

# !NARA

## *Fruit for development of the !Khuseb Topnaar*

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Foreword by Chief Seth Kooitjic

**Dedicated to**  
**Ouma Lydia Swartboo**  
(pictured in early 1970s on front cover)

respected elder of the !Khuseb Topnaar and resident of Armstraat,  
founding member of the NARA project,  
*for her devotion towards the !nara tradition.*

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**Foreword**  
**by Chief Seth Kooitjie**

When I was elected as Chief twenty years ago, I voted to uphold and promote the livelihood of my people, the Topnaar. Given the circumstances I inherited, there was no doubt in my mind about the difficult struggle ahead of me to try and address the difficulties within the traditional area of my community, as part of the community are living in the Namib-Naukluft Park. One of the most important issues I had to face was the one-sided policy prohibiting us from practising our traditional rights within our traditional territory. In so doing my community lost a great part of their culture and traditional way of life.

However, one part of our culture remained attached to my people as it has been and still is and will be their way of life for centuries to come. We have been given the opportunity to protect, conserve, and to promote the only remaining natural resource we can claim without any fear of contradiction: the !NARA PLANT.

Over the years, we met hundreds of researchers and people who wrote about the importance of the !nara plant and its cultural and traditional value in the lives of the Topnaar people. Indeed these articles and literature contributed to the exposure of the unique endemic plant. As the traditional authority, we realised that much more is needed to conserve and to secure the future of this important plant, at the same time, to ensure sustainable use of the plant through education programmes for the users of this Natural Resource.

I appeal to all Namibians and interested international parties throughout the world to play an active role in protecting these unique plants, by contributing towards the efforts of the leaders of the community to ensure the survival of the !nara plants. This can only be achieved by joining hands in the efforts to understand the process of how this plant ensures its survival in the desert. Also, equally important, are the factors contributing to the deterioration and decline of production by the plants.

Being a responsible leader, I would like to see this project fulfilling set objectives:

- to ensure the protection and survival of the !nara plant
- to ensure sustainable utilisation
- to ensure the successful cultivation of the !nara plant through research.

To this end I pledge all my support and would like to share with you the praise of the !Nara by the Elders of our community.

*You round food with many thorns,  
Foster mother of the Topnaar children,  
Even when I'm far away I shall think of you,  
You food of my ancestors,  
I will never forget you,  
There is no breast-feeding woman like you.*

With these few words, I thank everyone who contributed to the realisation of the first ever document initiated by the community and produced by the hard working researchers and students of the DRFN. I hope that this document will contribute towards promotion and sustainable utilisation of indigenous plants.

I would also like to take this opportunity to express my profound appreciation towards our government for recognising the need to assist the Topnaar Community to realise their dream by taking the initiative in providing funds for the first ever community-owned !nara project.

May God bless all your hard work.

I thank you.



**The Chief, S.M. Kooitjie, Topnaar Community**

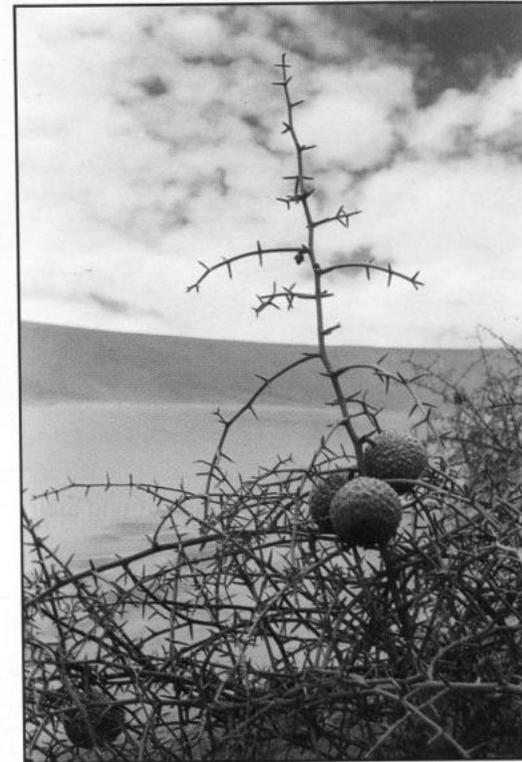
## Acknowledgements

- Chief Seth Kooitjie (Topnaar Chief): foreword, permission to conduct research, valuable information, discussion, interest and support
- Topnaar of the Lower Kuiseb Valley, and especially harvesters of Soutrivier, Klipneus, Swartbank, Ituseb, Ururas, Dawe-draes, Goâ-danab and Armstraat: information exchange, interviews on !nara resource management
- Hermann Areseb, resident of Armstraat: enthusiasm and field assistance
- Mary Seely, DRFN: encouragement, discussion, project planning
- Ulrike Büttendorf and Andreas Gazza Shilomboleni: assistance with conducting interviews, analyses and producing preliminary reports on the baseline study
- Deon Sharuru and Gabes !Nawaseb, DRFN: translations between English and Nama, valuable discussion of observations
- Prof. Fritz Becker, University of Namibia: guidance, discussion
- Manfred Menjengwa, Directorate of Rural Development: information & discussion
- Pierre du Plessis and Cyril Lombard, CRIAA SA-DC: information & discussion
- Dr. Gillian Maggs-Kölling, National Botanical Research Institute: discussion
- Dr. John Kinahan: discussion
- Vilho Snake Mtuleni, DRFN research assistant: assistance with fieldwork and workshops
- Other staff and interns of DRFN at Gobabeb: Shannon Anderson, Hendrik Bam, Birgit Breuninger, Karen Goldberg, Inge Henschel, Sonja Iwanek, Abigail Kham, Connie Krug, Rainer Krug, Olavi Makuti, Lesley Parenzee, Mark Robertson, Annabel Smith: support in numerous ways, including fieldwork, information exchange and workshops
- Pastor Walter Moritz: discussion, interest and a generous donation to the Topnaar for this project
- !nara primary wholesalers Mrs. Brits, Mrs. Owens, Mr. Webster, Mr. Yon of Walvis Bay: valuable information on wholesale
- !nara secondary wholesalers and retailers: Cape Town: Abrahamse & Sons, Atlas Trading, Gheewala & Sons, van Wyk; Lüderitz: Martins & Sons, Sneuve; Swakopmund: Granny's
- Permanent Secretary Tangeni Erkana and Director Maria Kapere of the Ministry of Environment and Tourism: permission and continued interest
- Lindsay Dentlinger, Pierre du Plessis, Nina Gruntkowski, Bill Hamilton, Sara Jensen, Mary Seely: comments on previous drafts.
- Namibian Indigenous Fruit Task Team: guidance, encouragement and financial support.

