Table 1. Biomass yield and other agronomic traits of lines developed in the project on increased biomass in chickpea at Tel Hadya, Syria, 1993/94.

Entry	Plant height	Primary branches plant^{-1}	Secondary branches plant^{-1}	Pods plant^{-1}	Seeds plant^{-1}	Biomass yield (kg ha^{-1})	Seed yield (kg ha^{-1})	Harvest index (%)	100-seed mass (g)
S 92217	79	3.8	6.5	24	23	5428	1951	36.0	38.7
S 92218	83	4.4	5.6	22	21	6244	2122	34.1	39.0
S 92249	84	3.3	6.3	24	28	6297	2620	41.6	35.9
S 92260	86	4.3	11.0	61	56	7317	2848	39.1	37.5
S 92307	76	3.6	4.4	27	27	5889	2346	39.7	32.2
S 92310	80	4.0	5.8	32	36	5511	2101	38.3	29.5
S 92312	79	3.1	6.1	27	30	5000	1896	38.0	34.1
S 92440	86	3.9	6.1	33	28	6311	2081	33.4	34.6
F_6 Sel 93th 34856	85	4.4	11.6	52	54	6361	2102	33.1	30.8
F_6 Sel 93th 34858	86	3.6	6.8	56	48	6417	2333	36.5	29.0
F_6 Sel 93th 34840	88	4.1	9.5	54	51	6522	2584	39.6	35.0
ILC 3279 (control)	70	3.0	5.0	34	31	5328	1969	37.0	25.0
Location mean	81.8	3.9	7.2	37.1	36.1	6052	2246	37.2	33.4
SE of mean	±1.57	±0.37	±1.16	±3.76	±4.2	±293.0	±88.0	±1.25	0.50
LSD at 0.05	4.52	1.07	3.32	10.8	12.0	843.3	253.3	3.6	1.45
CV(%)	3.8	19.7	32.0	20.3	23.2	9.7	7.8	6.7	3.0

Potential and Prospects of Introducing Chickpea into Sri Lanka: A Review of Earlier Research

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In Sri Lanka, chickpea is called *kondakadale* or *kadala*. It is consumed island-wide chiefly in the form of boiled snacks. To an extent its *dhal*, flour, and fried grains are also consumed. For boiling, bold kabuli types are preferred but in most shops desi types are also available. Traditionally, chickpea is not cultivated in Sri Lanka and its entire demand is met through imports, mainly from India. According to estimates available from the Sri Lankan Customs, between 1987 and 1993, an average of 9700 t of chickpea, costing around US $ 3.2 m, was imported annually (G M W Chithral, personal communication). In this article, besides reviewing the results of limited research conducted in Sri Lanka, its cultivation potential and prospects are discussed.

Varietal evaluation. A review of the Progress Reports of the Department of Agriculture reveal that eight ICRISAT chickpea lines were first evaluated in the 1974/75 *maha* (rainy) season. The report, prepared by K. Maheswary (cited by Kanakasundaram 1987) however, does not provide any details of varietal performance and only concludes that the evaluation carried out in the Dry Zone was unsuccessful due to the unfavourable season, and the occurrence of *Fusarium solani* root rot.

A serious effort to introduce chickpea in Sri Lanka was made in 1980/81 in the Northern Province at the Regional Research Centre, Kilinochchi, and the Agricultural Research Station, Thirunelvely. According to Kanakasundaram (1987) a set of 21 chickpea introductions from ICRISAT were evaluated for their performance in observational plots during the 1980/81 rainy (Oct–Feb) season at Thirunelvely, and lines such as T 104, RPSP 333, and RPSP 335 recorded more than 1.8 t ha^{-1} yield. These observations encouraged researchers to conduct replicated trials at two locations. Subsequently, 13 selected lines were evaluated at Kilinochchi and Thirunelvely in the 1981/82 *maha* season. This exercise continued during the 1982/83 and 1983/84 *maha* seasons, and yields of six promising lines are

Table 1. Yield (t ha^{-1}) of six chickpea lines found promising in Northern Province, Sri Lanka, 1981–84.

