12. PRODUCTION OF SOME FOOD LEGUMES IN CEYLON

G. W. E. FERNANDO*

Introduction

Ceylon's economy is founded on agricultural production with rice as the pre-eminent food crop and the basis for a large part of village agriculture. The plantation crops, tea, rubber and coconuts provide the main overseas funds on which depend the imports of great variety of manufactured products and of additional rice and other food stuffs including pulses.

Recent surveys and investigations carried out by food scientists show that the lack of proteins in sufficient levels in the diet of man in countries particularly in the South East Asia region has given rise to protein malnutrition. This condition is associated with mental retardation, a lower capacity for physical work and lethargy and is largely due to the lack of certain essential amino acids such as lysine and methionine. These essential amino acids are found in proteins of both plant and animal origin.

The annual per capita consumption of milk, meat and eggs in Ceylon is as follows:

Milk	45.6 lbs.	(2 oz. per day)
Meat	7.4 "	
Eggs	2.05 "	(22 eggs)

These consumption rates are extremely low by Western standards where an average person consumes 20 ozs. of milk per day, 250 eggs and 152 lbs. of meat annually. The Medical Research Institute of Ceylon recommends that an average Ceylonese needs to consume at least 5.49 oz. of milk per day to meet the nutritional requirements. This would mean that our present production levels need to be increased by over 300 percent, if this standard is to be reached and it will take many years before this can be achieved. Hence there is no doubt that a great need exists to increase protein consumption by non-conventional methods.

Pulses form an important constituent of the daily diet. A large variety of pulses such as lentils, green gram, black gram, cowpea, toor dhal, horse gram and peas are consumed in the country. A study of the per capita availability of pulses in the country reveals that their average consumption over the 12 year period, 1956–67 was 6.83 kg per annum. This availability is only about half of the per capita nutritional requirements of 12.77 kg per annum (or 35 gram per day).

In many countries of the world, the enhancement of the quality of food through a shift to the plant—animal—manfood chain would not be easy in view of the scarcity of grains and rapidity of growth of the population. The animal food chain is too expensive in terms of energy conversion and it is here that there is an urgent need to develop varieties of grain legumes which are high in the content of essential amino acids.

Import Substitution in Pulse Crops

Import of pulses at relatively cheap prices has been the main obstacle to extensive cultivation. The quantity and value of pulses imported to Ceylon for the period 1963–70 are shown in Table 1. A perusal of the pattern of imports and consumption of pulses

* Director, Agricultural Research Station, Maha-Illuppallama, Sri Lanka.

Table 1. Quantity and Value of Pulses Imported From 1963—1970 (Quantity in thousands of cwts & Value in Millions of Rs)

Year	Lentils		Chick peas		Toor dhal		Green gram		Edible peas		Black gram		Other pulses		Beans Edible dry		Total imports	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1963	291.4	7.8	173.7	4.9	367.0	12.5	123.4	4.8	100.2	3.4	117.5	5.8	0.2	0.006	—	—	1173	39
1964	380.1	9.2	370.9	9.6	199.4	8.1	200.9	6.7	141.8	3.8	52.2	2.2	392.9	10.9	0.2	0.03	1738	51
1965	165.7	4.0	146.2	4.7	174.0	10.1	226.9	7.5	137.2	3.4	116.9	4.9	172.2	4.5	0.1	0.009	1139	39
1966	461.2	16.3	195.5	6.2	316.4	11.9	233.7	7.4	140.3	4.2	113.8	4.3	352.1	14.3	0.9	0.1	1814	65
1967	218.5	7.5	293.3	10.0	133.6	4.9	213.6	7.5	103.9	3.2	131.2	3.9	295.3	14.3	8.4	1.05	1398	52
1968	503.2	27.3	318.1	12.2	13.8	0.5	119.6	5.5	116.4	3.5	87.6	3.7	58.5	3.6	1.2	0.03	1218	56
1969																	1736	78
1970																	1394	63
Average	336	12	250	8	201	8	186	7	123	4	103	4	212	8	2	0.2	1451	55

shows that lentils (*Lens esculenta*) alone constitute 45 percent of all pulses consumed in the country. Owing to its high palatability and good cooking qualities, lentil is a popular item of food in the daily diet of all classes of people in Ceylon. Although lentils have been tried in several agro-climatic zones of the island, it has not been possible to promote the cultivation of this crop on a commercial scale due to poor yields. Of the several varieties tested at Agricultural Research Station, Rahangala, only NP—11, an introduction from India performed well but the yields of NP—11 were in the region of 250 lbs per acre.

