a Not considering retailers

b Trend considering only wholesalers and hucksters for the badly discoloured category.

FIG. 1 Sequential description of the occurrence of losses in Blackeye Pea.



PROBLEMS IN LARGE SCALE PRODUCTION OF COWPEA IN COASTAL AREAS

C.F. Saraf

Edible legumes or food legumes play a very significant role in the daily diet of human beings. These food legumes,or pulses as they are commonly called, are unique since they provide mineral-and vitamin-rich vegetables,protein grains, nutritious fodder and soil-enriching green manures. Pulses are the cheapest source of proteins for many people who eat little or no meat, eggs or fish. One of the greatest values of legumes lies in their ability to enrich the soil through fixation of free nitrogen from the atmosphere with the aid of root nodule bacteria. Mostly of quick maturity, versatile growth habits, accommodative agro-climatic and soil requirements, the broad spectrum of over a dozen types of pulses belonging to many genera and species like chickpea, pigeon pea, mung, urid, cowpea and lentil form the linchpin of cropping systems either alone or in mixtures with major crops.

Cowpea, belonging to the leguminoseae family, is scientifically known as Vigna unguiculata. In olden days, the varieties under cultivation were of very long duration, low yielding and non-synchronous in maturity. Researchers have now been successful in evolving high yielding, thermo-and photo-insensitive, short duration, compact and bushy plants which are responsive to fertilizers and other inputs.

Before discussing the problems of large scale legume production in coastal areas, it will be worthwhile to know something about the drainage and soils of Guyana, as these are among the main contributors to the problems.

Guyana's four main rivers - the Corentyne, Berbice, Demerara and Essequibo - all flow from the South and empty into the Atlantic Ocean along the eastern section of the coast. Among the tributaries of the Essequibo, the Potaro, Mazaruni and Cuyuni drain the North West and the Rupununi drains the Southern Savannah. The country's rivers are part of the waterhead of the Amazon and Orinoco rivers and the head waters of the Rupununi in Brazil are often confused with those of the Amazon.

Drainage is poor (the gradient is only one foot per mile), there are many swamps and large areas are subject to flooding. The rivers are not very suitable for transportation because they are broken by rapids in the interior and their mouths are blocked by mud and sand bars that may occur two to three miles out at sea.

The coastal soils are fairly fertile but highly acidic. The clays of the coastal plain are composed of alluvium from the Amazon that was deposited by the South equatorial ocean current and from the country's rivers. They overlay white sands and clays and can support intensive agriculture. In Guyana, the per capita land utilisation is not very high. Unfortunately, much of this unutilised land is not easily accessible. The cost of clearing this land, transporting fertilizers and other inputs and distributing food is very high. Furthermore, the optimum management of humid, tropical climates and tropical soils is yet to be perfected for maximising profits. The best course, therefore is to make intensive use of existing cultivable lands.

Blackeye pea can be grown under a wide variety of soil and climatic conditions but one of the most critical factors is drainage. Excellent drainage is essential if cultivation of this legume is to be successful. Clay soils are very fine textured soils which are very difficult to cultivate. The timing of operations is very important and the land should be prepared with a minimum number of operations to obtain the best results. Blackeye peas do best with a rainfall of 25 inches per year and a temperature range between 68°F to 90°F.

It is always advisable to test the soils intended for legume cultivation. Soils analysis would give an idea of the structure of the soil, pH and fertilizer requirements. If the soils are very acidic, limestone would be needed as per recommendations from soil analysis data and this should be mixed in the top 6 inches of the soil three to five weeks before planting. Heavier soils require higher applications of limestone than light soils.

Land preparation for legumes is entirely different from that for sugarcane. It will, therefore, be worthwhile to train operators separately for these two crops.

The choice of variety would depend mainly upon the weather and rainfall pattern. Guyana has two clearcut Wet Seasons - April/May to August is a long wet season and December to February is a short wet season. Thus, for the long wet season, a late maturing variety is required and for short rainy season, an early maturing variety is preferred. At present only one variety (California No. 5) is available in the country and this is an early maturing variety.