	Maha 1981/82		*Maha* 1982/83		*Maha* 1983/84	Mean		
Variety line	Location 1	Location 2	Location 1	Location 2	Location 2	Location 1	Location 2	Overall
Annigeri	1.7	2.0	1.5	NT	NT	1.6	2.0	1.73
RPSP-333	2.1	NT	1.6	1.2	NT	1.9	1.2	1.63
F_3WF Gram 38 AINF	0.7	2.6	0.7	1.4	NT	0.7	2.0	1.35
RPSP-352	0.7	1.8	0.8	0.2	0.5	0.8	1.2	1.00
CPS-2	0.3	1.6	0.5	1.2	1.3	0.8	0.4	0.90
P-436	1.1	NT	0.6	1.3	0.5	0.9	0.9	0.88
Mean	1.1	2.0	0.95	1.28	0.60	1.05	1.42	1.25

Location 1 = Thirunelvely, Location 2 = Killinochchi, and NT = Not Tested.
Source: Kanakasundaram 1987.

Table 2. Yield (t ha^{-1}) of chickpea lines in adaptability tests at six locations, 1987/88 rainy (*maha*) season, Sri Lanka.

Location/variety	Annigeri	Chaffa	ICCC 32	ICCC 37	ICC V 2	ICCV 4	ICCV 5	T-13	Mean
Dry Zone									
Maha Illuppallama	0.3	0.3	0.1	0.5	0.3	0.3	0.2	0.4	0.30
Angunakolapellessa	0.6	0.4	0.5	0.3	0.5	0.5	0.4	0.5	0.46
Girandurukotte	0.3	0.1	0.6	0.1	0.2	0.1	0.3	0.2	0.24
Killinochchi	0.7	0.3	1.3	0.2	0.5	0.4	0.6	0.1	0.51
Intermediate Zone									
Pallekelle	0.4	0.3	0.1	0.6	0.2	0.2	0.1	0.6	0.31
Dodangoda	1.2	0.9	0.9	0.9	0.7	0.6	0.6	1.2	0.88
Mean	0.58	0.38	0.58	0.43	0.40	0.35	0.37	0.50	0.45

Source: AGLN Review and Planning Meeting, July 23-24, 1991, Kandy, Sri Lanka.

summarized in Table 1. The data indicated that lines such as RPSP 333, F_3WF Gram 38 AINF, and Annigeri can produce good yields. Yields were lower at Thirunelvely (1.05 t ha^{-1}), than at Kilinochchi (1.42 t ha^{-1}). Highest yield (2.6 t ha^{-1}) was recorded by F_3WF Gram 38 AINF at Kilinochchi in the 1981/82 *maha* season.

During the 1986/87 *maha* season, an ICARDA/ ICRISAT International Trial, consisting of 23 chickpea lines was conducted at the Regional Agricultural Research Centre, Maha Illuppallama in unreplicated plots. Seed yield of these lines, sown in early Dec, ranged between 0.01 t ha^{-1} (FLIP 82-115 C) and 0.62 t ha^{-1} (ILC 482) (Ariyaratne 1987).

Chickpea research in Sri Lanka was revived in 1987 with the support from ICRISAT's Asian Grain Legume Network (AGLN). Eight chickpea lines were evaluated in two agroecological zones (Fig.1) during *maha* season. The crop sown in the Up-country Intermediate Zone (IU3) failed because of heavy rains during the reproductive stage. The performance of these lines in the adaptability trials is summarized in Table 2. At Dodangoda,

Table 3. Yield (t ha^{-1}) of six chickpea lines at two sowing dates at Bandarawela, Sri Lanka, 1989/90 rainy (*maha*) season.