## List of abbreviations

BP	before present. In archaeology, "present" is taken as 1950
CBNRM	Community-Based Natural Resource Management
CRIAA SA-DC	Centre of Research Information Africa Action, Southern African Development and Consulting
DRFN	Desert Research Foundation of Namibia
GIS	geographical information system
GRN	Government of the Republic of Namibia
IFTT	Indigenous Fruit Task Team
MAWRD	Ministry of Agriculture, Water and Rural Development
MET	Ministry of Environment and Tourism
NARA	Natural Resource management of the #Aonin (different from !nara, the name of the fruit or plant)
NGO	non-government organisation
pers. comm.	personal communication
pers. obs.	personal observation
SADC	Southern African Development Community
SD	standard deviation
SSD	Social Sciences Division
TCF	Topnaar Community Foundation
UNDP	United Nations Development Program
WUE	water use efficiency

## Summary



!Nara (*Acanthosicyos horridus*) is a leafless, thorny, melon-bearing bush that grows in the Namib Desert. The plant is an important component of the dune ecosystem, providing shelter and food to many different animals, and bringing moisture via its deep roots to the desert surface.

!Nara is also a valuable resource for rural Topnaar (also called #Aonin<sup>1</sup>), a community of some 300 pastoralists and gatherers who live in the lower Kuiseb valley in the Namib. They traditionally depend on small stock farming and !nara harvesting and processing for their livelihood. Fruits are collected as food and the highly nutritious seeds are extracted for sale as a source of income. Based on a long tradition of gathering, the !nara has fundamental cultural value to the Topnaar, and enables them to maintain a degree of self-sufficiency in a seemingly depauperate desert environment.

<sup>1</sup> The symbols !, #, / and // denote clicks in the Nama language



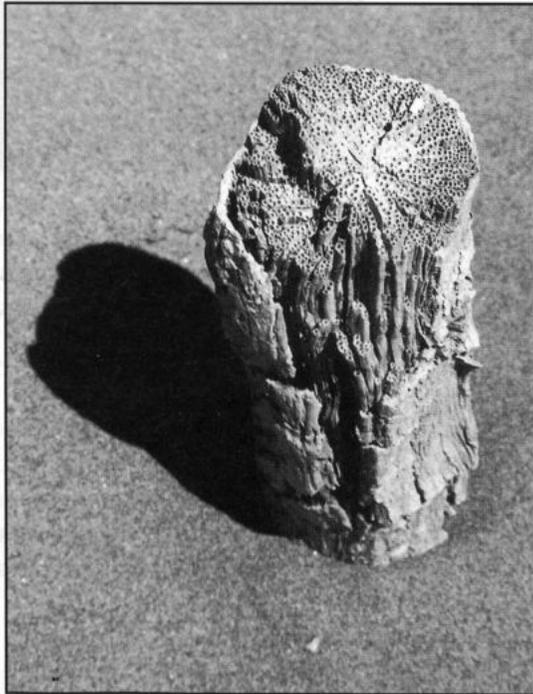
M. Seely

### **!Nara as a desert plant**

!Nara plants grow in the dunes and on the flanks of ephemeral rivers in the Namib sand sea. As they grow, wind-blown sand piles up around their branches, forming large hummocks.

The long tap root reaches from the surface to groundwater deep below. A dried fragment shows the many conspicuous xylem (water-carrying) vessels, which are the widest found in any living plant.

It also emphasizes the plant's dependence on a perennial supply of water underground.

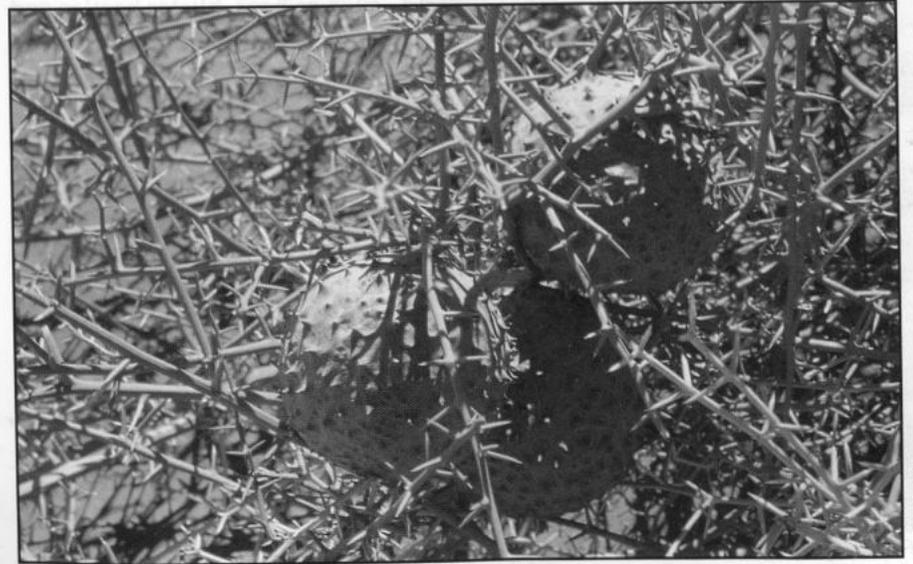


J. Pallett



DRFN

!Nara shows typical characteristics of a desert plant. It is leafless, with stomata lying in longitudinal grooves on the stem and possesses a thick cuticle to limit transpiration. Surface waxes and microscopic hairs also reduce stem temperature. The plants carry out low but steady photosynthesis and growth, which are related to the reduced plant surface area of the plant. Surprisingly, transpiration rate is high, giving rise to low water use efficiency.



