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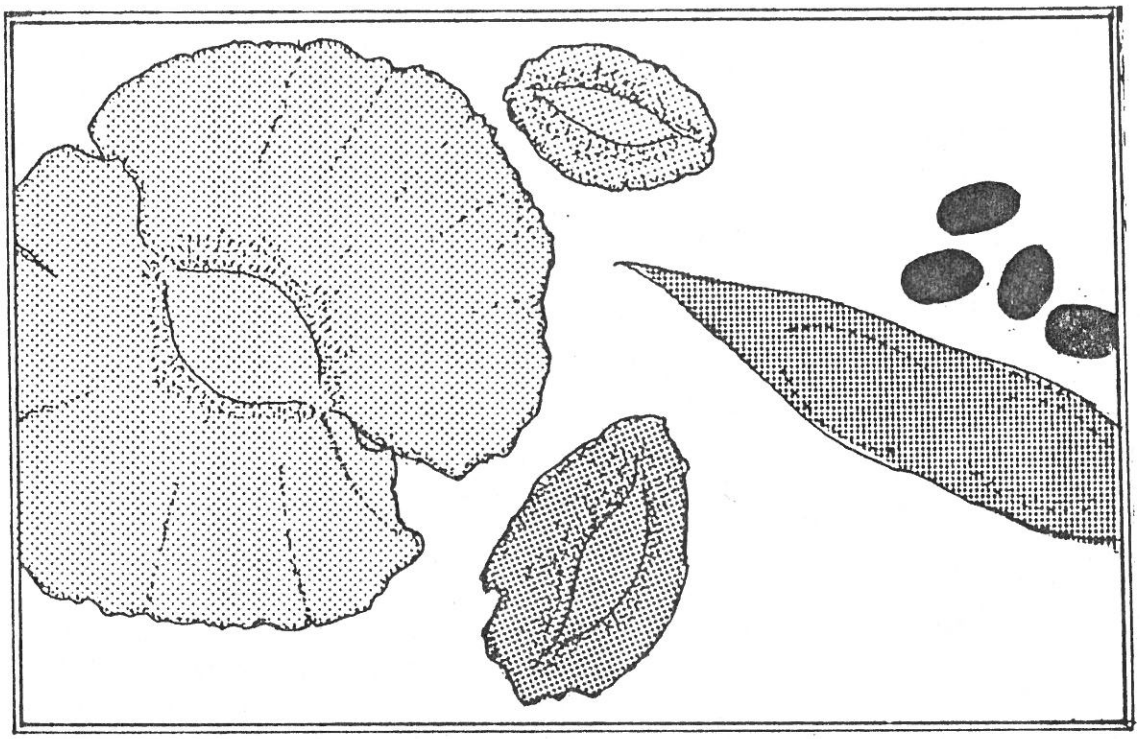

Tree Phenology and Seed Collection in Somalia

A.D. Leslie

British Forestry Project Somalia
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Preface

I would like to acknowledge the assistance of the following British Forestry Project staff; Dr. M. R. Bowen for his advice and for proof reading this document, W.S. Hallow for helping me with much of the fieldwork and sorting of the seed and A.I. Jamac for information on pretreatments used by the nursery staff.

I would also like to thank Richard Holt of CRDP and his counterpart A.A. Yasin for useful information on seed extraction and pretreatment.

Glossary of terms and abbreviations

CRDP	Central Rangelands Development Project
IBPGR	
NRA	National Range Agency
ODA	Overseas Development Administration of the United Kingdom Government.

Summary

Tree phenology in harsh arid and semi arid countries such as Somalia is usually linked to rainfall. Most trees come into leaf, flower and fruit after the two rainy seasons.

Seed collection, extraction, storage, insect damage and pretreatment are described. Efforts were concentrated on collection of native species for the 1989 field trials.

1. Introduction.

There is little information on tree phenology, seed collection and seed germination from Somalia. This study, conducted between May 1988 and May 1989 provides some data. Limited resources and difficult access meant phenology observations and seed collection were confined to the Southern Regions. Collection concentrated on useful native species for planting in the 1989 species elimination trials. Only small quantities were collected.

2. Background information.

Somalia is arid or semi-arid under most classifications. Rainfall is the major limiting factor to plant growth and likely to be the main influence on tree phenology. Rain falls in two rainy seasons, the gu and the dayr. These result from the movement of the Intertropical Convergence Zone and the associated Intertropical Front. Considerable rain can also fall on coastal areas during the hagaa. The timing of the gu and the dayr varies across Somalia, and from year to year. Generally however the rains follow a south easterly route across the country. Timing of the seasons in the area of collection are shown in fig. 1.

Temperatures are high in Somalia except in the mountainous areas of the north. Annual mean temperatures range from 30oC at Luuq to 18oC at Erigavo. During the year temperatures fluctuate very little.

3. Tree phenology

Initial information on tree phenology was obtained by examining specimens at the Somali National Herbarium. Unfortunately there were very few, even of common species. Those specimens in fruit and flower were recorded on Form TP1 (see appendix 1) to help with the timing of seed collection. Further information was obtained through searching the literature and through observation. Observations were initially noted on Form TP2. Later observations were recorded directly onto phenology diagrams (see appendix 2).

In harsh arid conditions as prevail over much of Somalia rainfall is the main factor influencing plant physiology (Deshmukh, 1986). Important factors in temperate regions such as day-length and temperature are relatively constant in the arid tropics. Another factor that may have an influence on the phenology of some Somali trees is animal activity, especially for seed dispersal and pollination. The timing of flowering could coincide with the time when pollinating insect populations were greatest.

Most tree species in Somalia come into leaf immediately before, or at the beginning of, the gu and dayr rainy seasons. The leaves are shed at the beginning of the jilaal dry season and reflush at the beginning of the gu. Inland, leaves are also shed