With the exception of lentils and bengal gram, many of the traditional pulse crops such as green gram, black gram, horse gram, toor dhal and cowpeas can be cultivated successfully in Ceylon. Work at Agricultural Research Station, Maha-Illuppallama has shown that toor dhal, and a variety of cowpeas known as Arlington can be used as direct substitutes for lentils. The question therefore is to formulate a policy which will encourage.

1. The development of those pulses which have been traditionally grown in the country.
2. The development of suitable substitutes which can be grown to replace lentils and chick pea.

In order to implement the programme of import substitution in pulse crops and to create an incentive to the producer, the present policy of the government is to raise the guaranteed price, ban the import of some items and probably restrict the import of others. According to the five year plan, the projected demand of pulses in 1976 is around 1,914,000 cwts. and the production target as set out in plan is 265,000 cwts. On the basis of demand therefore, an extent of about 180,000 acres is needed to achieve self-sufficiency in pulses.

Areas of Production

The greatest potential for the cultivation of pulse crops lies in the dry zone of Ceylon. The dry zone covers an area of approximately two thirds of Ceylon and the annual precipitation varies from 50"–75", but about three fourths of this amount is experienced during a period of about four months i.e. from October to January. There is consequently a long hot and dry period when atmospheric and soil moisture conditions are not unlike those obtaining in typical dry farming areas of tropical and semi-tropical countries.

There are two main cultivation seasons (1) Maha Season (October to February) which coincides with the period of the North East Monsoon and (2) Yala Season (March–September) which corresponds to the period of South West monsoon. During the Maha Season the rainfall distribution is reilable and it is the main growing season for a greater part of the dry zone. The rainfall distribution in Yala is erratic and unreliable and crops can be grown successfully only under irrigation.

The traditional method of cultivating land in the dry zone of the island is that of shifting cultivation, known locally as the 'chena' system. Most of the pulse crops such as ground nuts, green gram, toor dhal, black gram, horse gram and cow pea are therefore grown alone or in mixture with other crops such as maize, mustard and kurakkan in the chenas of Ceylon during the Maha Season.

Pulses

The pulses include species belonging to the family Leguminosae which are cultivated for their edible seeds. Because they are high in protein, the pulses provide a major source of protein in the diet of the rural population. In the five year plan (1972–1976) priority has been given to the cultivation of some pulse crops since a high potential for grown exists in this hitherto neglected field.

Table 2 gives the anticipated increase in the production of some pulse crops during the plan period:

Table 2. Production of Pulses (1,000 Cwts.)

	Production in 1970	Projected demand 1976	Production target 1976
Pulses	50.7	1,814	265
Green gram	38.7	—	200
Black gram	—	—	10
Cowpeas	12.0		55
Oil crops	—	—	—
Soyabean	—	—	63
Ground nuts	137	—	268

The important pulse crops that are grown in Ceylon are:

1. Green gram
2. Toor dhal
3. Cow peas
4. Black gram
5. Ground nuts
6. Soybeans

The main objectives in breeding pulses are:

1. Yield
2. Early & uniform maturity
3. Plant type
4. Shattering resistance
5. Disease and insect resistance
6. Quality
7. Direct substitutes for lentils

Green Gram (Phaseon aureus)

Green gram is the most popular pulse crop that is grown in Ceylon. It is traditionally grown in chenas, mixed, often with cereals like kurakkan (*Elusine coracana*) and maize (*Zea mays*). The current yields of green gram under field scale do not exceed 5 cwts per acre and consequently to meet the current demand of 233 thousands cwts, the total area required for this crop would be approximately 47,000 acres. It should however be emphasized that this yield is achieved under poor management conditions practiced in chena cultivation. If the crop is cultivated under settled and irrigated conditions the yields would be substantially greater as indicated in Table 3.

The varieties S_{12}, R.S_4 and S_{16} introduced from India and V.C 14 from Philippines gave higher yields over the recommended variety for two successive seasons.

The varieties recommended by Department of Agriculture are MI-1 and MI-2, and the demand for these varieties has been increasing. However, as seen from Table 2 several recent introductions from India have shown promise.

