Groundnut: ICRISAT and East Timor

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Abstract

Although it is widely grown in small plots as an upland crop with little or no inputs, groundnut is not a major crop in East Timor. The cultivars that are grown have low yield potential and there is a great potential to increase the cultivation of groundnut in the country. Under the ACIAR 'Seeds of life — East Timor' project, new groundnut cultivars were introduced and trialled in the 2000–2001 and 2001–2002 seasons at a number of locations. Many of the introduced varieties outperformed the local variety at all the locations. As well as stimulating the local food and oil processing industry, increased groundnut production would provide an opportunity to export the produce to neighboring countries in the region. To enable a sufficient supply of good quality seed of the improved varieties farmers should be encouraged to produce and save their own seed. For this to happen, they need training in seed production and processing as the seed crop requires different handling than the commercial crop.

Introduction

GROUNDNUT (*Arachis hypogaea* L.) is an annual legume, which provides a rich source of high-quality, edible oil (45–50%), easily digestible protein (23–25%), minerals, and vitamins. It ranks 13th among the food crops and annual oilseed crops in the world. Its high oil and protein contents serve important needs for food, energy, and industrial uses. Groundnut haulms provide excellent fodder for animals. Groundnut cake, obtained after extraction of oil, is used in the animal feed industry and also in human food preparations. Groundnut shells are used as fuel and as filler in animal feeds and fertilisers. They can also be used in making cardboards. Cultivation of groundnut helps to improve soil fertility as it leaves behind a substantial amount of nitrogen in the soil. The crop is cultivated under diverse growing conditions ranging from subsistence to high-input–mechanised agriculture. It can be grown as a sole crop, intercrop, or mixed crop.

Groundnut, which probably originated in the region of southern Bolivia and north-western Argentina, is grown in more than 100 countries on about 25 M ha with a total production of 33 M t and an average productivity of 1.3 t/ha. Over the past 12 years, the annual growth in area has averaged 1.8%, in production 3.3%, and in productivity 1.5% (FAO, 1999). Asia remains the largest producer of this crop, while China, India, and the USA are the leading groundnut producing countries in the world.

Cultivated groundnut has two subspecies *hypogaea* and *fastigiata,* which, in turn, have two (*hypogaea* and *hirsuta*) and four (*fastigiata, vulgaris, aequatoriana,* and *peruviana*) botanical varieties, respectively. Groundnut has several wild relatives, some of which are cross-compatible with the cultivated varieties, while others are not. These wild relatives of cultivated groundnut harbor resistance genes for many abiotic and biotic stresses that affect groundnut productivity. In Asia, these stresses include drought, rust, late leaf spot, early leaf spot,

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aflatoxin, collar rot, and stem and pod rots (all fungal diseases), bud necrosis and peanut stripe virus diseases, bacterial wilt, and *Spodoptera*, leaf miner, red hairy caterpillar, aphids, thrips, and white grub (all insect pests) (Nigam et al., 1991).

Groundnut improvement at ICRISAT

Two different approaches are adopted in groundnut improvement at ICRISAT. For subsistence farming, the emphasis is on reducing the yield losses caused by abiotic and biotic stresses through resistance breeding. For high-input farming, the emphasis is placed on improving yield potential and confectionery qualities. In the former, incorporation of genetic resistances may entail some cost of yield potential, but resistant cultivars give higher realized and stable yields under limited or no input farming. As inputs are no limitation in the latter, attempts are made to improve yield potential and seed quality to ensure higher realized yield with better seed quality.

There are several agronomic and end-use specific traits, which determine the adaptation and end use of new varieties. In oil types, crop duration, pod yield, pod shape, shelling outturn, and seed dormancy are important agronomic considerations. Additional agronomic traits that are required in confectionery types include seed mass, seed color, shape, and size, and percentage of sound mature seeds. The quality considerations in confectionery types include oil content, oleic/linoleic fatty acid ratio, protein content, sugar content, blanchability, taste and flavor, and pesticide residues. The first two traits are also important in oil types.

Conventional breeding dominates the genetic enhancement scene in groundnut. New breeding tools such as genetic transformation and marker-assisted selection are just emerging in the crop. Single and complex crosses are made among desired parents to generate segregating populations for selection of plants with the desired combination of traits. The pedigree method of selection is most widely used. In interspecific hybridisation, where genes from wild *Arachis* species are harnessed, chromosome doubling, embryo rescue, tissue culture, and back crossing are utilised (Singh et al., 1990). The selection environment reflects the near target-farming situation.