J. Pallett



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#### Flowering and pollination

Male and female !nara flowers grow on separate plants. Males (top) flower almost all year round, and attract a variety of insects such as bees, blister beetles and moths. Pollination is achieved mostly by two species of bees.

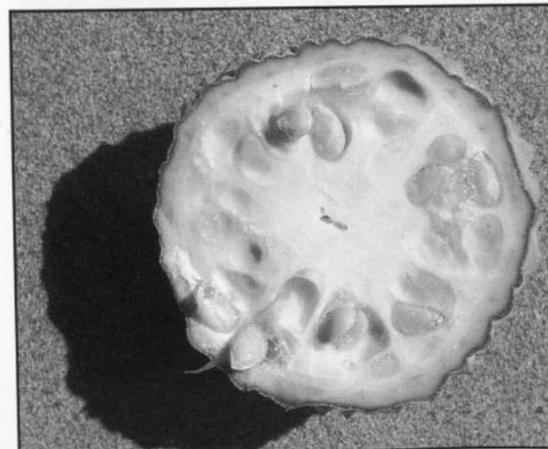
Female flowers (left) can be identified by the fruit bud which grows at the base of the flower. They grow in the summer months (September - April), and the fruit buds enlarge and develop once pollination has occurred.

#### Fruit production

!Nara melons take about three months to ripen fully. Tough and spiny on the outside, they contain juicy flesh and many nutritious seeds (pips) with-in.



M. Seely



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On average, melons weigh just under a kilogram and bear about 50 seeds; 11-20 melons are required for one kilogram of seeds. It is these seeds that play such an important role in the traditional lifestyle of the Topnaar.



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#### Agents that help or hinder !nara

Many Namib Desert animals play a role in the ecology of the !nara. !Nara crickets (top) and blister beetles eat soft parts such as the flowers and branch tips. The greatest damage to the plants, and especially its fruit, is done by domestic donkeys belonging to the Topnaar. Plants that are not visited by donkeys produce 5-10 times more melons than !naras that are browsed by them.