Greengram pods at the tender stage is used as a vegetable. The seed either whole or split is used as a breakfast food, sweet meats and in curries.

Toor Dhal (Cajanus cajan)

Toor dhal is the second major import item in the pulse group. Toor dhal can be easily established with the early October showers during the Maha season and the crop may be harvested in January or early February. Our investigations reveal, that in

Table 3. Varietal Trial on Green Gram

Varieties	Maha 1971/72 under rainfed lbs/acre	Yala 1971 under irrigation lbs/acr
1. 214062 sel (1)	907.0	1311
2. Green Mung p_{20} sel (1)	1005.5	1097
3. Green Mung p_8 sel (1)	1096.9	1160
4. Green Mund p_{13} sel (2)	971.5	1374
5. 222711 sel (2)	843.0	1374
6. 213012 sel (3)	794.0	971
7. Mungo C ES 14	956.0	1349
8. V.C. 14	1236.0	1487
9. MI-1 (control)	843.0	1298
10. Type 51	707.0	1059
11. MI-2	918.5	1122
12. S_{16}	1096.0	1941
13. S_{12}	1323.0	1752
14. $R.S_4$	1274.0	1790

addition, two ratoon crops are possible from the same crop. The varieties T_{64} and T_{85} have been recommended by the Department of Agriculture from a long time ago but they never became popular with the cultivators and is barely grown at present in the country. The recommended varieties T_{64} and T_{85} grow to a height of over 10 feet, and effective spraying of insecticides for the control of pod borers is not possible. The main limiting factor in extending the cultivation of this crop has been the occurrence of severe pod borer damage caused by a number of insect species. The major insect pests are:

1. *Heliothis armigera* (Hb)
2. *Maruca testulalis* (Gover.)
3. *Lampides boeticus* (L.)
4. *Sphenarches caffer* (Zell.)
5. *Melanagromyza obtusa* (Mollock)

The Agricultural Research Station at Maha-Illuppallama has now bred a dwarf variety of toor dhal which rarely attains a height of 4 feet. The dwarf dhal variety is a cross between varieties $T_{64} \times$ Trinidad. This new dwarf strain can be described as the "wonder crop of the dry zone". The outstanding characteristics of the dwarf variety are:–

1. It is an ideal crop to be grown in chenas of the dry zone under rainfed conditions
2. It is very highly drought resistant and can withstand long periods of drought.
3. The crop can be ratooned at least twice, so that it is possible to obtain 3 harvests from the same crop.
4. The dwarf habit of the plant permits effective and easy spraying for the control of pod borers.

Several insecticides were screened at Agricultural Research Station, Maha-Illuppallama for the control of pod borers and Table 4 gives the results of some of the promising insecticides used.

Azodrin and Thiodan at 1 lb a.i. per acre appeared to be effective in the control of these pests. Three applications of either insecticide at fortnightly intervals commencing from flowering have therefore been recommended.

Table 4. Insecticidal Control of Dhal Pest Complex

Insecticides	Active Ingredient per acre	Yield lbs/acre	Percent Increase of Yield over control
1. Azodrin 60E.C.	1 lb.	3,206	74.46
2. Thiodan 35E.C.	1 lb.	2,821	53.51
3. Furadan 75W.P.	2 lbs.	2,722	48.12
4. Lannate 90W.P.	1 lb.	2,545	38.47
5. Control	—	1,838	—

The new strain has been released to the extension service last year and it has been readily accepted by the cultivators. In 17 demonstration plots in cultivators fields, yields ranging from 1,000 to 1,500 lbs acre have been recorded from the first harvest.

Toor dhal can be a direct substitute for lentils and is widely consumed as a pulse crop throughout the island.

Cowpea (Vigna catiang)

Cowpea is an important leguminous crop which is grown for two purposes. It is widely used in Ceylon as a grain crop and a vegetable crop.

Of the two departmental selections, Bombay cowpea and Arlington cowpea which are used as grain crops, the latter has outstripped the former in popularity despite its lower yields. The variety Arlington has many of the desirable qualities of lentils and therefore it has been recommended as a direct substitute for lentils. In 1969 the acreage under variety Arlington was 2,548 acres as against 1,512 acres of Bombay. Hybridization work is in progress to obtain high yielding and uniform maturing types. Some of the resulting progenies have given yields superior to those of the parents. The cooking and splitting qualities of these hybrids are being investigated. Cowpea varieties which were grown in the Yala season under irrigation have yielded over 2,000–2,500 lbs, per acre as compared to yields of 600–1,000 lbs under rainfed conditions in Maha.