Seeds obtained from certified source normally would be treated with a fungicide/insecticide mixture for protection against the soil-borne diseases and pests. If the seeds are obtained from other sources they should be treated with a fungicide/insecticide mixture prior to planting. If the field has not been cultivated previously with blackeye, it will be worthwhile to inoculate the seed with an efficient Rhizobium strain immediately before planting. Inoculated seeds should not be dried in the sun as this destroys the Rhizobium bacteria.

The planting of a cowpea crop always has to be correlated with the weather in any area. Since the crop is normally consumed as a dry seed, it should be planted so that it matures in a dry period. On the basis of the rainfall pattern for the last 70 years, it is suggested that the best times for planting blackeye are December-January in the short rainy season and July in the long rainy season.

Large areas should be planted with tractor mounted ferti-seed drills. The seeds should be sown about one inch deep at a spacing of 24 inches between rows and about six inches between seeds within the row on heavy soils. On light soils, the inter-row spacing could be reduced to 20 inches. The seed rate thus varies between 20 to 25 lb. per acre. Since drainage is poor in coastal areas and legumes do not tolerate excess water for long periods, it is advisable to plant on ridges. This system wou d facilitate irrigation as well as the removal of excess water due to heavy rains during the crop season. A special type of ridge and furrow opener has to be designed for this type of planting.

The result of the soil test would indicate the amount and kind of fertiliser to be applied. The fertilizer should be applied in a band three inches away from the seed and three inches deep at the time of planting. In both heavy and light soils, muriate of potash (100 lb. per acre) should be applied as a second dose 3 to 4 weeks after planting. If the initial soil test shows high available nitrogen there is no need to apply starter nitrogen. Light soils may show some micro-nutrient deficiency and this should be rectified by application of a trace element mixture.

Good drainage, together with proper timing of ploughing and cultivation operations favour good weed control. In addition, immediately after planting, application of planavin (1.5 lb. per acre) is recommended. For weeds emerging at a later stage, grammoxone (1.0 pt. per acre) has been found to be effective but this should be applied with a protective shield.

CONCLUSION

Water management is the most ticklish problem in growing legumes in coastal areas. Planting on ridges on a large scale is recommended to facilitate drainage of excess water and irrigation as and when necessary. Application of irrigation by gravity is the cheapest and quickest method of irrigation. Legumes, in general, do not require many irrigations and only one or two applications may be required. It has been observed that the pre-flowering stage is the most critical from an irrigation point of view.

SEED PRODUCTION

Neville C. McAndrew

INTRODUCTION

In its truest sense the term "seed" defines the structure which develops from an ovule usually after fertilization. Within our sphere of activity, however, this botanical definition will not suffice fully and the term "seed" will be used in its agricultural or horticultural sense, that is, to denote a dry dispersal unit which develops from the ovule or ovary and associated tissues. This definition would encompass not only true seeds but also any fruits, e.g. achenes, caryopses, which consist largely of seed tissue. Seed within our context would mean an embryonic plant in a resting state. A further interpretation of seed can mean "seed" of any cereal, forage, legume, turf, root, vegetable, tobacco, fibre or oil bearing crop grown, sold or represented for sale for the purposes of propagation.

In attempting to discuss seed production it is appropriate at this point to briefly review the importance of seeds in general and the role seeds have played and continue to play in man's perpetual struggle to produce adequate quantities of food.

That seeds were a vital component to his survival was recognised by man at a very early stage and it was only through his eventual collecting, storing and planting seeds of desired plants at locations of his choosing that man was able to shift from nomadic existence to a way of life which signaled the beginning of the present world wide agricultural - industrial economic order.

Over the years seeds have been said to be many things. On one hand they have been called fortresses because they protect and sustain life, while at the other extreme they have been labelled enemies when they are of the unwanted kind and are sources of trouble and frustration. Of all the descriptions however, two most adequately explain what seeds are and what they do.