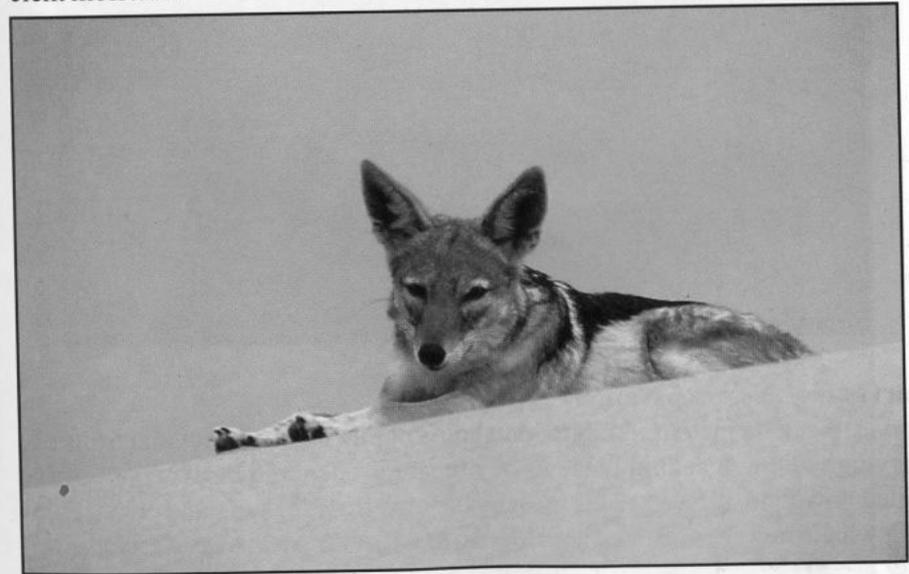


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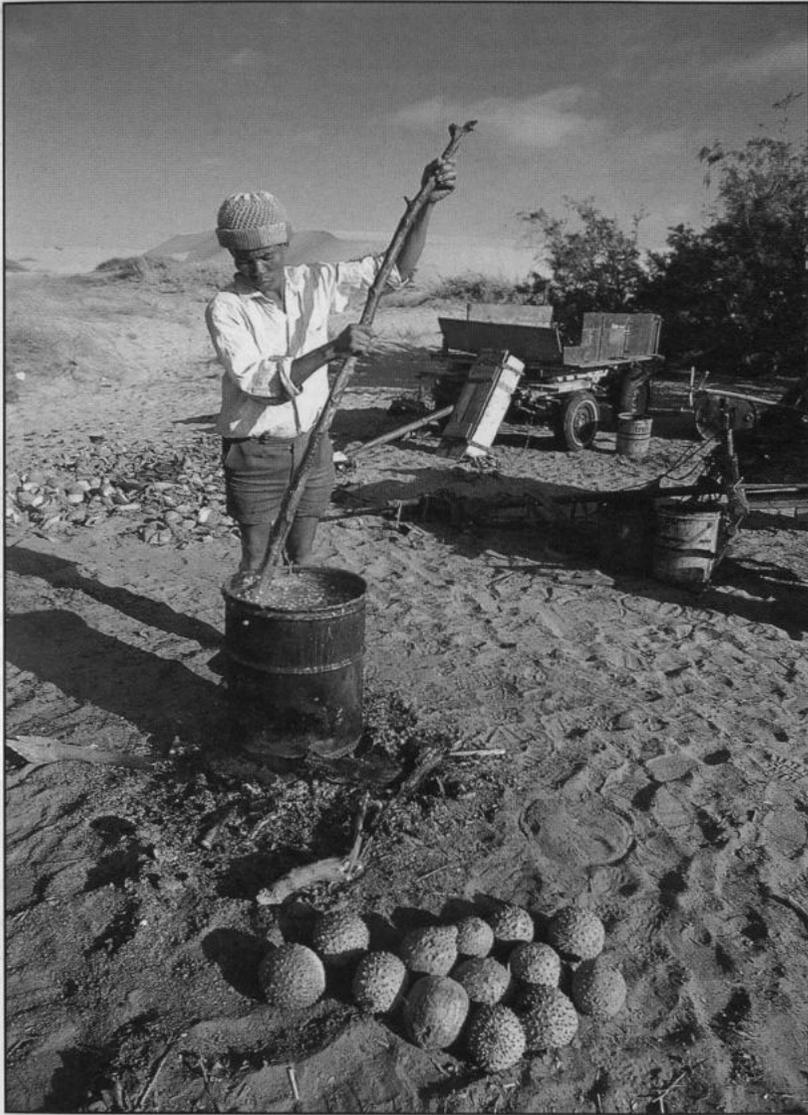


C. Berry

Jackals are the main dispersers of viable !nara seeds. They eat the fruit and excrete the undamaged seeds some distance from the plant, often at the base of dunes. Gerbils serve as short-distance dispersers, burying caches of seeds underground, where some may be forgotten and can germinate if there is sufficient moisture.



P. Tarr



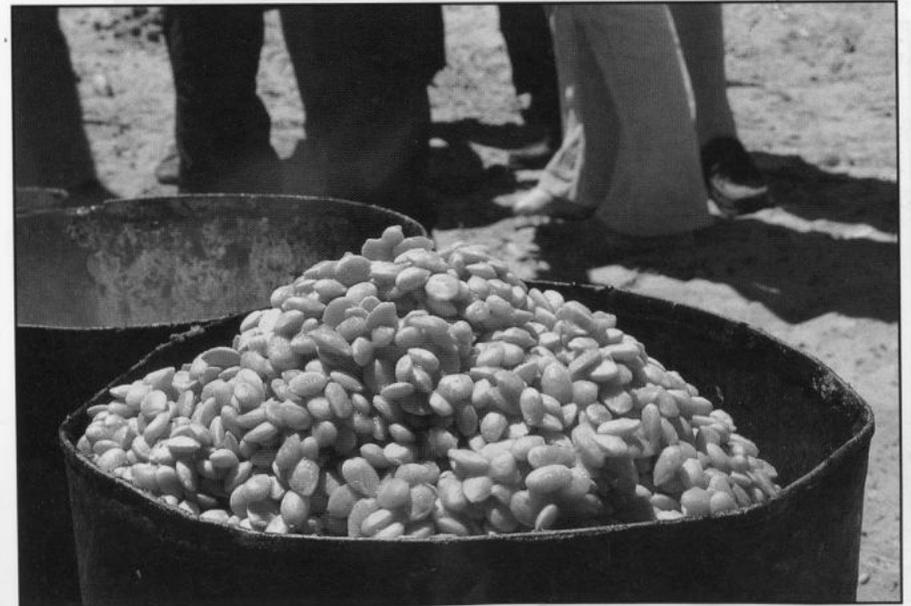
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### Harvesting and preparation

Harvesting !nara melons involves long hours of picking the individual fruits and carrying them to a central place to be prepared. There the flesh is cut out and boiled down in large vats. This loosens the pips from the pulp and cooks them, after which they are separated and dried to make a nutritious snack, "butterpips".



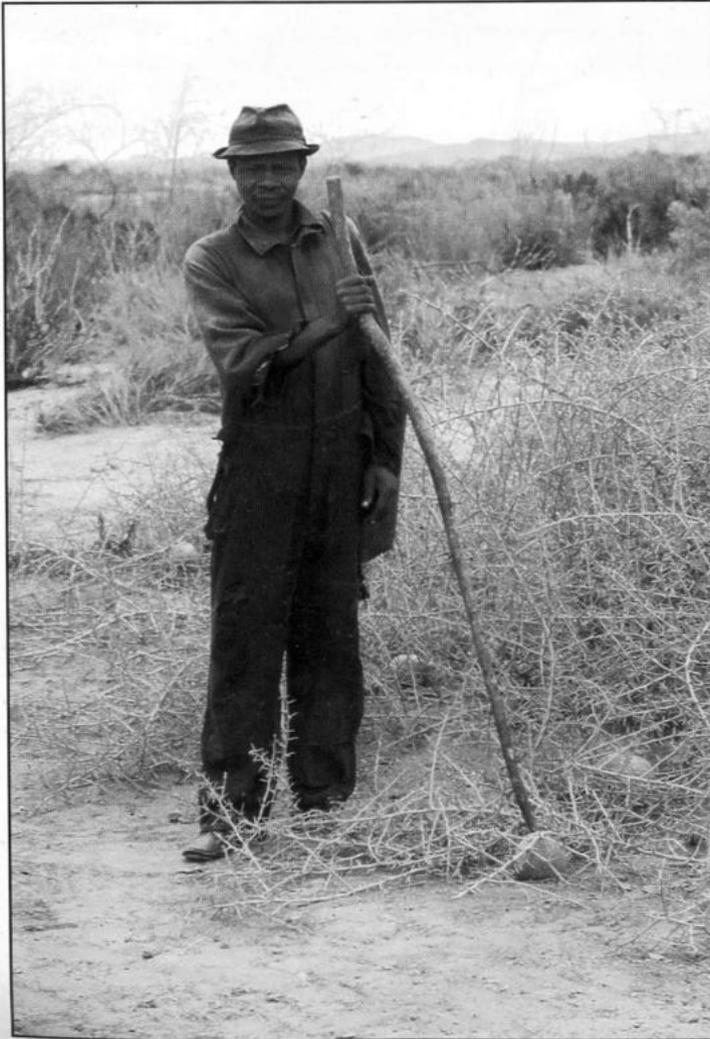
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### Property relations of !nara