A large number of vegetable varieties is grown throughout the island for the green pods which are relished as a vegetable.

Ground Nuts (Archis hypogea)

During the past few years the groundnut acreage has increased sharply. The extent cultivated increased from 8,880 acres in 1967–68 to 11,490 acres in 1968–69. Of the 1968–69 acreage approximately 9,340 were grown during the Maha Season and 2,101 acres in the Yala.

The groundnut may be broadly divided into 2 plants types, erect and spreading. The erect types are grown in irrigated tracts while the spreading types are grown in rainfed areas. The variety cultivated in most of the rainfed areas continues to be the local 4–4½ varieties.

Improvements in yields have been made through selection and several varieties have been recommended for cultivation. These include A_{20}, A_{92}, Uganda erect and Red Spanish. Recent investigations indicate that several new varieties have shown promise. The results are shown in Table 5. The results also indicate that the yields of groundnut can be raised by 100 percent when the crop is grown under irrigation.

The entire production of groundnuts is now utilized for direct human consumption. They are consumed either as whole nuts or whole nut products such as peanut butter.

Soybean (Glycine max)

Very little attention has been given to the cultivation and utilization of soybean as a pulse crop even though it is widely used as a food crop in China, Japan, Taiwan and other adjacent countries. Although soybean cultivated on an experimental scale for a

Table 5. Results of Varietal Trial on Ground Nuts

Variety	Yield in lbs/acre.	
	Maha 1971/72 under rainfed conditions	Yala 1971 under irrigation
1. Daiwal	1,652	4,114
2. A_{20}	1,499	3,647
3. Red Spanish	1,555	2,697
4. Uganda Erect	1,555	3,613
5. No. 23	1,652	4,183
6. A_{92}	1,426	3,682
7. V-53-Tatu	1,296	3,820
8. Big Japan	1,436	4,114
9. MI-1	1,944	4,391
10. South China variety	1,662	4,529
11. I.C 9808	1,134	3,060
12. MI-3	1,523	4,460
13. S-A-A-6	1,652	3,820
14. Ground nut	1,545	4,062
15. Valencia 247	1,523	3,993

sufficiently long time in Ceylon, it did not gain popularity as a crop for a number of reasons.

1. Non-availability of varieties which are adapted to tropical areas.
2. Lack of technological research in developing the industrial utilization of soybean as an oil crop.
3. Preference for other pulses to the soybean as a proteinaceous crop.
4. Lack of marketing faciilties and price incentives. It is only during the last three years that soybean has assumed some importance in the cropping patterns of the Department of Agriculture.

Considering the renewed interest and lack of suitable information regarding promising varieties and optimum agronomic practices, a programme was initiated at the Agricultural Research Station, Maha-Illuppallama in 1967, where over a 100 varieties were screened for their productivity. The yields of some of the promising soybean varieties are shown in Table 6.

The recommended soybean varieties are Hernon, Taichung E 26 and E32, TK No. 5

Table 6. Yield of Soyabean (lb. per acre) under rainfed and irrigated conditions

Variety	1966/67 Maha rainfed	1968 Yala irrigated	1968/69 Maha rainfed	1969 Yala irrigated	1969/70 Maha rainfed	1970 Yala irrigated
Glycine rugget	1,716	2,242	1,796	3,432	1,986	3,542
Taichung E26	—	1,886	1,570	2,840	1,824	2,288
Taichung E32	—	1,890	1,512	2,782	1,924	2,494
Tainung(R) 1	—	—	1,392	2,766	—	2,700
TK No. 5	—	—	—	2,768	2,222	2,741
Black Manchurian	—	2,358	1,720	3,316	2,200	3,631
Hernon	1,560	2,292	—	2,766	—	—

and Tainung (R) 1. Hernon is a cream seeded 4 to 4½ months variety which is suitable for cultivation during the Maha season in the Bibile and Moneragala tracts where the rainfall pattern is unsuitable for the growth of short-age varieties. Short age varieties are recommended only under irrigation in Yala for such districts. Taichung E 26 and E 32, TK No. 5 and Tainung (R) 1 are cream seeded 80 to 90 day varieties which are suitable for cultivation during Maha and Yala in all parts of the dry zone. Yields of over 1,500 lbs per acre under rainfed and 2,500 lbs per acre under irrigation have been obtained. These yields are comparable with those obtained in major growing areas of the world.

