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CARDI'S ROLE IN THE RECENT DEVELOPMENT OF THE ONION INDUSTRY IN BARBADOS

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ABSTRACT

Although large-scale commercial onion production began in Barbados about 1970, by 1987 77% of the annual demand was still being imported. Furthermore, exports declined from 700 t in 1972 to zero in 1987. The major factors that led to the decline in the industry were the seasonal production of the crop, 'blast' disease and the short shelf-life of the varieties grown. CARDI has been involved in a National Onion Development Programme, initiated in 1987, with the objective of removing these constraints to development of the onion industry. The other collaborators are the Ministry of Agriculture, onion growers, the University of the West Indies, the Sugar Technology Research Unit, and the Caribbean Meteorological Institute. The study undertaken by CARDI involved the testing of approximately 80 short and intermediate day onion varieties to select suitable high performance cultivars, adapted to climatic conditions in the Caribbean which would store well under ambient conditions. Two Israeli varieties, Grandstand and Arad, and Mercedes, a variety from the USA were selected because of their favourable yield and outstanding storability. These are the only varieties being produced commercially in Barbados at the present time. The period of availability of the local onion has been extended from 5 months in 1980 to 10 months in 1991. Export was restarted in 1995, with favourable response on bulb quality. There have been initiatives in onion production in St Kitts/Nevis, Grenada, St Vincent, Antigua and Montserrat. Transfer of technology from Barbados resulted in the transformation of the commercially grown varieties used in these countries between 1988 and 1993, with at least 90% of the acreage cultivated to Grandstand and Arad. Although considerable progress has been made, constraints remain which must be addressed, e.g. the lack of adequate drying and storage facilities in all countries involved, control of weeds and 'blast' disease in the field, and the lack of proper production planning. The search for varieties tolerant to 'blast' continues.

INTRODUCTION

Although records show that onion was grown on a small scale in Barbados at the turn of this century, the crop did not become commercially important until the late 1960s with the advent of mechanized precision planting of vegetable crops by local growers.

Granex F_1 Hybrid was the most widely grown variety during the initial stages of commercial production. The variety is high yielding, but the bulbs are soft and mild and have

only a few dry outer scales which are easily shed. Since this and many other US short-day hybrids were not bred for storage, their shelf-life is expectedly limited.

During 1968 to 1986, more than 100 short and intermediate day varieties, mainly from USA, Israel, Netherlands, Japan, Africa, Spain, France and New Zealand were evaluated by CARDI and Ministry of Agriculture (Chandler et al., 1973; CARDI, 1984; CARDI, 1986). These preliminary agronomic and storage trials resulted in the replacement of the standard commercial variety Granex F_1 Hybrid to a large extent with the less perishable but lower yielding Hybrid F_1 Golden (Chandler and Williams, 1979; unpublished). Seed of this variety was not available on the market after 1987.

The relatively limited shelf-life of the onion varieties grown, and the seasonal production of the crop created major marketing problems on the domestic market and hindered opportunities for the development of intra-regional trade in onions. The crop was produced largely by sugar estates in their 'thrown out' fields under rainfed conditions. Harvest was generally limited to a 14-week period between mid January and the end of April, with over 50% being harvested in March. Post-harvest handling systems were inadequate, and there was a lack of storage facilities.

With such practices, spoilage contributed significantly to the decline in exports from 700 t in 1972 to zero in 1987 and self-sufficiency has remained at the relatively low level of approximately 23%. The coincidence of the availability of Barbados onions for export with low world market prices during March and April, and the high price of local onions when compared with extra-regional supplies exacerbated the problems of the export industry. These problems, together with the continual threat of 'blast' disease resulted in fluctuating acreages and production, since growers considered the crop to be 'high risk' (Chandler, 1989; unpublished). The area planted in a particular year depended on the severity of pre - and post-harvest losses experienced during the preceding year (Table 1).

Consequently, studies carried out for the government documented the urgent need in the short term, to find varieties with better storage potential under local ambient conditions and which would allow the extension of the production season (IICA, 1981; Orshan, 1982; Julien, 1983).

The National Onion Development Programme

This programme started in 1987 with the primary objective of providing the research necessary to remove the major constraints to the production of onions in Barbados. The programme was multidisciplinary and involved researchers from all the major agricultural institutions in Barbados: the Caribbean Agricultural Research and Development Institute, the Ministry of Agriculture, the University of the West Indies (Faculty of Agriculture, Trinidad and Faculty of Natural Sciences, Barbados), Barbados Sugar Industry Limited (the onion growers) and the Caribbean Meteorological Institute.