The importance of !nara in Topnaar culture is reflected in the unique property relations of the Topnaar to the plants. The !Khuseb Topnaar traditionally had a system of private ownership over the !nara plants giving exclusive access by certain harvesting groups to specific !nara bushes. The property relations have changed significantly over the past few decades and !nara bushes are now communally shared, leading to conflicts between professional and occasional harvesters. Jurisdiction over the land has gained higher priority than ownership and use of !nara plants.



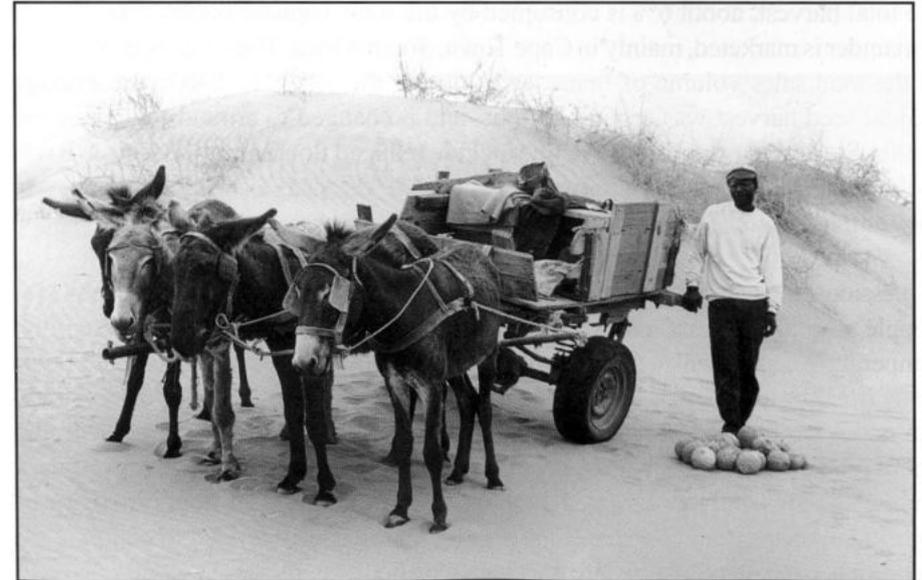
M. Seely

### The NARA programme

Recent changes in the socio-economy of the Topnaar have led to a situation where higher income is required to meet basic needs and better education, while the !nara yield and market threaten to decline. In response, in 1997 the NARA programme (NAtural Resource management by the ≠Aonin) was established as a collaborative initiative between the Topnaar Community Foundation and the Desert Research Foundation of Namibia. Planning is guided by the Strategy and Action Plan for Promoting Indigenous Fruit in Namibia.

The Topnaar community requested that four questions be addressed:

1. Has !nara fruit production changed, and, if yes, why?
2. How can harvesting be sustainably managed?
3. How can the !nara plant be cultivated without depleting other natural resources?
4. How can the !Khuseb Topnaar obtain appropriate and predictable income through !nara?



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### Today's !nara business

A baseline study gathered information from rural Topnaar, including harvesters, to establish the past and present marketing situation and to establish future options. Of the total harvest, about 6% is consumed by the rural Topnaar community and the remainder is marketed, mainly in Cape Town, South Africa. There has been a decline in the total sales volume of !nara seeds: during the 1950s to 1970s, the average annual seed harvest was around 26 tons, and it changed to around 15 tons in the 1990s. Several reasons for the decline include reduced flooding in the Kuiseb River Delta, changes in the harvesting rights among Topnaar, as well as changes in harvesting methods and patterns.

Professional !nara harvesting requires a group of two to three strong, healthy, dedicated people who are able to endure the strain of collecting !nara melons through hot temperatures, long walks, and four months of 11-hour workdays in the !nara fields away from the home village. Harvesting is very labour-intensive, requiring 2-4 man-hours per kilogram of seeds depending on the quality of the season, and earning about NS6.50/kg. Nevertheless, professionals obtain more than a quarter of their annual income from !nara sales. A total of 70-80 thousand man-hours are required to bring in the seasonal harvest. The youth of today is disinclined to continue the traditional harvesters' way of life under such difficult conditions.