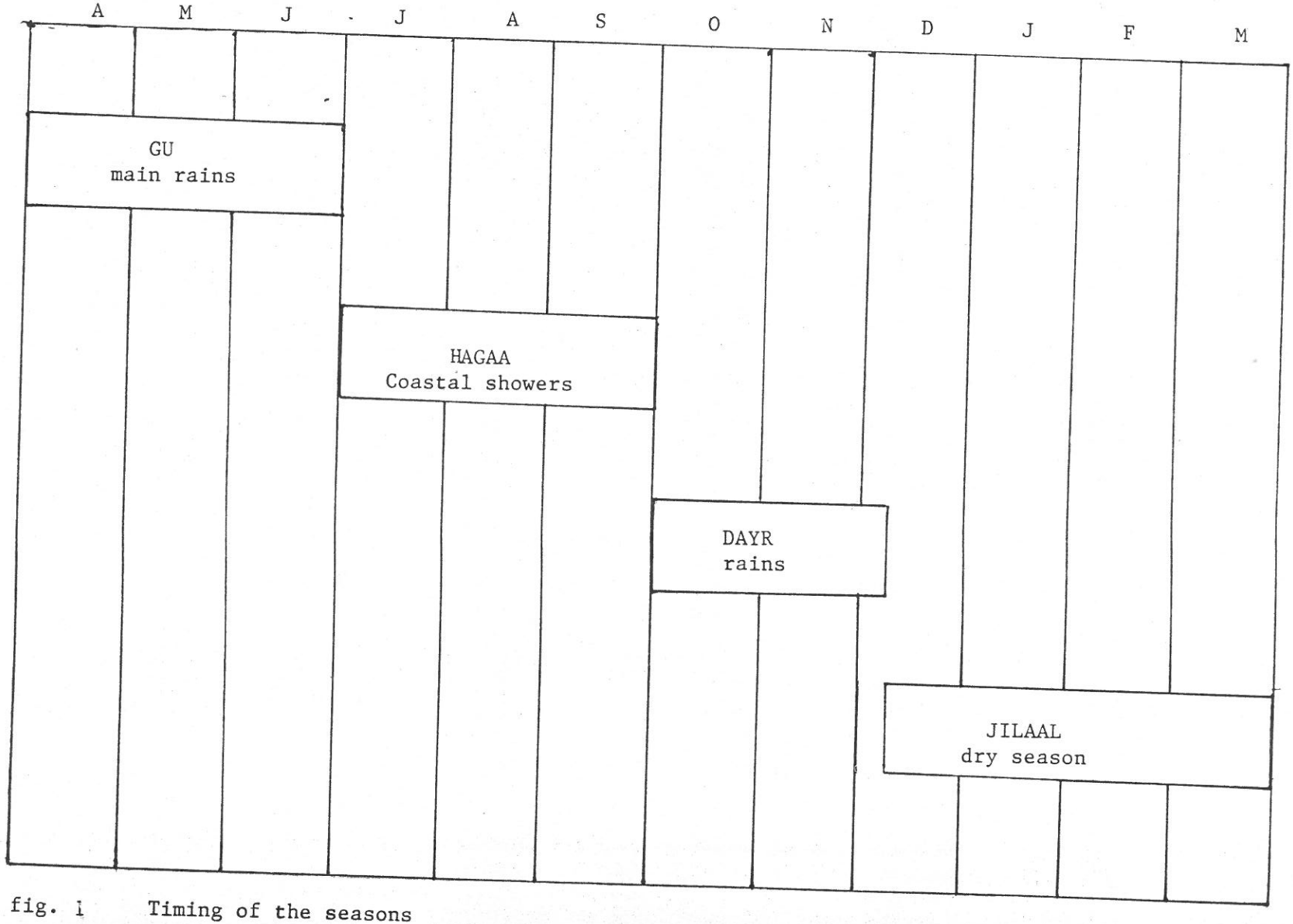

fig. 1 Timing of the seasons

during the hagaa. In coastal areas most trees are in leaf from the beginning of the gu to the end of the dayr. The leaves are not shed in the hagaa. Early accounts of the Somali vegetation recognised these rapid responses to rainfall:

> "Certainly for long periods, especially when the rains are delayed it [the vegetation] does present a poor appearance, but what a reward awaits the keen botanist after a few showers; the whole scene is changed as though some magic wand had been passed over it, the trees in a few days more or less covered with leaves, and in another week or fortnight they are in flower, and the air is laden with the sweet scent of the acacias" (Drake-Brockman, 1912).

In many species, such as the acacias, flowering occurs just before, or at the beginning of the rainy seasons. Most trees fruit at the end of the two rainy seasons when there is sufficient water for fruit development. Where the tree is on a wet site, such as in a drainage basin, the fruiting season is often extended and is more prolific. Rainfall can have a detrimental effect on fruiting, when heavy rain damages the flowers. Acacia bussei near Qansaxdheere which was in flower did not develop fruit. The local people attributed this to damage to the flowers by heavy rainfall.

Within a small area trees of the same species will flower at approximately the same time. This is linked to the very localised pattern of rainfall.

4. Collection and handling of seed

Twenty tree or shrub species were chosen for seed collection. They are native or naturalised, multipurpose trees and were thought to offer potential for tree planting programmes. Seed was collected for testing these species in the species elimination trials established by the BFPS between 1987 and 1989. The uses of these species are shown in table 1. Other native species and two exotic species were collected as opportunity arose.

4.1 Collection

The manpower assigned to seed collection was one forester a forest technician and a driver. None was employed full - time on this task. One vehicle, a Land Rover 110 van was used. This had a roof rack that served as a good platform for seed collection from taller trees. Relevant information was noted on the seed collection form (appendix 2a).

Villagers were employed to collect the seed of most species. Care was taken to ensure that they could identify the desired species as vernacular names of trees sometimes cover several species. For example, hareeri covers both Terminalia prunioides and Terminalia spinosa. Many methods of collection were used,

including beating the seeds from branches onto a sheet underneath the tree and using hooked poles to pull down branches to an accessible height.

table 1 Uses of chosen species

Species	Uses
Acacia bussei	charcoal, fibres, fodder
Acacia nilotica	fuelwood, fodder
Acacia mellifera	fuelwood, fodder
Acacia senegal	fuelwood, charcoal, poles, fodder, gum for chewing and medicines
Acacia seyal	fuelwood, fodder, medicines
Acacia tortilis	fuelwood, fibres, fodder, seeds as food*
Balanites aegyptiaca	fruit*, construction, implements, household utensils, shade
Combretum sp.	fodder
Cordia sinensis	fruit, tool handles
Dobera glabra	fruit*, fodder, shade, stools and beds, utensils
Delonix elata	implements, fodder
Dichrostachys cinerea	utensils, fodder
Grewia villosa	fruit, fodder
Lawsonia inermis	cosmetics, stools, implements
Parkinsonia raimondoi	---
Terminalia orbicularis	firewood, utensils
Terminalia prunioides	firewood, charcoal, poles, fodder
Terminalia spinosa	firewood, charcoal, poles, fodder
Ziziphus spina - christi	fruit, construction, utensils
Ziziphus hamur	fruit

* in times of famine

table 2 Dates and sites of collection.

Species	Dates	Sites
Native species		
Acacia bussei	4/1/89	Nr. Qansaxdheere
Acacia horrida (bush)	1/10/88	Buulo Dacar, nr. Afgooye
Acacia nilotica	23/8/88, 30/11/88	Nr.Shalambood on Baraawe road
Acacia nubica (bush)	1/10/88	Buulo Dacar, nr. Afgooye
Acacia mellifera	4/2/89	Celcillan
Acacia senegal (bush)		Km13 near Afgooye
Acacia senegal (tree)	18/12/89	Habiibayaale, nr. Qansaxdheere,Bay Region
Acacia senegal (tree)	1/89	Nr. Awdinle, Bay Region
Acacia seyal (tree)	10/11/88	Jowhar sugar estate
Acacia seyal (bush)	11-12/88	Awdinle, Bay Region
Acacia stuhlmannii	6-12/11/88	Between Balcad and Jowhar
Acacia tortilis	2/89	Muguurto, Nr Afgooye
Balanites aegyptiaca	29/8/88, 7-9/12/88	Balcad village, Balcad Nature Reserve
Combretum sp.	14/5/88	Buulo Dacar, nr. Afgooye
Conocarpus lancifolius	1/12/88	Belet Weyne
Cordia sinensis	13/8/88, 7/9/88	Nr. Afgooye, in Muqdisho
Dobera glabra	2/88	Qansaxdheere, Bay Region
Delonix elata	2/11/88	Nr. Afgooye
Dichrostachys cinerea	2/11/88	Nr. Afgooye
Garcinia livingstonei	10/12/88	Balcad Nature Reserve
Grewia sp.	11/88	Nr. Qansaxdheere
Grewia villosa	18/9/88	Sagalad, nr Afgooye