CARDI'S ROLE IN THE PROGRAMME

CARDI was responsible for agronomic and storage trials aimed at finding one or more varieties that would:

- Produce commercially acceptable yields when grown during the major growing seasons
- Store for more than 8 weeks under ambient temperature and humidity conditions.

Evaluation of bulbing characteristics of varieties

In the absence of a specific breeding programme for the Caribbean, advanced germplasm from North America, Europe, Middle and Far East areas was screened. The initial selection of germplasm to be tested was based on daylength requirement, bulb colour and where possible, storage life. Short and intermediate daylength varieties were recommended by seed companies or selected using the descriptive lists in seed catalogues. Emphasis was placed on yellow bulbed varieties, although a smaller number of red and white varieties was included for comparison. Varieties listed as having at least a medium storage life were included where possible.

Preliminary sequential screening of 58 varieties from North America, Europe, Israel and Japan (See Appendix I for details) was conducted during January, February, March, April, May, June, August, September, October and December 1987.

Table 1 Onion production, imports and exports for Barbados 1970-87

Year	Local production		Imports	Exports
	(hectares)	(tonnes)	(tonnes)	(tonnes)
1970	36	543	1,500	81
1971	62	907	1,513	54
1972	101	1139	1,292	734
1973	81	816	1,304	499
1974	87	823	1,163	183
1975	66	816	1,244	465
1976	46	680	1,649	297
1977	67	693	1,313	293
1978	57	743	1,711	195
1979	71	540	1,511	71
1980	44	520	1,831	30
1981	31	435	1,778	0
1982	23	476	1,773	23
1983	43	764	1,400	3
1984	24	549	1,983	0
1985	38	776	1,703	0
1986	71	459	2,143	0
1987	63	467	1,807	0

Source: Barbados Ministry of Agriculture/Barbados Marketing Corporation

All trials were conducted in the low to medium rainfall area of the island (average rainfall 1,140–1,400 mm). The dark clay soils occurring in this area are predominantly smectoid in nature, and have been identified as being most suited to onion production (Eavis and Jeffers, 1970) with a pH about 7.5 and organic matter of approximately 4% (Vernon and Carrol, 1966). Altitude is less than 60 m above sea level.

Raised beds 168 cm wide with five rows, or 180 cm wide with six rows, were used. Intra-row spacing was approximately 2.5 cm. All trials were irrigated and the standard commercial agronomic and pest control practices were used (Chandler, 1995).

Varieties were said to have bulbed when well defined bulbs with a bulbing ratio (bulb diameter to pseudostem diameter) greater than 2 were produced. At least 50% of the plants of varieties which were considered to have bulbed must have reached maturity and exhibited senescence of foliage at harvest. Varieties that did not bulb were defined as those which produced thick necked elongated swellings rather than well-defined bulbs.

During March and April, germination of all varieties was negligible, and the trials were abandoned. The August planted trial was affected by 'blast' disease at an early stage and no results were recorded. The September trial was abandoned due to a high weed incidence.

Of the 23 varieties planted at all sowing dates, 10 varieties (Granex F_1 Hybrid, Texas Grano 502, Golden, Special 38, Henry's Special, Yellow Creole, Arco 3144/Y, Texstar 80, Granex 33 and Grandstand) exhibited the potential to produce well-defined bulbs, a high percentage of which reached the foliage collapse stage, indicating maturity, at all sowing dates. An additional variety, Red Bombay, which was not planted in January, bulbed at all other sowing dates. The varieties Hi Ball, Top Keeper and Keep Well did not bulb at either sowing date. Of the 23 varieties planted at all sowing dates, the percentage of varieties which bulbed was lowest (57%) from the June planting, compared to 61% for February, 74% for October, 83% for December and 78% for January.

Yield and storage evaluation

Since onions grown under Barbados conditions are affected by a wide range of weed species and a number of pests and diseases that require a high level of management and inputs for their control (Chandler, 1989; unpublished), high commercial yields are necessary to recover investment in production costs. Furthermore, post-harvest losses must be reduced to a minimum. Therefore, selection of varieties must take into consideration, not only bulbing ability, but the capacity of varieties to consistently produce commercially acceptable yields of high quality bulbs with a long shelf-life under ambient conditions.