The breeding materials developed at ICRISAT — early-generation bulks, advanced-generation breeding lines, country-specific populations, and regional and international trait-specific trials — are made available to national programs on request for direct introduction or further *in situ* selection and release of cultivars. National programs in collaboration with ICRISAT have so far released 63 improved groundnut cultivars in 32 countries. Thirty-seven more varieties in 12 countries are likely to be released soon.

Groundnut in East Timor

No reliable area or production statistics of groundnut in the country are available. Although it is widely grown in small plots as an upland crop with little or no inputs, it is not a major crop in East Timor. The crop is generally free from abiotic and biotic stresses except for iron chlorosis and a moderate intensity of foliar diseases (rust, late leaf spot, and early leaf spot). Nondescript cultivars with low yield potential are grown and the produce used for direct consumption. There is great potential to increase the cultivation of groundnut in the country. Opportunities exist for its export to the Southeast Asia region. Further, introduction of legumes in cropping systems will help to stabilise the productivity of cereal-based cropping systems. However, it is essential to introduce new high-yielding cultivars to promote groundnut cultivation in the country. In the short term, introduction of improved, advanced-generation genetic materials and their subsequent evaluation for local adaptation and high yield would be a desirable approach to make the new cultivars available to farmers.

Following this approach, ICRISAT, under an ACIAR-funded and coordinated project, 'Seeds of life — East Timor', introduced into East Timor 15 advanced varieties in the 2000–2001 season (Table 1) and five more advanced varieties in the 2001–2002 season (Table 2). These 15 advanced varieties were evaluated in replicated trials at various locations during the 2000–2001 and 2001–2002 seasons in the country (Tables 1 and 3). Many introduced varieties outperformed the local variety at all the locations. Considering the vast agroclimatic variation in the country, the locations were grouped into three clusters; <1000 mm rainfall (Table 4), 1000–1500 mm rainfall (Table 5), and >1500 mm rainfall (Table 6).

The first ranking variety at each location and the first three varieties in each cluster are listed in Table 7. A careful perusal of Table 7 identified four varieties, ICGV# 94063, 93269, 95278, and 95248 which often yielded 2–3+ t/ha of kernels and were worthy of further on-farm testing across the country and for initial seed increase. Local check varieties, in contrast, yielded 1–2 t/ha. The five varieties introduced in the 2001–2002 season were evaluated separately at one location (Table 2). These varieties were selected for introduction after a visit to farmers' groundnut fields during the 2000–2001 cropping season. These varieties gave an outstanding

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Table 1. Performance of groundnut genotypes in a multilocation trial, East Timor, 2000–2001.

Genotype	Pod yield (t/ha)				
	Maubisse	Aileu	Maliana	Mean	Rank
ICGV 95278	1.19 (5)[a]	2.19 (3)	3.39 (2)	2.26	1
ICGV 94040	0.69 (13)	1.50 (13)	3.94 (1)	2.05	2
ICGV 93269	0.69 (12)	1.53 (11)	3.33 (3)	1.85	3
ICGV 93277	0.66 (14)	1.69 (8)	3.11 (4)	1.82	4
ICGV 92120	1.08 (6)	2.22 (2)	2.17 (10)	1.82	5
ICGV 94002	1.42 (2)	1.83 (5)	2.19 (9)	1.82	6
ICGV 94037	1.06 (8)	1.72 (7)	2.64 (6)	1.81	7
ICGV 95248	1.50 (1)	2.25 (1)	1.56 (15)	1.77	8
ICGV 94106	1.28 (4)	1.36 (15)	2.53 (7)	1.72	9
ICGV 93261	1.33 (3)	0.78 (16)	2.94 (5)	1.69	10
ICGV 94016	0.75 (11)	1.89 (4)	2.28 (8)	1.64	11
Local	1.08 (7)	1.64 (10)	2.03 (12)	1.58	12
ICGV 95322	0.89 (9)	1.75 (6)	1.67 (14)	1.43	13
ICGV 95299	0.81 (10)	1.47 (14)	2.00 (13)	1.43	14
ICGV 94063	0.61 (15)	1.53 (12)	2.08 (11)	1.41	15
ICGV 95353	0.56 (16)	1.69 (9)	1.31 (16)	1.19	16
Mean	0.98	1.69	2.38		
CV(%)	68.6	41.3	28.7		
l.s.d.	1.16	1.21	1.16		
			l.s.d. (Genotypes)	0.88	
			l.s.d. (Location)	0.38	

[a] Figure in parentheses refers to the rank at the location.

performance of 4–6 t/ha of pods. Three of these varieties, ICGV# 87123, 88438, and 86590, were selected for seed increase and multilocation on-farm trials in the country.