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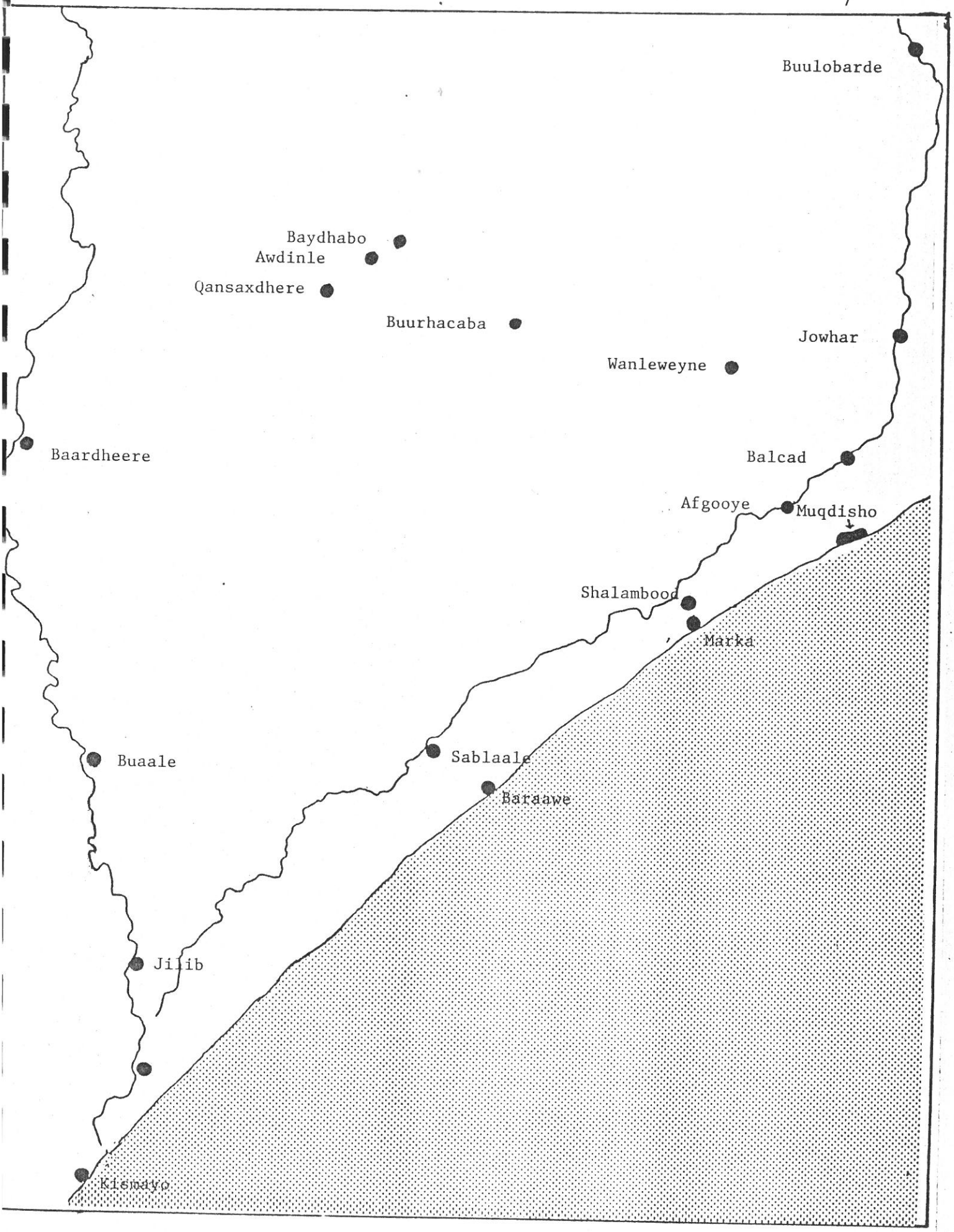
Lawsonia inermis	22/5/88	Sablaale yaar, nr. Sablaale
Maerua kirkii	10/11/88	Nr. Jowhar
Mimusops fruticosa	8/1/89	Balcad Nature Reserve
Parkinsonia raimondoi	17/11/88	Km12 along Muqdisho - Afgooye road
Parkinsonia sp.	17/11/88	Km10 along Muqdisho - Afgooye road
Tamarindus indica	5/9/88, 22/12/88	Muqdisho, Hammer Weyne market
Terminalia orbicularis	22/12/88	Qansaxdheere
Terminalia prunioides	13/7/88	Qansaxdheere Between Awdinle and Berdale and between Awdinle and Qansaxdheere
Terminalia spinosa	13/7/88	Between Awdinle and Berdale and between Awdinle and Qansaxdheere.
Ximenia americana	4/12/88	20 km S of Balcad
Ziziphus hamur	7/88	Bought at the market at Luuq
Ziziphus spina-christi	28/6/88, 4/12/88	BFPS compound, Muqdisho, 10 km S of Balcad.
Exotic species		
Parkinsonia aculeata	5/11/88	Jimbiley, nr. Jalalaqsi
Prosopis juliflora	2/11/88	small plantation nr. Afgooye

Fruits were placed in cloth sacks in the field. This was to reduce the accumulation of water from condensation which encourages the growth of fungi. Date and location of collection of each species is shown in table 2. Locations are shown on map 1.

During collection much variation in form was noted in some species; particularly Acacia nubica, Acacia horrida and Acacia seyal which exist in two forms, arborescent and bush. This may be phenotypic, genotypic or both. Acacia senegal appears to have three forms, a bush form, var. karensis and two tree forms, var. senegal and var. leiorhachis. Collections of the different forms were kept separate.

4.2 Extraction

The methods used to extract the seed are listed in table 3.



map 1. Location of places mentioned in the text. Scale c. 1; 2,000,000

table 3 Methods of extraction.

Species	Method of Extraction
Acacia bussei	Seeds were scraped from the open pods.
Acacia horrida	Seeds were scraped from the open pods.
Acacia mellifera	Seeds were scraped from the open pods.
Acacia nilotica	Ripe pods were split open using a mortar and pestle and the seeds removed.
Acacia nubica	Seeds were removed from the mature pods by hand.
Acacia senegal (tree)	Seeds were removed from slightly green pods and dried.
Acacia senegal (bush)	Seeds were scraped from the open pods.
Acacia seyal(bush & tree)	Seeds were stripped from open pods by hand.
Acacia stuhlmannii	Seeds were removed from the closed pods by hand.
Acacia tortilis	Seeds were removed from the closed pods by hand.
Balanites aegyptiaca	Fruits were left to dry in the sun. The fruit and stone was split using pliers and the seed removed. This method damaged a high proportion of the seed.
Combretum sp.	Wings were stripped by hand before storage.
Conocarpus lancifolius	
Cordia sinensis	Fruit was dried and the seed then extracted from the flesh by hand. Removing the flesh from the seed proved difficult.
Delonix elata	Seeds were removed from the dried pods by hand.
Dichrostachys cinerea	Seeds were removed from the dried pods by hand.
Dobera glabra	Seeds were removed from the fruit by hand, scraping off the thin layer of flesh.
Garcinia livingstonei	No treatment required
Grewia villosa	Flesh was eaten and the seeds spat out.
Lawsonia inermis	Fruit was thoroughly dried. It was then crushed with a pestle and mortar. The small seeds were sorted from the debris by sieving.
Maerua kirkii	Seeds were removed from the fruit and dried.
Mimusops fruticosa	Seeds were removed from the fruit by hand.
Parkinsonia aculeata	The dried mature pods were broken open and the seeds removed.