James Delouche referred to the seed as "One of nature's truly marvelous inventions. An incredible example of miniaturisation, a vital link in the unbroken thread of life".

Victor Boswell wrote "Above all else, they (seeds) are a way of survival of their species. They are a way by which embryonic life can be almost suspended and then revived to new development even years after the parents are dead".

It is because of this direct and indirect dependence on plants for food that Boswell's comments are significant in determining the role seeds play in man's never-ending quest for more and better food. Man's willingness to produce adequate quantities of quality seed of desired crops, to efficiently process these seeds, to store them for extended periods and in such a manner that they retain their viability, and then to later plant and produce successful crops from these seeds, can well be the most important factor that determines the level of success he achieves in his efforts to survive in his environment.

In the not-too-distant past, Governments and other organizations have allocated substantial proportions of their resources in terms of money, personnel and effort to plant breeding. This undoubtedly is as it should have been and this basic step in crop improvement should receive even more emphasis today. However, history has also revealed that in the absence of any organised system of transferring the achievements of breeding programmes to their intended target - the farmers - many varieties have been lost, mixed with inferior varieties or failed to leave the experimental station. Fortunately, it has now been fully recognised by both developed and developing countries that any successful agro - based economy must incorporate a dynamic seed programme to ensure that adequate quantities of good quality seed reach the farmer at the right time and at prices he can readily afford.

Seed is no longer regarded as a by-product of crop production but more as the catalyst, which, in relation to most other inputs, a relatively small quantity is required, but its vital importance to any successful crop production exercise is no longer under-estimated. This revolution in thought has placed the modern seedsman, whether he is engaged in production, processing or marketing, between ambitious breeding programmes developing new and better varieties and discriminating farmers demanding more top quality seeds of improved varieties.

Furthermore, the success of any breeding programme can only be measured in terms of the impact the new varieties make in improving production and productivity on the farm and often the singular factor which limits the level of success is the availability of adequate quantities of good quality seed.

OBJECTIVE

The principal objective of seed production is to ensure that the fruits of the plant breeder's labours - the new and improved varieties - are easily transferred to the farmer in as unaltered a form as is practically possible. To fully achieve this objective a number of essential requirements must be fulfilled. Seed reaching the farmer is expected to have a high degree of varietal (genetic) purity and high germination potential: it must be free of noxious or objectionable weed seeds, other crop seeds, seed borne diseases and inert matter. Compared to producing a commercial crop, seed production requires a higher level of care and control if varietal purity is to be maintained.

SEED CERTIFICATION

The Association of Official Seed Certifying Agency (AOSCA) has provided the minimum standards for the production of seed of the certified classes. The Pedigree System functions in maintaining the genetic purity and identity of seeds-factors of paramount importance and such characteristics as yield, quality, disease resistance and morphological features are involved.

Most annuals, including the grain legumes, are usually Pedigreed through the classes Breeder, Select, Foundation, Registered and Certified, according to the AOSCA certification programme.

By definition Breeder seed is seed directly controlled by the originating or sponsoring plant breeding institution, firm, or individual and is the source for the production of seed of certified classes.

Select seed is unique to the Canadian Certifying Scheme. It is the approved progeny of Breeder or Select Seed produced in a manner to ensure its specific genetic purity. Select seed is not a seed of commerce.

Foundation seed is the progeny of Breeder, Select or Foundation seed handled to maintain genetic purity and identity. Production must be acceptable to the certifying agency.

Registered seed is the progeny of Breeder, Select, Foundation or Registered seed so handled as to maintain satisfactory genetic purity and identity and must be acceptable to the certifying agency.

Of these classes Certified Seed - the terminal pedigreed class - is the seed that is widely sold for general farm use. Each class within the Pedigree System allows for a maximum level of contaminants either in the form of off-types, diseased seeds or objectionable weeds (see Annex I) and at the same time it stipulates the number of generations seed from any class can be multiplied before being relegated to the next class. The system incorporates vigilant inspection of seed plots at one or more times during the growing period of the crop to ascertain whether all possible precautions have been taken to remove sources of contamination.