Ceylon imported Rs. 70 million worth of milk produtcs last year and the present 5 year plan (1972–1976) hopes to achieve self-sufficiency in milk products while meeting the demand for liquid milk at current levels of per capita consumption. One of the primary requirements for any successful animal husbandry programme is the availability of high quality feed. Ceylon imports a large quantity of fish meal as a protein supplement for live stock. It is felt however, that soybean cake left after the extraction of oil can completely substitute fish meal when fortified with the addition of some amino-acids like methionine. According to the five year plan, the animal feed industry will need 4,600 tons of fish meal in 1972 and this will increase up to 6,500 tons in 1976. In terms of soybean, the quantities needed are approximately 6,000 tons in 1972, increasing up to 8,600 tons in 1976. On this basis, the acreage needed under soybean will vary from 12,000 acres in 1972 to 17,000 acres in 1976 to meet the requirements of the animal industry. The oil left atfer the extraction of cake will fine its way as raw material to industry. In addition to these uses, a special effort will be made to popularize the crop for edible purposes such as weaning foods, soya flour and soya milk during the plan period.

Black gram (Phaseolus mungo)

Black gram is not so popular as green gram and the acreage under this crop is estimated to be less than 500 acres. Almost all the requirements of black gram are therefore imported from India. The recommended variety is MI-1 and results from yield trials indicate that it is consistently superior to other varieties as shown in

Table 7. Varietal Trial on black gram

	lbs/acre	
	Maha 1971/72 under rainfed conditions	Yala 1971 under irrigation
1. MI-1	1,371	2,773
2. Wooly Purol	1,191	2,634
3. Uffari 14	1,361	2,659
4. Gualier 2	1,352	2,130
5. Tabbowa	1,096	2,546
6. Gualier 18	1,333	2,559
7. 5499	1,267	2,357
8. Uffari 16	1,219	2,609
9. Type 9	1,286	2,029
10. Sindhakeda 1-1	1,219	2,080
11. No. 1766	1,248	2,710
12. Urid 55	1,286	2,357
13. BR-1	1,153	2,231
14. Mash 35-5	983	1,878

Table 7.

Black gram is a valued pulse which enters into several food preparations in Ceylon.

More research work is needed for conclusive experimental evidence concerning the best management practices for high yields of individual pulse crops grown in different agroclimatic zones under rainfed & irrigated conditions. A concerted and comprehensive research programme on these crops is currently in hand at the Agricultural Research Station, Maha-Illuppallama Ceylon.

Discussion

J. Fukui, Japan: There are many kinds of well-known oil plants in Ceylon. For example, oil palm. So I think that it is better to use soybean as a protein producing plant than to use it as oil plant. What do you think on this point?

Answer: We are not interested in soybean as a oil crop. At the moment, we are interested in the soybean meal which can be a substitute for fish meal. Soybean oil is a by-product in the process. We hope to promote soybean for other edible uses in the future.

P. P. Kurien, India: (1) Is it not possible to develop varieties of lentils suitable for Ceylon's climate, rather than substitute with other grain legumes and change food habits? (2) In what from soybean is consumed in Sri Lanka? (3) Have you got any legume processing mills in Sri Lanka to process grain legumes to dhal?

Answer: (1) Several lentils varieties have been introduced to Sri Lanka, but only ND-11 has done well. But the yields in the region are of about 250 lb/acre, therefore it is not economic. (2) Soybean is not consumed to any appreciable extent in Sri Lanka. (3) We do not have a machine to process the dhal. On a small scale, a grinding stone is used to process the dhal in rural areas. Our designs center is developing a processing machine but in the meantime we have called for quotations from India to purchase a machine.

R. Ito, Japan: A dwarf variety of toor dhal bred out at Maha-Illuppallama is said to have high drought resistant quality. I wish to know how about its top-root ratio compared with other varieties.

Answer: We have not compared the top-root ratio of this dwarf with other varieties but the roots go to a depth of about 3 feet.