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Parkinsonia raimondoi	The dried mature pods were broken open and the seeds removed.
Prosopis juliflora	Pods were cut into small sections and the seeds removed from the sticky pod
Tamarindus indica	Fruits were placed in water and the seeds removed by hand from the pulp.
Terminalia orbicularis	Outer layer with the wings was removed. The spongy tissue around the seed was also removed.
Terminalia prunioides	Wings were stripped at planting by hand.
Terminalia spinosa	As for T. prunioides.
Ziziphus hamur	Flesh was removed after drying. The stones were then cracked using a pair of pliers or a rock and the two seeds removed. This method resulted in a high proportion of damaged seed.
Ziziphus spina-christi	As for Z. hamur.

Since extracting our seed more information has been found for Balanites spp. Removing the seed from the stone is unnecessary and can cause damage to the embryo. Removing Ziziphus spp. from the stone is also unnecessary (Yasin, pers. comm).

4.3 Preparation

Seed and fruits were sun dried on a rack, made of two wooden frames covered with mosquito netting. The frames were placed one on top of the other and held about 30 cm off the ground by concrete blocks placed at each corner. (fig. 2). This design allowed air to circulate around the seeds. This method is simple and cheap but will not reduce moisture content below about 11% (Bowen, pers. comm.).

4.4 Seed storage

Seeds can be classified into two broad groups, recalcitrant and orthodox. Recalcitrant seeds are difficult to store as they cannot be dried below a high moisture content of around 30% and will not survive temperatures below 5oC. Orthodox seeds are readily dried to about 5% moisture content on a wet weight basis. They can be stored at low temperatures for long periods. Most of the seeds collected were orthodox. There were problems in reducing the water content of Dobera glabra and Garcinia livingstonei.

Reducing water content reduces or eliminates damage by biotic agents such as insects and fungi. Reducing moisture content to between 12 - 14% stops fungal damage and below 8% prevents insect damage. Harrington (1963, 1970 in Willan 1985) provides two useful guidelines for storage of agricultural seed:

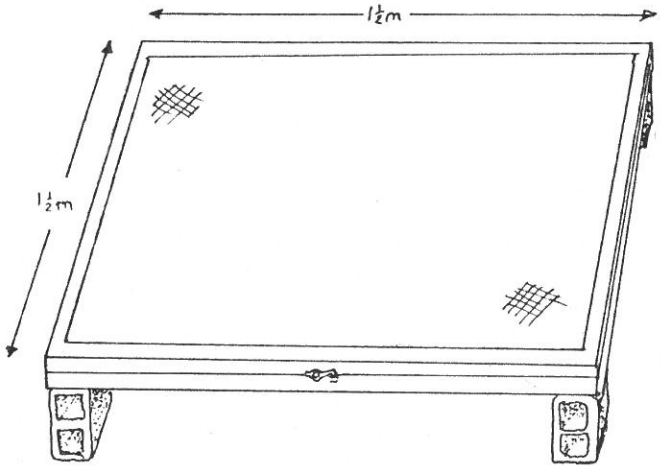


fig. 2 Seed drying frame.

(1) For every decrease in moisture content of 1% below 13% there is a doubling of a seed's life. Moisture contents of 4 to 8% are considered safe for orthodox seeds.

(2) Between 0oC and 50oC every reduction in temperature of 5oC doubles the time the seed is viable.

Seeds were stored in labeled, sealed clear polythene bags. The labels were of the same format as the seed register and seed collection forms (appendix 2a, 2b, 2e). The bags were kept, at room temperature, in a metal cupboard. The species were arranged alphabetically for easy location. Refrigeration was not considered necessary because of the short storage time. Most seed was to be sown within the year.

It was decided to produce a new updated register. The seeds were catalogued alphabetically, by genus. Species were also listed by their number in the seed register. An inventory was made of the quantity of seed of each species. For this the weights of the seeds were measured. These are shown in appendix 4.

Damage

The seed of several species showed damage by biotic agents. The agent responsible and the proportion of seed damaged is described in table 4. Insects were responsible for most of the damage.

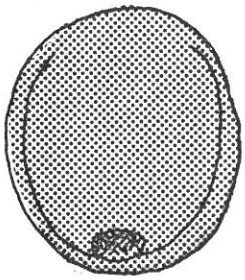
Bruchid beetles are the most important damaging agent of seeds of species collected. Damage is usually characterised by a very small, difficult to see entrance hole, while the larva is developing within the seed and a larger exit hole when the adult has emerged (fig. 5). The proportion of seed damaged is difficult to assess and is likely to be underestimated. This is owing to the extended time taken for the beetles to develop and emerge, varying from 3-4 weeks to many months (Southgate, 1983). Lepidopterans are pests of the native Parkinsonias, Delonix elata and Balanites aegyptiaca. These moths develop within the seed protected by the hard seed coat of Parkinsonias and Delonix and by the tough stone of Balanites (fig 6). The Balanites seed collected from the ground were damaged by ground squirrel. Several weeks after collection, cleaning and storage of Cordia sinensis small wasps were observed in the sealed polythene bag.

To prevent damage by insect pests during storage the seeds of susceptible species were dusted with a locally available DDT insecticide. Damage of stored seed was recorded on Form SEED4 (See appendix 2d).

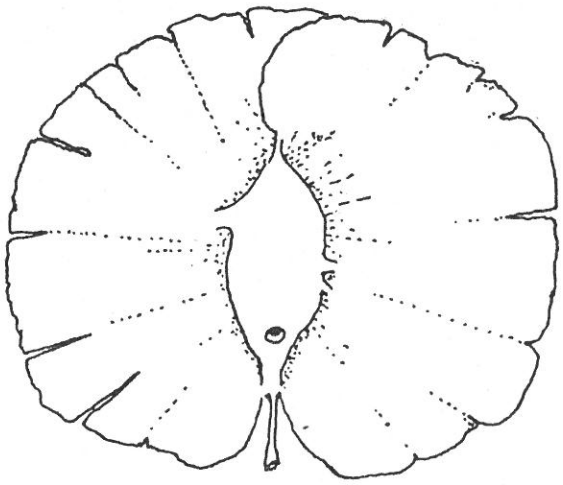
table 4 Damaging agents

	Species	Damaging agent	% damaged
(1)	Acacia bussei	Bruchid beetles	21
(2)	Acacia mellifera	Bruchid beetles	-
(3)	Acacia nilotica	Bruchid beetles	ca. 10
(4)	Acacia nubica	Bruchid beetles	-
(5)	Acacia senegal	Bruchid beetles	7
(6)	Acacia seyal	Bruchid beetles	6
(7)	Acacia stuhlmannii	Bruchid beetles	7
(8)	Acacia tortilis	Bruchid beetles	3
(9)	Balanites aegyptiaca*	Lepidopteran	13
		Ground squirrel	5
(11)	Cordia sinensis	Hymenopteran	-
(10)	Delonix elata	Lepidopteran	-
(11)	Dichrostachys cinerea	Bruchid beetles	37.5
(12)	Parkinsonia raimondoi	Lepidopteran	2
		Bruchid beetles?	7
(13)	Parkinsonia schiona	Lepidopteran	11
(14)	Tamarindus indica	Weevil	24
(15)	Terminalia orbicularis	Bruchid beetles	-
(16)	Terminalia prunioides	Bruchid beetles	-