More detailed yield and storage trials carried out during the period 1987 to 1994 with the varieties selected from the preliminary trials and an additional 26 varieties from USA, Holland and Israel (see Appendix I) resulted in three varieties – Grandstand and Arad (Hazera) from Israel and Mercedes (Petoseed) from USA – being recommended for commercial use. These varieties consistently produced the equivalent of over 50 t/ha in trials in the major

growing seasons, i.e. October and January, and more than 90% of the bulbs remained sound after 12 weeks in storage.

Yields tended to be higher in the October planting, compared to the January planting, and time to maturity was longer for the October planted trials. A similar result was obtained by Guzman and Hayslip (1962) in Florida. Growth analysis revealed that leaf areas of all varieties tended to be higher in the October planting which could possibly account for the higher yields. Bulb defects such as doubling and thick necks were generally confined to the October planting. Pike and Lopes (1988) noted that doubling (splitting) in onion was a complex process involving interactions between varieties, planting dates and other environmental factors, and Robinson (1971) noted that less splitting occurred in smaller bulbs. The smaller bulbs produced from the January plantings would therefore be less likely to split than the larger bulbs from October plantings.

Storage trials were carried out using ventilated plastic field baskets under ambient conditions. Disease rather than sprouting or desiccation accounted for most storage losses, and Aspergillus niger was the major disease causing losses. Small bulbs stored better than large bulbs and thin-necked bulbs better than thick-necked ones. White bulbed varieties sprouted least, but were most susceptible to infection by Asp*ergillus niger*. It would appear therefore that under the high temperature storage conditions in Barbados it is likely to be more profitable to regulate storage conditions to minimize disease incidence rather than to minimize desiccation, so that smaller bulb sizes should be selected for storage and the larger bulbs marketed promptly after harvest.

Solar drying trials

Although selection of varieties with inherently good storage characteristics was one of the major objectives of the National Onion Development Programme, it is important to develop post-harvest crop management methods that will further ensure the marketing of a good quality crop. Since Asp*ergillus niger* caused up to 47% losses in some varieties, controlling this disease is a priority. Complete surface drying and neck closure of bulbs is reported to reduce losses from pathogens during storage (Jamieson et al., 1976). Although field drying or 'windrowing' is the cheapest and most widely used method of drying onions in the tropics, it is risky, even in the dry season.

Solar drying in a protected environment was therefore tested as an alternative method of drying onions. The objective was to determine the conditions (i.e. temperature, air flow and time) necessary to dry bulbs under local conditions, and to compare the storability of bulbs dried by this method with those dried by the traditional windrowing method. A packed bed solar drier originally designed to dry lumber was used. During the drying operation, heated air was forced through the bulbs which were loaded on the perforated floor of the drying bin. (Chandler, 1995).

Although the temperatures achieved by the drier exceeded the maximum safe temperature of 38 $^{oC\ re}$commended for onions, there was no evidence of physiological damage, and

a marked improvement of the scale leaf colour and condition was observed after 4 days of drying. Some shedding of scale leaves did occur, possibly due to these high temperatures and the high airflow used (60 m^3/min per t).

Storage of solar-dried bulbs was significantly better than that of windrowed bulbs up to 8 weeks in storage. Thus solar drying in a protected environment could be a useful alternative to field drying of onions, although the economics of such drying would have to be considered. One grower in Barbados has since successfully dried his crop using a solar drier designed to dry hay.

Commercial production

The selection of varieties with high yields and improved storability coupled with the increased use of drip irrigation by growers has resulted in an extension of the period of availability of locally produced onions from 5 months in 1980 to 10 months in 1991. Furthermore, import figures show that in 1992, more than 50% of the onions consumed were grown locally.

There has been an increased interest in onion production by small farmers, and in 1994/95, of the 60 ha grown, 11 ha were grown by small farmers compared to only 1 ha in 1990/91 (Simpson, 1995).

The improved quality of the bulbs produced by the new varieties has resulted in attempts being made to restart exports, and favourable responses have been received from trial shipments to Trinidad during 1995.