The Organization for Economic Cooperation and Development (OECD) has also developed a certification scheme. This scheme recognises two categories, basic seed and certified seed of the first and successive generations. In this scheme the number of generations from parental material to basic seed is strictly limited. The plant breeder together with the certifying agency must decide on the maximum number of generations of certified seed that are to be produced from basic seed after considering such technical aspects as self-pollination and cross-pollination of the crops.

Uniformity in seed certification also facilitates international trade in seed providing there is reciprocal recognition of certified classes and implementation of the control measures that have been instituted.

VARIETAL (GENETIC) PURITY

It is necessary to emphasise that maximum effort should be exerted to avoid or to minimise contamination of seed lots. Rogues, which are undesirable plants in a seed plot, are of several types. Perhaps the simplest rogue to recognise is a corn plant in a field of blackeye peas, however, less identifiable types arise from genetic changes within the variety (mutation or chromosone aberration) or from inter-crossing. Rogues can also be the product of mechanical mixtures with other varieties, other crops or weeds that are difficult to separate, and such mixtures can occur in any one of the many stages in the production of seeds. Diseased plants and weeds, while in fact they are not true off-types, should be removed whenever feasible.

Roguing is the act of removing by hand all undesirables from seed plots and any questionable plant should be rogued to ensure that the seed produced is of the highest quality.

FACTORS INFLUENCING SEED QUALITY

Perhaps the most obvious characteristic is that they must possess the ability to germinate i.e. seeds must be viable. Any seed lot must exhibit a high germination potential. Other desirable characteristics include the ability of the seeds to produce healthy vigorous seedlings. While a high germination potential alone does not give a complete picture of seed quality, it is often the only indicator that is available to determine whether a particular seed lot is good or bad.

The problems generally associated with poor quality seed were once though to have their origin somewhere in the storage cycle and it was felt that a good storage environment would be the solution. The concept has now been broadened to include not only the storage cycle but also the pre-storage history of seed lots as it is recognised that the best storage conditions have never improved seed quality. Seeds that are taken out of storage are never of a higher quality than when they were put into storage. In fact, the quality is always lower, for the deteriorative processes in seed are inexorable. In order to obtain good quality seed after storage it is essential that one must commence with top quality seed material and this initial quality is determined to a large extent by conditions which prevail during the pre-storage cycle. Events which occur during the post-maturation pre-harvest period can predispose seed to rapid rates of deterioration during storage life.

It is sufficient to remember that seed achieves functional and physiological maturity at the time of maximum dry weight accumulation and this occurs at a moisture content too high for mechanical harvesting and for proper storage. After maturity there follows a period of weight loss during which the plant loses water as it dries off in the field until it is harvested. Delays in harvesting mean that seeds are in effect being stored in the field and field conditions are seldom, if ever ideal for proper storage.

Untimely harvesting and the improper use and adjustment of harvestng equipment are detrimental to seed quality. Mechanical damage of one form or another frequently result when seed is harvested at moisture contents that are either too high or too low. Damage of this type can have three possible effects as follows:

- Direct effects that result from impact and abrasions and which immediately render the seeds incapable of germination

- Latent effects where it seems that deterioration is initiated at the sites of mechanical fractures and bruises and later show up in poor keeping quality.

- Indirect effects where ruptures in the fruit coat or seed coat play an important role in the incidence and severity of certain seed rotting organisms and susceptability to damage by seed treatment chemicals and fumigation.

Unfavourable weather conditions, characterised by periods of high temperatures and high relative humidity can and often do adversely effect seed quality during this post-maturation pre-harvest cycle. At the same time prolonged periods of hot dry weather during maturity can cause a reduction in seed size. One way of minimising these risks especially in cases where irrigation is unavailable, is to plant at the right time in order to utilise the full growing season and to ensure that harvesting is done during the drier months of the year.