* collection included a high proportion of fallen fruit

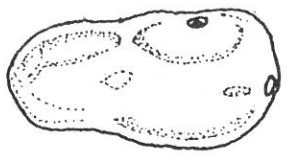


Bruchid beetle damage to Acacia nilotica X6

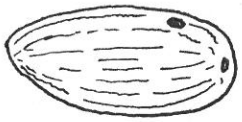


Bruchid beetle damage to Terminalia orbicularis X1

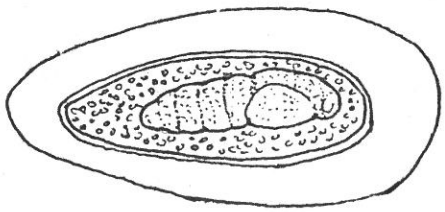
fig. 3 Bruchid beetle damage



(a)

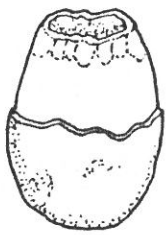


(b)



(c)

Lepidopteran damage to Balanites aegyptiaca
(a) fruit X1, (b) stone X1 (c) Longitudinal section of stone X2



Ground squirrel damage to Balanites aegyptiaca X1

fig. 4 Damage to Balanites aegyptiaca

5. SEED PRETREATMENT AND GERMINATION.

5.1 Pretreatments

Pretreatment of seed is often required to obtain uniform and rapid germination.

A review of the available literature indicated appropriate pretreatments. These are shown in table 5.

table 5 Recommended seed pretreatments.

Species	Pretreatment
Acacia spp.	A boiling water treatment: immersing the seeds in 4-10X their volume of boiling water. Take water off the boil. Soak the seeds in the gradually cooling water for 12-24 hours. This can give erratic results (Doran et al, 1983). Treatment with concentrated sulphuric acid is considered more effective than boiling water for African Acacias. Commercial grade acid (95%) is required. Soak for 20-60 minutes. The solution should be heated to between 20-27o C for best results (Doran et al, 1983). Scarification of the shoulder of the seed is thought to be one of the most reliable pretreatments (fig 3). There are occasions when chipping the seed coat has had a detrimental effect on germination (Doran et al, 1983). Dry heat and microwaves are also mentioned as possible pretreatments (Doran et al, 1983).
Acacia nilotica	Soft coated, fresh seeds need no pretreatment. Dipping seeds in boiling water for 5-30 seconds or pouring boiling water over them and then leaving them in the water until it cools are recommended. Seeds with very hard coats can be soaked in concentrated sulphuric acid for 60-120 minutes (FAO, 1974a, Turnbull, in Doran et al, 1983).

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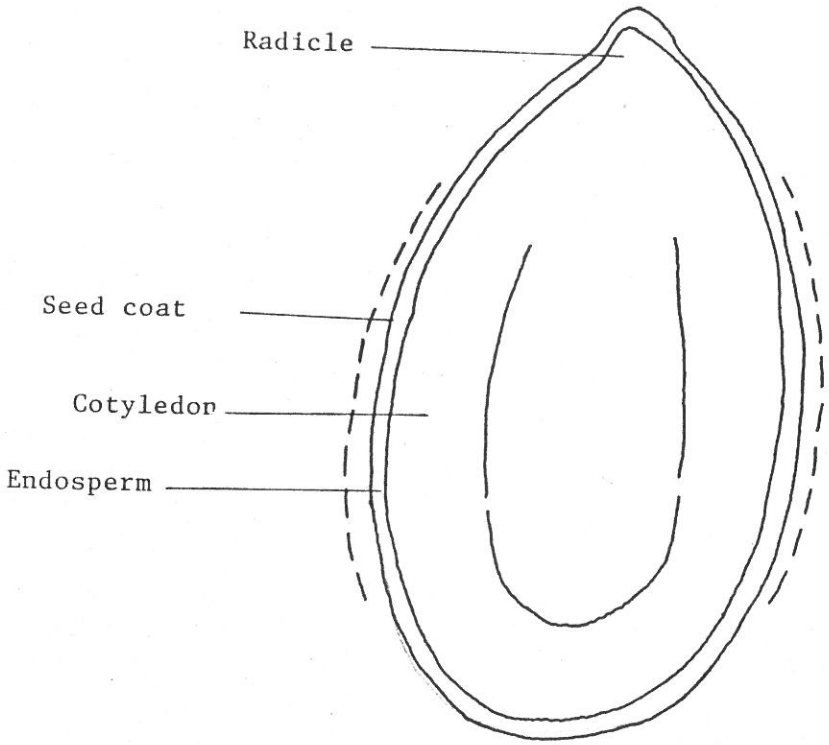
Acacia senegal	Soft coated, fresh seeds with soft seed coats need no pretreatment. Older seed can be immersed in concentrated sulphuric acid for 3-15 minutes or dipped in boiling water for 5 seconds (Kaul & Manochar, 1966; Cheema and Qadir, 1973; Giffard, 1975; NAS, 1980; Turnbull, unpublished; all in Doran et al, 1983).
Acacia tortilis	Soak in concentrated sulphuric acid for 20-120 minutes. Immersion in boiling water may also be effective. IBPGR (1984) recommend mechanical or chemical scarification.
Balanites aegyptiaca	Soak seed overnight to improve germination (Teel, 1984; Holt, pers comm).
Combretum spp.	Teel (1984) recommends that the seed be sown fresh for Combretum schumanii.
Tamarindus indica	Nicking the seed coat results in quick germination (Teel, 1984). Various water treatments are recommended; soaking in cold water for 24 or 48 hours and soaking in hot water for 24 hours (Von Carlowitz, 1986). IBPGR (1984) also recommend soaking in hot water.
Terminalia orbicularis	Removing the wings resulted in germination of about 20% (Jamac, pers comm).
Terminalia prunioides	Teel (1984) recommends burning the seed.
Terminalia spinosa	Soaking the seed is recommended (Holt, pers comm)
Ziziphus spp.	Information on Ziziphus mauritiana recommends removing the seed from the stone immediately before sowing (Teel 1984). Other sources suggest scarification (UNSO/FINNIDA undated) and soaking in cold water for 48 hours.
Ziziphus spina-christi	Scarification followed by soaking in cold water is recommended (von Carlowitz, 1986).

Limited information on viability meant most seed was sown fresh. Pretreatments used are listed in table 6.



------ Safe area for scarification

fig. 5 Scarification of Acacia seed (CFI undated)

table 6 Seed pretreatment used

Species	Seed pretreatment
Acacia albida	Scarification.
Acacia bussei	Scarification.
Acacia horrida	Scarification.
Acacia mellifera	Scarification.
Acacia nilotica	Scarification.
Acacia nubica	Scarification.
Acacia seyal	Scarification.
Balanites aegyptiaca	No pretreatment to the stone. Earlier attempts to remove the seed from the stone resulted in much damage and poor germination.
Cordia sinensis	Sown in the fruit or extracted from the fruit. No other treatment.
Grewia villosa	No pretreatment.
Lawsonia inermis	No pretreatment.
Parkinsonia raimondoi	No pretreatment.
Terminalia orbicularis	No pretreatment.
Terminalia prunioides	Burning, soaking and no pretreatment.
Terminalia spinosa	Burning, soaking and no pretreatment.
Ziziphus hamur	Extracted seeds sown with no pretreatment.
Ziziphus spina-christi	Extracted seeds sown with no pretreatment.