Transfer of technology

The model used by CARDI has been preliminary screening of varieties in Barbados, with recommendations then made to St Vincent, St Kitts, Nevis, Grenada, Montserrat and Jamaica. The transfer of technology has resulted in the transformation of the commercially grown cultivars in the Eastern Caribbean between 1988 and 1993. Prior to the Barbados study, the varieties grown commercially were Granex F1 Hybrid, Special 38, Golden, Texas Grano 502 and White Robust. Following the study at least 90% of the acreage in the countries listed was cultivated to Grandstand or Arad or a combination. Mercedes is currently being evaluated in St Kitts and St Vincent (Table 2).

Despite the strides made recently in the onion industry, several problems remain. Although the cause of 'blast' disease was identified as Xanthomonas *campestris*, (Paulraj, 1991) there is still no consistent control in the field. The recommendation of interplanting three beds of carrot with three beds of onion (Paulraj, personal communication) has been tried on a commercial field and, although results look promising, no statistical trials have been done.

Table 2 Commercial production data for varieties selected in the study

Country and season	Variety	Yield (t/ha)	Total area planted (ha)
Barbados	Grandstand	10	2
1988/89 Rainfed	Grandstand	32	NA
Irrigated			
1989/90 Rainfed	Grandstand	25-38	15
Irrigated	Grandstand	39	NA
1990/91 Rainfed	Grandstand	14-18	68
Irrigated	Grandstand	37	NA
1991/92 Rainfed	Arad	19-30	16
Drip irrigated			
July	Arad	29	NA
January	Arad	56	NA
	Grandstand	56	51
1992/93 Rainfed	Grandstand	16	53
Irrigated	Arad	62	49
1993/94 Drip	Arad	75	NA
Irrigated	Mercedes	62	NA
Antigua			
1988/89	Grandstand	NA	<1
1991/92	Grandstand	NA	8.1
1992/93 Rainfed	Grandstand	15	12.1
St. Kitts/Nevis			
1991/92 Rainfed	Grandstand	27	1.2
1992/93 Irrigated		37	4.4
Montserrat			
1992/93	Grandstand	11 (dry)+	3.8
	Arad	3 (green)	
St. Vincent			
1993/94	Grandstand	NA	6.5
Grenada			
1993/94	Grandstand	NA	1.2

(NA = not available)

Collaborative work has been undertaken by UWI, Cave Hill and CARDI with regard to selection of varieties tolerant or resistant to 'blast'. So far, two Israeli varieties, H942 and H508 (Hazera) appear promising.

Although the problem of poor germination during March, April and May has not been thoroughly investigated, indications are that frequent light irrigation would assist. Also, the

lack of adequate facilities for drying and storing the crop so that marketing can be efficiently and effectively done continues to hamper the further development of the industry with the result that farmers still consider onion to be a high-risk crop.

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APPENDIX I

Varieties tested 1987–90

Henry's Special, Yellow Creole, Early Yellow Premium, Red Creole C5, Granex 33, Ring Gold, Tropicana, Yellow Bermuda, Dessex PRR, Gold Rush, Texspan, El Toro, Special 38, Hyb. 3144/Y, Ringer Grano, Texstar 80, Granex Hyb., Texas Grano 502, Golden, Red Commander, White Robust, White Creole, (Arco Seed Co., USA), Tip Top, (Ferry Morse, USA), Galaxy, Nova (Neuman Seed Co., USA), Radar (Bejo Seed Co., Holland), Targa, Yellow Sweet Spanish, Valenciana Durable, Red Bombay, Rijnsberger, (Nickerson, Holland), Bliss, Hystar, Red Synto (Pop Vriend, Holland), Autumn Pride, Autumn Keeper, Autumn Beauty (Royal Sluis, Holland), Uien HM1 (Sluis & Groot, Holland), Ben Shemen, #86, Aviv, Beth Alpha Autumn, Stavi, Grandstand (H7), Grano 3, Yodalef, #9, (Hazera, Israel), Express Yellow, Hi-ball, Keepwell, Senshuyi Yellow, Hi-keeper, Top Keeper, Dragon Eye, Superex, Amber Express, Tropic Ace, Tough Ball (Takii, Japan).

Additional varieties tested 1990–94

Arad, Moab, Barak, Sivan, H1208, H815, Grano F_1, H942, H952, RAM763, HA508, H811, H489, H95, H891, H944 (Hazera) Mercedes, PSX13589, PSX13489 (Petoseed), RS266, RS209, RS218, RS201, RS204 (Royal Sluis), Z251, Z218, Z204 (Neuman).