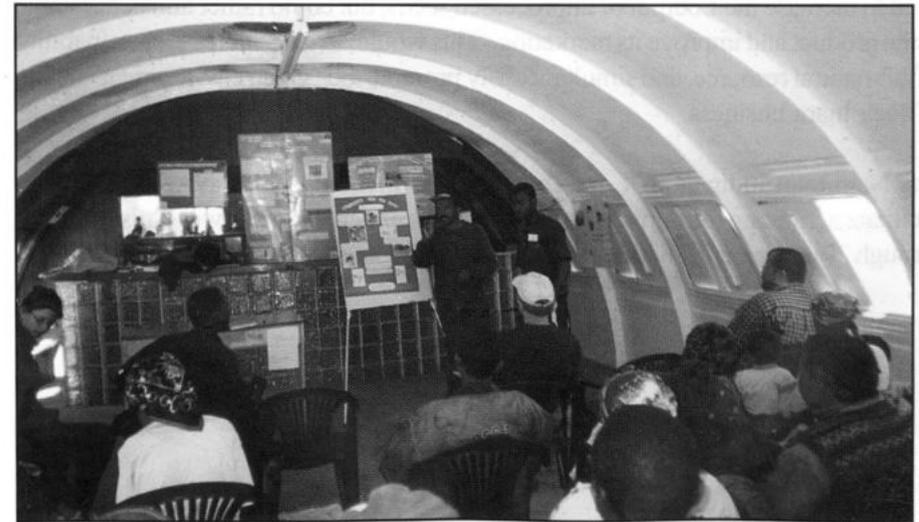
### Market development

Interviewed Topnaar suggested that higher returns for effort would provide incentives for young people to enter the !nara business. To achieve this, marketing of !nara products would have to be upgraded, incorporating a diverse product strategy, a reorganised distribution system, an appropriate price policy and promotion by effective market communication.

Topnaar would like to implement these changes by forming a co-op of small-scale manufacturers marketing !nara for middle-to-high income consumers in Namibia and international tourists. !Nara products can be marketed as a special delicacy under bold images such as "*romantic cultural tradition*", "*genuine indigenous Namibian product*", or "*supporting rural people in harsh desert conditions*".

### Co-operative

A Topnaar !nara co-op would enable the Topnaar to take over the seed trade with distributors in South Africa and to invest in product development and value-adding processes. At workshops and community meetings such as illustrated here, Topnaars have requested training to improve product processing and business skills, and expressed the desire to participate in research to implement sustainable natural resource management.



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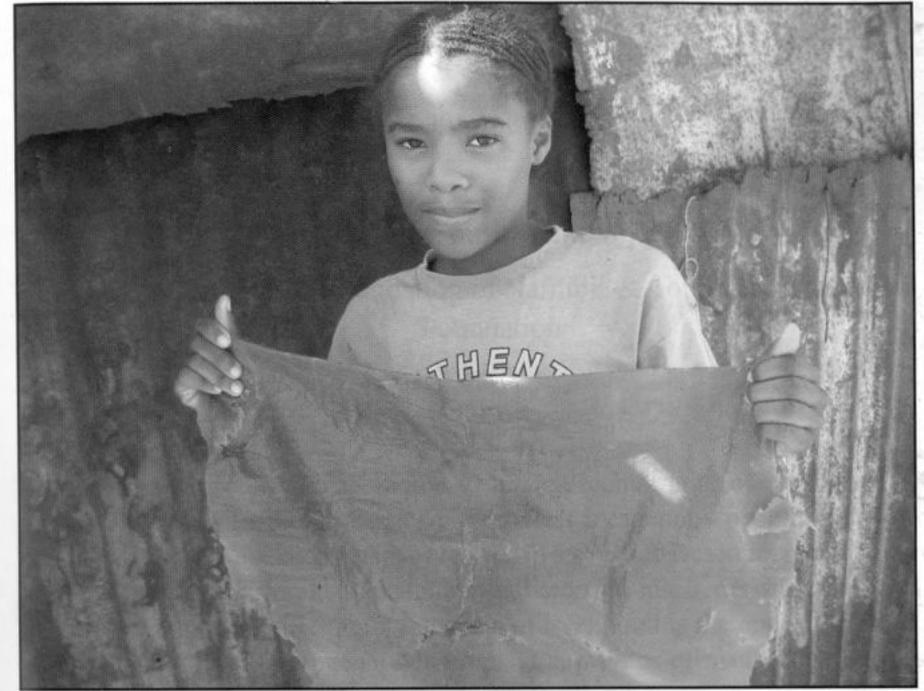


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### Diversified !nara products

Initial indications are that a few Namibian retailers of exclusive products are interested in promoting attractive !nara products. If this takes off, !nara harvesters would not need to increase their output of unprocessed seeds, but could rather add better value to the product and improve its marketing. This would, in turn, increase sustainability of this natural resource, and simultaneously promote the “green environment” image of such !nara business.

The Namibian Indigenous Fruit Task Team is involved in the NARA project to facilitate achieving the aim of sustainable development in the Lower Kuiseb Valley through Topnaar-controlled !nara business.



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A young girl proudly shows some sun-dried hoagaribeb made from boiled !nara flesh after the pips have been removed. She shares the Topnaar’s hope for a future where she will taste greater benefits and profits arising from !nara harvesting.

# PART I: BACKGROUND

## Chapter 1

### !Nara: culture, nature and nurture

by Desert Research Foundation of Namibia & Topnaar Community  
Foundation

#### Introduction

The Lower Kuiseb Valley<sup>2</sup> is home to a small community of rural Topnaar or ≠Aonin<sup>3</sup>, a Nama tribe and one of the oldest indigenous people of Namibia. Belonging to the Khoekhoen, who have lived in the Namib Desert for many centuries, rural Topnaar are pastoralists and hunter-gatherers. While herds of goats and cattle are the mainstay, another important basis of livelihood is the ancient tradition of gathering fruit of the indigenous !nara plant as well as of many other species of *veldkos*<sup>4</sup> plants (van den Eynden *et al.* 1992). !Nara forms part of the Topnaar's culture, tradition, nutrition and economy, and represents their dependence on and awareness of the natural environment. In short, it represents their culture, nature and nurture.

The living conditions of the rural Topnaar in 12 settlements with a total population of about 300<sup>5</sup>, is affected by several internal and external factors. For example, the nearby urban centres of Walvis Bay and Swakopmund attract people away from the Lower Kuiseb Valley and have other effects on the socio-economic

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<sup>2</sup> 23°05'S / 14°30'E – 23°38'S / 15°12'E

<sup>3</sup> ≠Aonin is the Nama expression for the Topnaars. In this book, ≠Aonin and Topnaar are used interchangeably. Also, rural Topnaar are referred to here as !Khuiseb Topnaar.