Scarification was used for the Acacia spp. Treatment with concentrated acid was considered too dangerous and treatment with boiling water liable to damage the embryo. Scarification gave good germination for all but Acacia nilotica of which a high proportion were damaged by Bruchids. Reasonable (>25%) germination was obtained for all species except Terminalia spp. and Balanites aegyptiaca. Most of the Balanites seed used was poor quality or damaged in extraction. Extracting the seed from the stone and pretreatment is not necessary.

5.2 Germination

Germination for four species was noted.. Bar charts of germination plotted against time were produced for three species and are shown in appendix 5.

table 7 Germination percentage with different pretreatments

Species	Pretreatment	Germination %
Cordia sinensis	Fresh seed, no pretreatment	23
Terminalia orbicularis	Fresh seed, dewinged	20
Terminalia prunioides	Fresh seed, no pretreatment	0
	Fresh seed, burnt	0
	Fresh seed, soaked	0
Terminalia spinosa	Fresh seed, no pretreatment	0
	Fresh seed, burnt	0
	Fresh seed, soaked	0
Ziziphus hamur	Fresh seed, no pretreatment	30

6. Future recommendations

Obtaining seed has been a major constraint to many forestry projects in Somalia. Poor roads and long distances to travel take their toll on vehicles and staff. This, and the unpredictability in the quantity of seed produced due to climate and predators makes seed collection difficult.

For certain genera such as Parkinsonia and Acacia successful pretreatments are known. Investigating the effect of different pretreatments would be useful for other genera, such as Terminalia. For some of the potentially useful species, information on viability over time in different conditions would be worthwhile.

Other work could investigate the pattern of germination over time. This, combined with information on initial growth would allow estimates of time taken to obtain a reasonable sized transplant.

The seed of many of the selected species has been collected before and many of the species have been planted in small numbers in Somalia. Unfortunately, little of this experience has been recorded. In future a database including location, time of fruiting and flowering and vernacular names of useful native trees would aid collection. Another could include information on germination following different pretreatments.

References

CFI (undated) International Trial of Dry Zone Hardwood Species, CFI, Oxford, 6p.

Deshmukh, I. (1986) Ecology and Tropical Biology, Blackwell Scientific publications, 397p.

Doran, J.C. et al (1983) Handbook on seeds of dry zone acacias, FAO, Rome, 92p.

Drake-Brockman, R.E. (1912) British Somaliland, Chapter XIII, The Flora and Fauna, 221-265.

FAO (1975) Forest tree seed directory, FAO, Rome, 283p.

IBPGR (1984) Forage and browse plants for arid and semi - arid Africa, Royal Botanic Gardens, Kew, London, 293p.

Southgate, B.J. (1983) Handbook on seed insects of Acacia species, FAO, Rome, 30p.

Teel, W. (1984) A Pocket Directory of Trees and Seeds in Kenya, Kengo, Nairobi, 151p.

UNSO/ FINNIDA (undated) Nursery and propagation trials report, (SOM/82/S01), Coastal Sand Dune Fixation Project, Baraawe area, 17p.

Von Carlowitz, P.G. (1986) Multipurpose Tree and Shrub Directory, ICRAF, Nairobi, Kenya, 265p.

Willan, R.L. (1985) A guide to forest seed handling - with special reference to the tropics, FAO Forestry Paper 20/2, Rome, 379p.

appendix 1
Phenology data forms.

Record No._____ FORM TP1

Species_____

Date __/ __/ 89 Recorder_____

Location_____

_____

Soil colour_____ Texture_____ Drainage_____

Topography_____

Leaf (1) None, (2) Partial, (3) Full

(1) Bud, (2) Young, (3) Mature, (4) Senescent

Flower (1) None, (2) Sparse, (3) Moderate, (4) Heavy

(1) Bud, (2) Mature, (3) Dead

Fruit (1) None, (2) Sparse, (3) Moderate, (4) Heavy

(1) Immature, (2) Mature, (3) Fallen

What proportion of trees of the same species show the same response?