Line	15 May	15 June	Mean
ICCL 87202	1.1	0.7	0.90
ICCL 87210	1.3	0.8	1.05
ICCL 87212	0.9	0.3	0.60
ICCL 86214	1.1	0.7	0.90
ICCL 87224	1.5	0.4	0.95
Annigeri	1.5	0.8	1.15
Mean	1.23	0.62	0.93

Source: Nilmalgoda (1990)

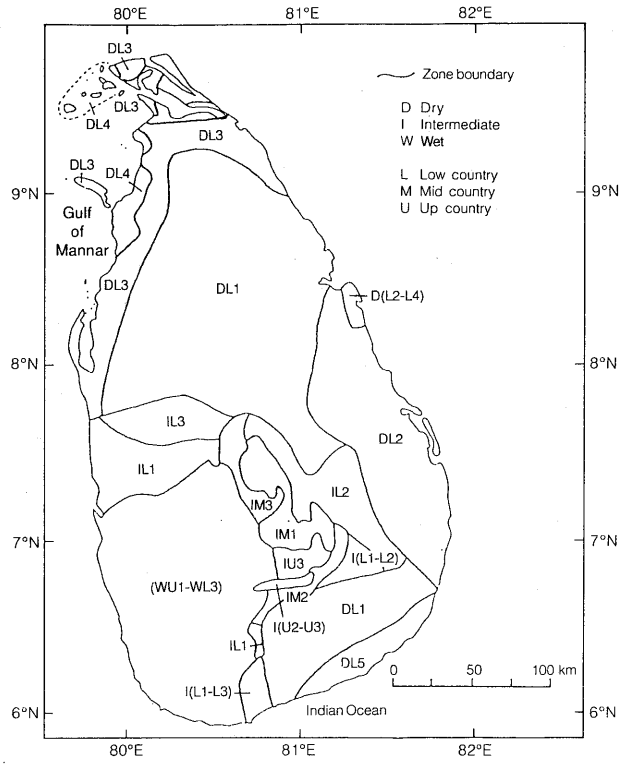

Figure 1. Agroecological zones of Sri Lanka.

located in the Mid-country Intermediate Zone (IM3) highest yields (1.2 t ha^{-1}) were obtained with Annigeri and T 13. Across the locations cultivar Annigeri and ICCC 32 produced the highest (0.58 t ha^{-1}) yield, followed by T 13 (0.50 t ha^{-1}).

The last chickpea varietal evaluation trial was conducted in 1991 in the Up-country Intermediate Zone. The lines, introduced from ICARDA, took more than 5 months to mature and the best line produced about 1.0 t ha^{-1}. (Ariyaratne et al. 1991).

Sowing season and time. The Dry Zone has two cropping seasons: *maha* (Oct–Feb), 1200 mm rainfall, and *yala* (Mar–Jul) with 300 mm rainfall. The mean temperatures during *maha* (around 26°C) are lower than those of *yala* (around 29°C) and chickpea, a cold loving plant, finds *maha* more suitable. However, heavy rains in Oct and Nov restrict the cultivation of chickpea between Dec and Feb. During this period the mean maximum (around 30°C) and minimum (around 21°C) temperatures are conducive to chickpea growth. In the Up-country Intermediate Zone, chickpea can also be sown in the *yala* season.

Experiments have been conducted to determine the optimum dates of sowing of chickpea in both *maha* as well as *yala* seasons. In the Dry Zone of Northern Region, five chickpea lines were sown between 15 Oct 1981 and 15 Jan 1982. The data indicated a strong variety × sowing date interaction. The most favourable time of sowing was found to be from late Nov to mid-Dec. These sowings gave an average yield of 1.3 t ha^{-1} (Kanakasundaram 1987). The lines flowered between 49–62 days. Six newly developed chickpea lines from ICRISAT were sown at monthly intervals from 15 May to 15 Sep 1989 to determine the optimum time of *yala* sowing in the Up-country Intermediate Zone. Of these, only the 15-May and 15-Jun sowings produced grain, in the remaining sowings, no grain was harvested because of rains during the reproductive stage. In the 15-May sowing, an average of over 1.0 t ha^{-1} yield was recorded, and ICCL 87224 and Annigeri produced 1.5 t ha^{-1} (Table 3). The 15-Jun crop produced an average of 0.6 t ha^{-1}. (Nilmalgoda, 1990).