<sup>4</sup> *veldkos* is an Afrikaans word referring to food gathered from the surrounding natural environment.

<sup>5</sup> In the Namibian Census of 1991, the Lower Kuiseb Valley Enumeration Area comprised 332 people (National Planning Commission 1991). The rural population may not have changed much, as Budack (1977) reported a similar population of rural Topnaars for 1975. Recent unofficial estimates put the urban Topnaar population at about 700.

and environmental system of the rural Topnaar community. Bulk water extraction for urban and industrial supply is blamed for reducing the groundwater available to the Topnaar. Furthermore, the integration of the Lower Kuiseb into the Namib-Naukluft Park and Walvis Bay Park affects rural development. On the other hand, the rural Topnaar strive for some degree of self-sufficiency and are often more entrepreneurial than urban Topnaar.

The Topnaar Community Foundation (TCF) was formed in 1996. In its constitution, the main aim is “to cater for the socio-economic development, needs and interest of the Topnaar people”. In 1996, the TCF requested the Desert Research Foundation of Namibia (DRFN)<sup>6</sup> to assess the existing socio-economic and ecological interrelationships of the Topnaar’s resource, the !nara plant, as a preliminary approach to facilitate improved sustainable resource management. As a result, a joint programme was initiated: NARA - NATURAL Resource management of the ≠Aonin. Besides focusing on !nara as a resource, NARA also incorporates sustainable resource management of water and livestock.

In 2000, a workshop on “Promotion of Indigenous Fruits of Namibia” was held in Windhoek, bringing together all stakeholders (governmental and non-governmental organisations) involved and interested in indigenous fruits. One major outcome of this workshop was the formation of the Indigenous Fruit Task Team (IFTT). Six Namibian fruits were identified as having high priority for immediate action: !nara is one of them. Since then monthly meetings have taken place and a “Strategy and Action Plan for Promoting Indigenous Fruits in Namibia” was developed (Indigenous Fruit Task Team 2001).

<sup>6</sup> The DRFN is a Namibian non-government organisation (NGO) dedicated towards creating and furthering awareness and understanding of arid environments and developing the capacity, skills and knowledge to manage these appropriately. This is achieved through research, training and environmental education, via several projects relating to arid lands and desertification control in the Southern African Development Community (SADC). While the DRFN headquarters are located in Windhoek, much of its research has over the past 40 years been undertaken in the Namib Desert at the Gobabeb Training and Research Centre, situated on the ephemeral Kuiseb River, 80 kilometres southeast of Walvis Bay. Gobabeb is located in the centre of this hyperarid desert, where annual rainfall is a mere 20 mm, and evapotranspiration 3500 mm. The DRFN and its numerous collaborators from all over the world have accumulated knowledge and data on the Namib environment with a bibliography exceeding 1400 publications (Henschel *et al* 2001). For further information, see website [www.drfn.org.na](http://www.drfn.org.na)

The !nara (*Acanthosicyos horridus* Welw.) is an endemic cucurbit of the Namib Desert. It plays a key role in the life of the !Khuseb Topnaar. The fruit has high nutritional value, and the sale of its seeds contributes significantly to the semi-subsistence economy of the !Khuseb Topnaar. !Nara utilisation is an old tradition (Sandelowsky 1977) and Topnaar culture is very closely bound to this unique plant. The existence of this reliable food in the desert probably contributed towards the early development of a domestic way of life by the Topnaar in the form of pastoral villages (Kinahan 2001; Vigne 1994). It also led to the situation of private ownership of harvesting rights – an unusual feature for an otherwise typical pastoral Nama tribe. This exceptional position among the Nama tribes gave rise to the common Nama name, !Naranin, which expresses the Topnaar’s dependence on this desert plant. Today, !nara harvesting and livestock husbandry remain pillars of livelihood for the !Khuseb Topnaar. More so, !nara has fundamental cultural value and is important for the traditional lifestyle and efforts at maintaining self-sufficiency in this seemingly depauperate desert environment. Indeed, !nara harvesting is a key for the Topnaar’s existence in the desert, as it represents environmentally sensible land-use.

### The !nara of the Topnaar

The !nara is invaluable for Namibia, the Namib Desert, and the Topnaar. Its multifaceted relevance is illustrated in the !nara triad (Fig. 1.1):

- **CULTURE: !Nara is a unique cultural product** - irreversibly bound to the development of the Topnaar and their traditions; reliable food that was the driver of early domestication by the Topnaar in historic times; multifaceted cultural values to the Topnaar giving rise to the nickname “!Naranin” and images of !nara as “many-breasted foster mother of the ≠Aonin children”, and numerous poems praising !nara. !Nara stands for the pride and self-sufficiency of the Topnaar.
- **NATURE: !Nara is a unique natural product** - endemic to the Namib Desert; an important illustration of the principles of desert ecology and ecophysiology; of high scientific interest because of its ecological importance to many animals and to the desert surrounding; a natural resource superior to alien crops in this area.
- **NURTURE: !Nara is a unique nutritional and economic product** – being a desert plant, the !nara has a high nutritional value because of its high content of

unsaturated fatty acids and proteins; the fruit flesh, juice and seeds are tasty and there are multiple uses for each; the roots have medicinal value; seeds can be stored for a long time and are easy to transport. In Nama, '!Na' stands for 'more than enough' because if you eat the !nara, you don't need anything else (Kooitjie, pers. comm.).

The multiple facts enhance each other, thereby intimately connecting the Topnaar to their environment and connecting the desert environment and its people to the outside world.