Most, Many, Few

Notes_____

_____

_____

Record No._____ FORM TP2

Species_____

Date collected __/ __/__ recorded __/ __/ 89

Recorder_____

Location_____
_____

Leaf (1) None, (2) In leaf

(1) Bud, (2) Young, (3) Mature, (4) Senescent

Flower (1) None, (2) In flower

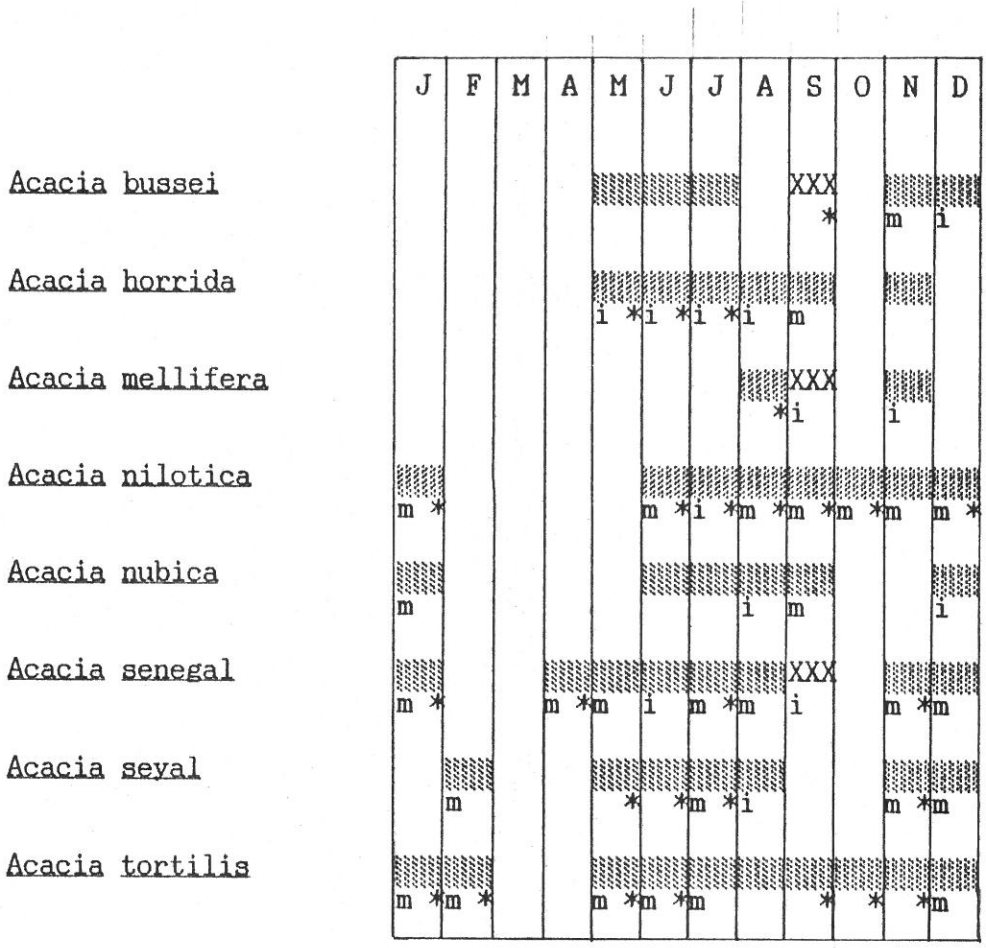
(1) Bud, (2) Mature, (3) Dead

Fruit (1) None, (2) In fruit

(1) Immature, (2) Mature

Notes_____
_____
_____

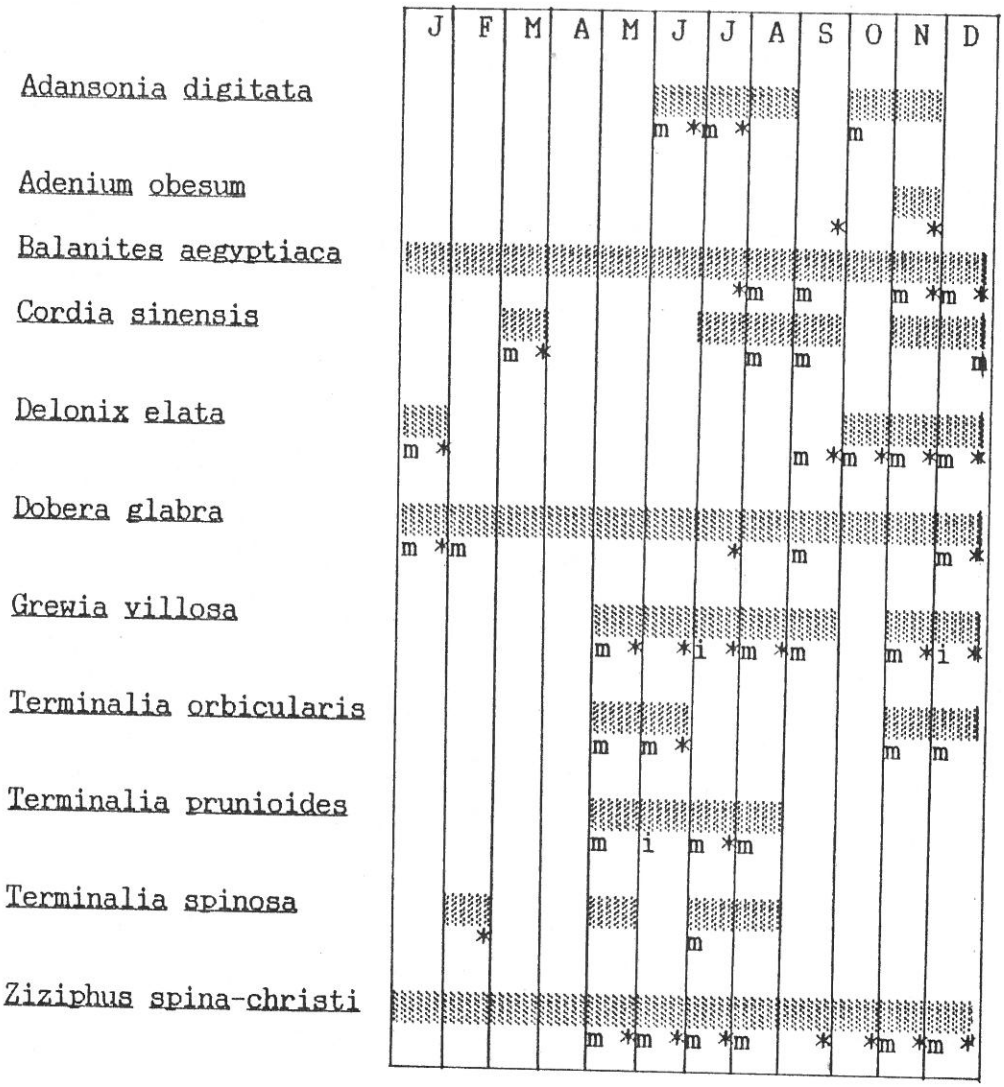
appendix 2
Tree phenology diagrams.



KEY

No leaves	X
In leaf	▒
In flower	*
Immature fruit	i
Mature fruit	m

Phenology information on Acacia spp. in Southern Somalia



KEY

No leaves	X
In leaf	▒
In flower	*
Immature fruit	i
Mature fruit	m

Phenology information on native spp. in Southern Somalia

appendix 3
Seed collection and germination forms.

SEED COLLECTION REPORT FORM SEED 1

SEED LOT NO. _____

COLLECTION NO. _____ SPECIES _____

REGION _____ DATE ___/___/88 RECORDER _____

LOCATION _____

_____

_____

_____

TOPOGRAPHY FLAT/HILLY SOIL DEEP/INTERMEDIATE/SHALLOW

SLOPE: STEEP/MEDIUM/GENTLE Drainage: _____

Stoniness: _____

Texture: _____

RAINFALL Mean annual _____ Wet months _____ Dry months _____

TEMPERATURE Mean annual _____ Mean max. _____ Mean min. _____

Stand (i) Natural Groups/Open Thin/Dense

Young/Middle Aged/Old

(ii) Plantation Age:_____ years Height:_____ m. Diam:____cm

Original Source _____

Associated Species _____

FORM Boles Single/Multiple Straight/Fair/Poor

Crowns Flat/Narrow/Average/Wide

Seed Crop Light/Medium/Heavy

_____

Seed Collection No. of Trees _____ Min. dist apart _____

Dates of Collection _____

Remarks _____

_____

_____

SEED REGISTER FORM SEED 2

SEED LOT NO. _____

ORIGINAL SEED LOT NO. _____ or COLLECTION NO. _____

SHIPPER _____ or COLLECTOR _____

RECORDER _____

ORIGIN COUNTRY _____ REGION _____ VILLAGE _____

Latitude _____ Longitude _____ Altitude _____

Rainfall Zone _____

SITE DESCRIPTION _____

_____

Number of Mother Trees _____

Date of Collection __/ __/ __ Date of Storage __/ __/ __

Quantity in Store _____

ALLOCATIONS

DATE	Demand No.	Issued to	No. of g issued	No. of g remaining

SEED GERMINATION FORM SEED 3

SEED LOT NO. _____ ORIGINAL SEED LOT NO. _____ or

COLLECTION NO. _____ SPECIES _____

DATE OF COLLECTION ___/___/88 DATE OF SOWING ___/___/88

RECORDER _____

SEED PRETREATMENT _____

RESULTS: No. Seeds sown _____

Date				
No				
Date				
No				
Date				
No				
Date				
No				
Date				
No				
Date				
No				