Pests and diseases also affect seed quality and this can only be minimised by proper crop husbandry practices.

Severe weed infestation, in addition to giving a field an unsightly appearance, often creates an undesirable microclimate which can delay crop maturity and usually result in harvesting problems especially if harvesting is mechanically done.

It is clear that seed production requires higher levels of crop husbandry and higher levels of farmer awareness and education. It is an essential component of any crop production programme and is expected to develop simultaneously with any plant breeding and varietal selection programme. The seed producer, like his counterpart in processing and marketing, must be aware of his responsibilities and be willing to accept the challenge.

PRESENT SITUATION IN GUYANA

The question of local production of seed of food legume crops still needs to be resolved. We are all aware that Guyana in her present financial situation, cannot afford the foreign exchange needed to continually import substantial quantities of seed that can be domestically produced. The Ministry of Agriculture on its Research and Demonstration Stations has attempted in the past and continues in its efforts to produce seed to satisfy local demands. These efforts have met with limited and varying levels of success. However, in considering the current drive to increase production of all food crops, especially the food legumes, it is clear that these modest measures would be unable to satisfy local needs.

Attempts at involving the large state agencies in food legume seed production have met with failure in most cases, for one reason or another. An outstanding and most encouraging exception in this respect is the Guyana Rice Board which has in these past few years produced substantial quantities of blackeye seed of good quality.

PROPOSAL

As an interim measure, my proposals to implement a seed production programme for the food legumes are as follows:

1. That the production of Breeder and Basic seed be the responsibility of the Ministry of Agriculture. Production would be supervised by the Specialist Officer responsible for legumes. These production plots can be located on research stations and demonstration farms. The seed crops are to be carefully inspected and rogued to ensure the highest level of genetic purity and freedom from seed-borne diseases. For ease of handling, it is suggested that no single plot of Breeder Seed should exceed 0.25 ac. and those of Basic Seed 0.5 ac.

2. That the Guyana Rice Board and the Guyana Sugar Corporation (Other Crops Division) produce Basic Seed on plots of 1 to 5 acres from seed supplied by the Ministry of Agriculture. This proposal is dependent on the Plant Breeder or Specialist Officer (Legumes) providing detailed descriptions of the characteristics of each variety.

3. That major agencies, especially the Guyana National Service and the Caricom Corn and Soyabean Company, which are both highly mechanised, produce Certified Seed (first and second generations), the acreage to be determined from projected seed demands.

4. That the Seed Processing Unit of the Ministry of Agriculture act as the Certifying Agency.

5. That the Ministry of Agriculture purchase seed from these producers at a mutually agreed price. This seed material to be processed and stored by the Ministry for subsequent sale and/or distribution to farmers and farming organisations.

The proposals are straight forward and are intended to minimise problems associated with seed availability. No doubt a seed production programme will achieve the successes envisaged only if reliable forecasts of seed requirements are available to permit the formulation of concrete and workable seed production plans. With the existing guidelines on how to produce seed of food legume crops and with timely forecasts of seed demands I am confident that by working together and with the right approach this challenge would pose no serious problems.

ANNEX I

MINIMUM SEED CERTIFICATION REQUIREMENTS.

(a) Field and Garden Bean

'. APPLICATION AND AMPLIFICATION OF GENERAL CERTIFICATION STANDARDS

The General Seed Certification Standards, as adopted by the International Crop Improvement Association, are basic and together with the following specific standards constitute the standards for certification of field and garden bean seed.

II. LAND REQUIREMENTS

A field must be free from volunteer bean plants unless the volunteer plants are of the same variety and of equal or higher seed class than that planted.

III. FIELD INSPECTION

Seed fields shall be inspected for off-type and diseased plants at least once prior to harvest.

IV. FIELD STANDARDS

A. General

1. Unit of certification: The unit of certification shall be a field separated from the remainder by a definite boundary, at least 10 feet wide, not planted in beans.