Table 2. Performance of newly introduced groundnut genotypes, East Timor (2001–2002).

Genotype	Major trait(s)	Pod yield (t/ha)
ICGV 86590	Foliar diseases resistance	3.92*
ICGV 86564	Large-seeded (Confectionery)	3.80
ICGV 88438	Large-seeded, tolerance to iron chlorosis (Confectionery)	4.61*
ICGV 89214	Large-seeded, tolerance to iron chlorosis (Confectionery)	4.04
ICGV 87123	Medium-duration	5.76*

* Selected for seed increase and farmer participatory on-farm variety selection trials.

Potential for groundnut and East Timor's future needs

From the results of limited trials conducted in 2000–2001 and 2001–2002, it is abundantly clear that groundnut has an excellent potential to perform in East Timor and help in increasing the income of poor farmers. Increased groundnut production would not only stimulate the local food and oil processing industry but would also provide an opportunity to export the produce to neighboring countries in the region which are currently the net importers of the commodity. Groundnut cake obtained after extraction of oil would support the local animal feed industry. These activities will lead to increased employment opportunities at the local level. Good quality groundnut free from aflatoxin and chemical residues is in great demand on the international market and commands a premium price. The food use of groundnut will grow in future. However, to produce premium quality groundnut, it is important that there is a change from subsistence agriculture to assured input growing conditions. Particularly, the crop should not suffer moisture stress at the podding stage as its produce becomes vulnerable to aflatoxin contamination under drought. As the crop is generally free from diseases and insect pest damage, opportunity exists to produce organic groundnut using decomposed organic matter for nutrient supply and natural plant products and biological agents for control of diseases and insect pests.

Because of the large agroclimatic variation in the country, it would be advisable to release agroclimatic zone-specific cultivars to harness their full potential for the benefit of farmers. The same would apply to cultural practices and production techniques.

Table 3. Performance of groundnut genotypes in a multilocation trial, East Timor (2001–2002).

Genotype	Kernel yield (t/ha)			Mean	Rank
	Baucau	Betano	Loes		
ICGV 94063	2.45 abcd	1.02 bcdef	3.43 e	2.30	1
ICGV 95278	2.54 bcd	1.03 bcdef	2.55 d	2.04	2
ICGV 95299	2.21 abcd[1]	1.49 fg	2.26 cd	1.99	3
ICGV 93269	2.72 d	1.15 cdefg	2.04 abcd	1.96	4
ICGV 93277	2.10 abc	1.14 cdefg	2.47 cd	1.90	5
ICGV 94002	2.15 abc	1.36 efg	2.18 bcd	1.90	6
ICGV 95248	1.73 a	1.71 g	2.05 abcd	1.83	7
ICGV 95322	2.84 cd	1.27 defg	1.36 a	1.82	8
ICGV 95353	2.19 abc	0.78 abcd	2.42 cd	1.80	9
ICGV 94016	1.86 ab	0.78 abcd	2.13 abcd	1.59	10
ICGV 92120	2.39 abcd	0.58 abc	1.73 abc	1.57	11
ICGV 94106	2.03 abc	0.55 ab	1.85 abc	1.48	12
ICGV 93261	2.15 bcd	0.31 a	1.91 abcd	1.46	13
Local	1.67 abc	0.64 abc	2.04 abcd	1.45	14
ICGV 94037	1.84 abc	0.84 abcde	1.47 ab	1.38	15
			l.s.d. (Genotypes)	0.657	
			l.s.d. (Location)	0.294	

Column means followed by the same letter are not significantly different ($P \leq 0.05$) according to Duncan's multiple range test.

Table 4. Performance of groundnut genotypes at <1000 mm rainfall locations, East Timor (2001–2002).

Genotype	Kernel yield (t/ha)		Mean	Rank
	Betano	Loes		
ICGV 94063	1.02 (8)[a]	3.43 (1)	2.23	1
ICGV 95299	1.49 (2)	2.26 (5)	1.88	2
ICGV 95248	1.71 (1)	2.05 (8)	1.88	3
ICGV 93277	1.14 (6)	2.47 (3)	1.81	4
ICGV 95278	1.03 (7)	2.55 (2)	1.79	5
ICGV 94002	1.36 (3)	2.18 (6)	1.77	6
ICGV 95353	0.78 (10)	2.42 (4)	1.60	7
ICGV 93269	1.15 (5)	2.04 (9)	1.60	8
ICGV 94016	0.78 (10)	2.13 (7)	1.46	9
Local	0.64 (11)	2.04 (10)	1.34	10
ICGV 95322	1.27 (4)	1.36 (15)	1.32	11
ICGV 94106	0.55 (13)	1.85 (12)	1.20	12
ICGV 94037	0.84 (9)	1.47 (14)	1.16	13
ICGV 92120	0.58 (12)	1.73 (13)	1.16	14
ICGV 93261	0.31 (14)	1.91 (11)	1.11	15

[a] Figure in parentheses refers to the rank at the location.