SEED DAMAGE FORM SEED 4

SEED LOT NO. _____

ORIGINAL SEED LOT NO. _____ or COLLECTION NO. _____

DATE OF COLLECTION __/ __/ __ DATE OF RECORD __/ __/ __

_____

DAMAGING AGENT _____

TYPE OF DAMAGE _____

_____

PROPORTION OF SEEDS AFFECTED _____%

TYPE OF STORAGE _____

_____

TYPE OF TREATMENT TO DAMAGING AGENT _____

_____

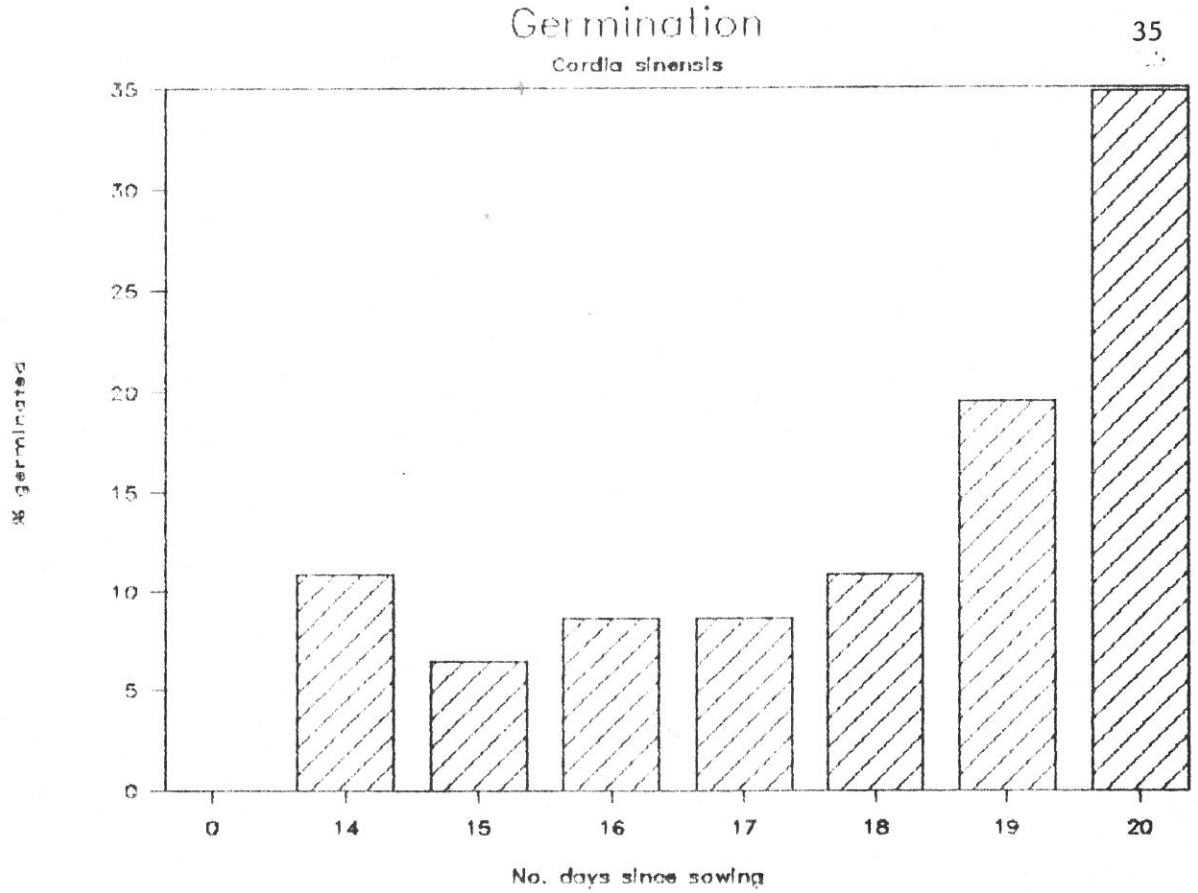
_____

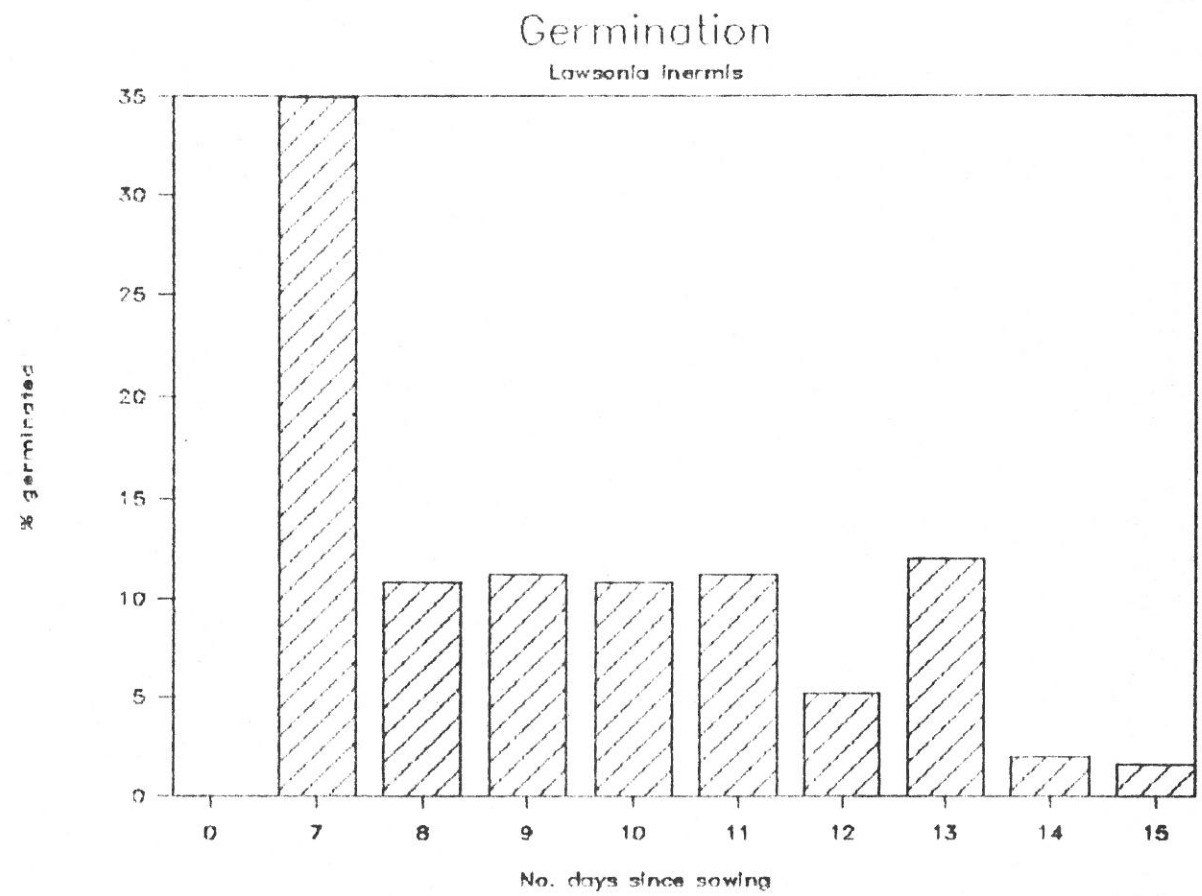
appendix 4
Seed weights.

Species	seeds/kg
Acacia albida	
Acacia bussei	
Acacia horrida	26,000
Acacia mellifera	22,300
Acacia nilotica	13,100
Acacia nubica	11,200
Acacia senegal	17,100
Acacia seyal(tree)	46,300
(bush)	37,000
Acacia tortilis	27,200
Albizia antihelmentica	2,900
Balanites aegyptiaca*	1,900
Cordia sinensis	8,800
Dichrostachys cinerea	83,300
Dobera glabra	3,700
Garcinia livingstonei	
Grewia tenax	45,500
Grewia villosa	22,500
Lawsonia inermis	166,700
Maerua kirkii	1,700
Mimusops fruticosa	3,500
Parkinsonia raimondoi	600
Parkinsonia sp.	3,700
Tamarindus indica	1,700
Terminalia orbicularis	2,900
Terminalia prunioides**	4,900
Terminalia spinosa**	14,900
Ximenia americana	1,300
Ziziphus hamur	78,100
Ziziphus spina-christi	45,500

* extracted from stone
** with wings.

appendix 5
Germination against time.


Germination
Cordia sinensis
% germinated
0
5
10
15
20
25
30
35
0
14
15
16
17
18
19
20
No. days since sowing


Germination
Lawsonia inermis
% germinated
0
5
10
15
20
25
30
35
0
7
8
9
10
11
12
13
14
15
No. days since sowing