2. Management: Poor stands, poor vigor, lack of uniformity, excess weeds or conditions which are apt to make inspection inaccurate or bring certified seed into disfavor shall be cause for rejection.

B. Specific Requirements

Factor	Maximum permitted in each class		
	Foundation	Certified	Registered
Other varieties	None	0.10%	0.05%
Other Crops (inseparable)	None	0.10%	0.05%
Bacterial bean blights & wilt ..	1.0%	2.0%	1.0%
Mosaic (Seed-borne)............	0.0%	1.0%	0.5%
Anthracnose	0.0%	1.0%	0.5%
Total seed-borne disease	1.0%	3.0%	1.5%

V. SEED STANDARDS

Factor	Standard for each class		
	Foundation	Certified	Registered
Pure Seed	95.0%	98.0%	98.0%
* Inert Matter (maximum)	N.S.	2.0%	2.0%
Foreign material (maximum)	N.S.	0.50%	0.50%
* Splits and cracks (maximum)...	N.S.	1.0%	1.0%
* Other Factors - Such as colour Badly discoloured (maximum)	N.S.	1.0%	1.0%
* Weed Seeds (maximum)	N.S.	0.10%	None
* Other Crop Seeds	None	0.20%	1.10%
Other Crops (maximum)	None	0.10%	0.05%
Other Varieties (maximum) ..	None	0.10%	0.05%
Germination (minimum)	N.S.	85.0%	85.0%

* The total of inert matter (including foreign material), splits and cracks, badly discoloured, other crops, other varieties, and weed seed alone or in combination shall not exceed 2% except in N.S. - No Standard.

(b) Mung Bean

1. APPLICATION AND AMPLIFICATION OF GENERAL CERTIFICATION STANDARDS

The General Seed Certification Standards, as adopted by the International Crop Improvement Association, are basic and together with the following specific standards constitute the standards for the certification of Mung Beans.

II. LAND REQUIREMENTS

The land shall not have produced Mung beans, other than certified seed of the same variety, the previous year.

III. FIELD INSPECTION

Seed fields shall be inspected at least once prior to harvest, preferably after pods are well developed.

IV. FIELD STANDARDS

A. General

1. Unit of certification: The unit of certification shall be a field or a portion of a field separated from the remainder by a definite boundary, at least 10 feet wide, not planted in Mung beans.

2. Management: Poor stands, lack of vigor, evidence of poor cultural care, lack of uniformity or conditions which are apt to make inspection inaccurate or bring certified seed into disfavor shall be cause for rejection.

B. Specific Requirements

Factor	Maximum permitted in each class		
	Foundation	Certified	Registered
Other varieties	None	0.1%	.01%
Other crops (inseparable)	None	0.1%	.01%
Disease (total)	1.0%	5.0%	2.0%
Bacterial blight (pod infection)	1.0%	5.0%	2.0%
Mosaic (common)	0.5%	2.0%	1.0%
Anthracnose	0.3%	1.0%	0.5%

V. SEED STANDARDS

Factor	Standards for each class		
	Foundation	Certified	Registered
Pure Seed	95.0%	98.0%	98.0%
Inert Matter (maximum)	5.0%	2.0%	2.0%
Total Weed Seeds (maximum)	None	0.10%	0.05%
*Objectionable (maximum)	None	None	None
Other Crop Seeds	None	0.20%	0.10%
Other Crops (maximum)	N.S.	0.10%	0.05%
Other Varieties (maximum) ...	None	0.10%	0.05%
Germination (mimimum)	N.S.	85.0%	85.0%

* Objectionable weeds as shall be designated by the certifying agency.

N.S.: No Standard.

ANNEX II

SEMINAR ON LARGESCALE PRODUCTION OF LEGUMES

Date: January 25 and 26, 1979

Venue Ogle Training Centre

Sponsors : Ministry of Agriculture, Guyana
and
The Inter-American Institute of Agricultural Sciences.