Table 5. Performance of groundnut genotypes at 1000–1500 mm rainfall locations, East Timor (2000–2001 and 2001–2002).

Genotype	2000–2001 Maliana Pod yield (t/ha)	2001–2002 Baucau Kernel yield (t/ha)	Rank[a]
ICGV 94040	3.94 (1)[b]	—	
ICGV 93269	3.33 (3)	2.72 (2)	1
ICGV 95278	3.39 (2)	2.54 (3)	2
ICGV 93277	3.11 (4)	2.1 (10)	3
ICGV 93261	2.94 (5)	2.15 (8)	4
ICGV 92120	2.17 (10)	2.39 (5)	5
ICGV 94106	2.53 (7)	2.03 (11)	6
ICGV 94063	2.08 (11)	2.45 (4)	7
ICGV 95322	1.67 (14)	2.84 (1)	8
ICGV 94037	2.64 (6)	1.84 (13)	9
ICGV 94002	2.19 (9)	2.15 (9)	10
ICGV 95299	2.00 (13)	2.21 (6)	11
ICGV 94016	2.28 (8)	1.86 (12)	12
Local	2.03 (12)	1.67 (15)	13
ICGV 95353	1.31 (16)	2.19 (7)	14
ICGV 95248	1.56 (15)	1.73 (14)	15

[a] Assumes equal shelling outturn for all the genotypes at Maliana.

[b] Figure in parentheses refers to the rank at the location.

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Figure 1. Brian Palmer and workers in a field of groundnuts. Photographer: Eric McGaw

Table 6. Performance of groundnut genotypes at >1500 mm rainfall locations, East Timor (2000–2001).

Genotype	Pod yield (t/ha)		Mean	Rank
	Maubisse	Aileu		
ICGV 95248	1.50 (1)[a]	2.25 (1)	1.88	1
ICGV 95278	1.19 (5)	2.19 (3)	1.69	2
ICGV 92120	1.08 (6)	2.22 (2)	1.65	3
ICGV 94002	1.42 (2)	1.83 (5)	1.63	4
ICGV 94037	1.06 (8)	1.72 (7)	1.39	5
Local	1.08 (7)	1.64 (10)	1.36	6
ICGV 94016	0.75 (11)	1.89 (4)	1.32	7
ICGV 95322	0.89 (9)	1.75 (6)	1.32	8
ICGV 94106	1.28 (4)	1.36 (15)	1.32	9
ICGV 93277	0.67 (14)	1.69 (8)	1.19	10
ICGV 95299	0.81 (10)	1.47 (14)	1.14	11
ICGV 95353	0.56 (16)	1.69 (9)	1.13	12
ICGV 93269	0.69 (12)	1.53 (11)	1.11	13
ICGV 94040	0.69 (13)	1.50 (13)	1.1	14
ICGV 94063	0.61 (15)	1.53 (12)	1.07	15
ICGV 93261	1.33 (3)	0.78 (16)	1.06	16

[a] Figure in parentheses refers to the rank at the location.

The non-availability of good quality seed of improved varieties of groundnut in required quantities remains a bottleneck in most of the developing countries. Farmers should be encouraged to produce and save their own seed. However, for this to happen successfully, they should be given training in seed production and processing as the seed crop has different handling requirements than the commercial crop.

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Table 7. Summary analysis of 2000–2001 and 2001–2002 performance of groundnut genotypes, East Timor.

Location	<1000 mm rainfall		1000–1500 mm rainfall		>1500 mm rainfall	
	Betano	Loes	Maliana	Baucau	Maubisse	Aileu
Best performer	ICGV 95248	ICGV 94063	ICGV 94040	ICGV 95322	ICGV 95248	ICGV 95248
Overall						
1	ICGV 94063*		ICGV 93269*		ICGV 95248*	
2	ICGV 95299*		ICGV 95278*		ICGV 95278*	
3	ICGV 95248*		ICGV 93277*		ICGV 92120*	

* Selected genotypes for seed increase and farmer participatory on-farm variety selection trials underlined: ICGV# 94063, 93269, 95278, and 95248.

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