Biotic and abiotic constraints. No systematic studies were conducted to document important biotic and abiotic constraints. Some high temperature related physiological problems were recorded during the varietal evaluation trials. These include flower drop, poor pod filling, and stunted growth.

Helicoverpa armigera was found to be the major pest. Damage by *Chrysomelide* beetles was also observed at some places. Fusarium wilt, collar rot, brown leaf spots, *Macrophomina phaseoli*, and botrytis (?) were the diseases reported by various researchers.

General discussion. Because of the strong demand for chickpea, and the very attractive prices it fetches, researchers in Sri Lanka have wondered if chickpea could be grown locally. The ideal temperatures for the cold-loving chickpea are to be found in the Up-country, and parts of the Mid-country Intermediate Zones. The experiments conducted in these areas support this view and yields of over 1 t ha^{-1} have been recorded. However, in these areas, land availability is limited and competition from high value and more remunerative vegetable crops will not permit the introduction of chickpea. Considering these factors, it appears that chickpea has to find a place in the Dry Zone, and perhaps to some extent in the Intermediate Zone.

The major constraints chickpea cultivation is likely to face in the Dry Zone are high temperature and terminal drought. The date-of-sowing trials suggest that sowings between late Nov and early Dec are likely to be the most suitable for chickpea growth.

This will provide the cool weather essential to accumulate sufficient biomass for producing reasonable yields. The environment becomes unfavourable after Feb and this leaves about 90–100 days in which to produce a chickpea crop. Lines maturing in less than 4 months should be evaluated for adoption. Also, the ideal genotypes for this environment should have the ability to withstand one or two heavy showers which might be experienced during the early growth period. It is also advisable that sowing be done on ridges for effective drainage. At present the occurrence of diseases and pests and the losses caused by them is not known. However, the limited information available suggests that *Helicoverpa armigera*, and root rot and fusarium wilt are potential biotic stresses which should be considered while selecting germplasm for evaluation in the Dry Zone. The most important research needs at present are to identify short-duration genotypes which can tolerate high temperature and related stresses. The multilocation testing indicates that within the Dry Zone there are pockets such as Kilinochchi where good yields can be obtained. In addition suitable areas which could be brought under chickpea cultivation with or without irrigation should be identified.

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Pathology

A Report on Three Chickpea Diseases in Sri Lanka

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Research on chickpea in Sri Lanka dates back to early 1970s. However, these programs were not very successful because of various reasons such as nonavailability of adaptable varieties, appropriate production packages, etc. (Saxena et al. In press).

In the 1995/96 rainy season, 240 varieties from ICRISAT, and 423 breeding lines from ICARDA were tested in 8 different experiments to evaluate their general performance under the Dry Zone conditions at the Field Crops Research and Development Institute, Maha Illuppallama. The seed was sown on 1st and 5th Dec 1995. Plot size varied from 1.2 m^2 to 4.8 m^2 and number of replications varied from 1–3 depending on the objectives of the experiment. These germplasms were also used to study various diseases and other agronomic characters. A brief description of diseases identified from chickpea research plots during the season is given below.

Wilt

Some accessions of chickpea breeding materials showed symptoms of wilt during the seedling stage. The disease incidence was 10–20% in the affected lines, ICCV 95433, ICCV 95416, ICCV 92320, and ICCV 95414. Dropping of leaves and petioles was visible initially in the upper part of affected plants. Affected seedlings gradually turned yellow, and then straw colored. Some of the plants showed symptoms of partial wilting. Affected plants, when uprooted before drying, showed no external rotting, drying or discoloration. When the stems were split open, a brown discoloration was observed in the xylem.

Similar symptoms have been reported in Sri Lanka in late 1980s (Ariyaratne et al. 1991). While the causal agent has not yet been identified, the symptoms of the plant indicate that it is *Fusarium* spp.