PARTICIPANTS

1. REPRESENTATIVES FROM PRODUCTION AGENCIES:

- Guysuco
- Guyana National Service
- Guyana Rice Board
- Guyana Defence Force
- Guymine
- Police
- CARICOM Corn/Soya Company

2. STAFF OF THE MINISTRY OF AGRICULTURE:

Agri. Officer (Legumes)	J. Ross
Agri. Officer (Weed Control)	N. Robertson
Agri. Officer (Soil Fertility)	M. Forrester
Agri. Officer (Communications)	C. Roberts
Agri. Officer (Entomology)	K. Croal
Agronomist (Seed Processing)	N. McAndrew
Senior Microbiologist	H. Persaud
Sr. Agri. Officer (Training)	W. Matadial
Coordinator (Special Projects)	L. Amsterdam
Plant Pathologist	F. MacDonald

3. STAFF OF IICA:

Agricultural Engineer	P.F. Robinson
Agricultural Production Specialist	R.E. Pierre
Specialist in Agricultural Investigation Adviser to Director of Regional Coordinator	A.M. Pinchinat
Director - Office in Guyana	H.R. Barreyro

ANNEX III

PROGRAMME

Thursday, January 25, 1979

CHAIRMAN: L. Amsterdam

8.30 - 8.40	-	INTRODUCTORY REMARKS BY CHAIRMAN
8.40 - 9.00	-	OPENING ADDRESS - Hon. Minister of Agriculture
9.00 - 9.30	-	PRE-EVALUATION SESSION - W. Matadial
9.30 - 9.45	-	COFFEE BREAK
9.45 - 10.30	-	ROLE OF LEGUMES IN CARIBBEAN FARMING SYSTEMS - A.M. Pinchinat
10.30 - 11.15	-	FOOD LEGUME PRODUCTION - GENERAL ASPECTS. - R.E. PIERRE
11.15 - 12.00	-	SITE SELECTION, LAND PREPARATION AND FIELD LAYOUT - P.F. Robinson
12.00 - 13.30	-	LUNCH

CROP PRODUCTION (COWPEA)

13.30 - 14.00	-	VARIETY SELECTION AND PLANTING - J. Ross
14.00 - 14.30	-	INOCUCUM AND INOCULUM - H. Persaud
14.30 - 15.15	-	SOIL CONDITIONS AND FERTILIZER REQUIREMENTS . M. Forrester
15.15 - 15.30	-	COFFEE BREAK

CROP PRODUCTION (COWPEA)

15.30 - 16.00	-	WEED CONTROL - N. Robertson
16.00 - 16.30	-	PESTS AND THEIR CONTROL - K. Croal
16.30 - 17.00	-	DISEASE AND THEIR CONTROL - F. McDonald

Friday, January 26, 1979

CHAIRMAN: A.M. Pinchinat

8.30 - 9.15	-	COMBINE HARVESTING - P.F. Robinson
9.15 - 10.00	-	DRYING AND PROCESSING - N. McAndrew
10.00 - 10.15	-	COFFEE BREAK
10.15 - 12.00	-	FIELD TRIP TO L.B.I. ESTATE - L. Amsterdam
12.00 - 13.30	-	LUNCH
13.30 - 14.00	-	STORAGE - N. McAndrew
14.00 - 14.45	-	MARKETING AND POST-HARVEST LOSSES - H. Barreyro
14.45 - 15.45	-	PROBLEMS IN LARGESCALE PRODUCTION OF COWPEA - C.F. Saraf and PANEL (L. Amsterdam, A. Pinchinat, P. Robinson, R. Pierre)
15.45 - 16.00	-	COFFEE BREAK
16.00 - 16.30	-	SEED PRODUCTION - N. McAndrew
16.30 - 17.15	-	DISCUSSION
17.15 - 17.30	-	POST-EVALUATION - W. Matadial
17.30 - 17.40	-	CLOSING REMARKS - H. Barreyro