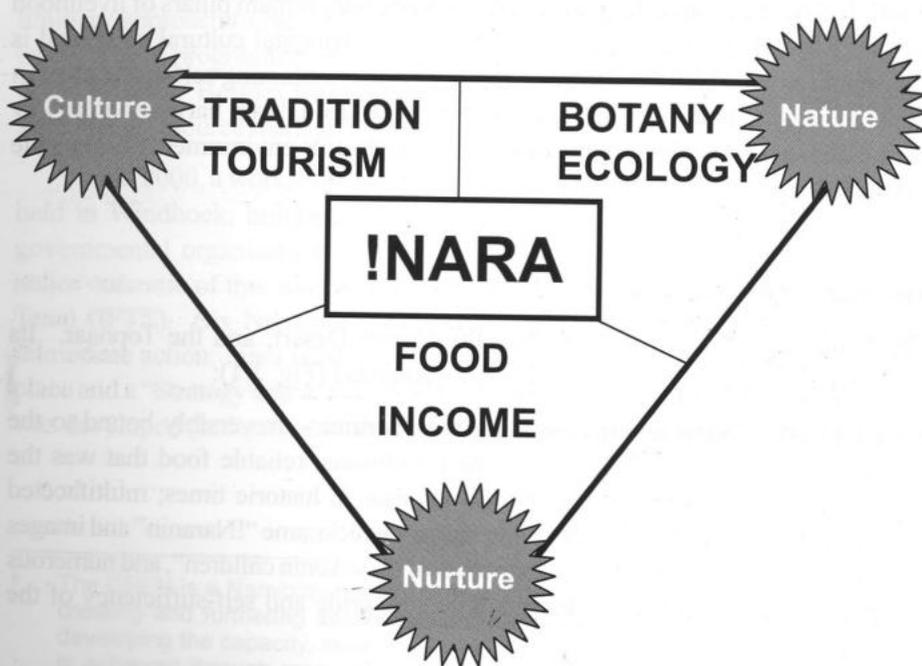


Figure 1.1: The !nara triad: three-in-one integration of the significance of !nara.

## The NARA programme

In recent years, conflict has arisen over the perceived decline of the annual !nara yield and the need for higher income. This has resulted in severe harvesting competition and uncontrolled exploitation of this traditional resource. As a result, the idea of a Community-Based Natural Resource Management project was born. In November 1997, the TCF and DRFN called a workshop with members of the Topnaar community to identify the nature and extent of the perceived problems and to formulate goals for the sustainable use of !nara. The Topnaar Community came up with the following key issues that form part of the NARA programme (Breuninger & Henschel 1997; Dausab 1997):

1. Has !nara fruit production changed, and, if yes, why?
2. How can harvesting be sustainably managed?
3. How can the !nara plant be cultivated without depleting other natural resources?
4. How can !Khuiseb Topnaar obtain an appropriate and predictable income through !nara?

The NARA Programme has an interdisciplinary approach, simultaneously dealing with biological (germination, water requirements, dispersal) and socio-economic aspects (harvesting techniques, utilisation pattern, marketing) of the plant. The work connects the indigenous community, scientists and stakeholders. This natural resource management programme comprises five phases:

- Analysis of biophysical and socio-economic factors affecting !nara productivity and the profitability of !nara utilisation in former and current times;
- Design of an appropriate cultivation, harvesting and management strategy;
- Implementation of the management system;
- Monitoring, evaluation and redesign;
- Long term monitoring and maintenance of !nara management.

NARA is a community-based and participatory development programme. All steps involve the !Khuiseb Topnaar in recognising and using their own capability to design and implement the plan to utilise their natural resources. Initial cooperation

with partners of the DRFN and other organisations that may become involved in the process should only catalyse and guide the process while the community retains full responsibility at all stages.

This report endeavours to facilitate informed decision-making and planning by the Topnaar for their own future, and may act as a guideline for partners and potential partners on how to assist this process. It contains a baseline study that sums up the activities, developments and findings of NARA up to this stage and presents them against the background of the natural, cultural and economic environments. The baseline study analyses the status of rural development and serves as a basis for future planning, such as the introduction of small-scale enterprises and small-scale markets built on !nara.

The book gives a brief history of the Topnaar people in relation to the !nara (Chapter 2), and describes the utilisation of !nara (Chapter 3) and several recent studies on the biology, ecology and ecophysiology of the plant (Chapter 4-9). !Nara property relations (Chapter 10) builds up an understanding of social aspects affecting access to !nara. This is followed by the baseline study, the central component of this report (Chapter 11). Finally, there are some initial plans and suggestions by the community and project partners on how NARA could now proceed (Chapter 12).

## Chapter 2

### !Nara in Topnaar history<sup>7</sup>

by Nina Gruntkowski and Joh Henschel

Evidence of the oldest use of !nara seeds dates back approximately 8000 years, from Mirabib, an inselberg on the gravel plains of the central Namib Desert<sup>8</sup> (Sandelowsky 1974). Although it is not proven that today's Topnaar descended from the people who lived in the Mirabib shelter, it is considered likely. Sandelowsky (1977) assumes that the most successful subsistence strategy was the exploitation of resources in a few surrounding areas. For the people in this area, who were probably hunter-gatherers, these could have been the coast, the river banks (with !nara fields) and areas with higher rainfall further inland. However, the absence of pottery in these early records makes stewing and storage of !nara unlikely (Kinahan 2001), and the utilisation of !nara may have been confined to the temporary availability of ripe fruit.

It is generally acknowledged that nomadic Khoe pastoralists introduced a subsistence economy to southern Africa, clearly distinct from the agropastoralism of Bantu people, about 2000 years ago. Archaeological finds, including ones from the !Khuseb area, include the appearance of pottery, particularly narrow mouthed storage vessels without soot (Kinahan 2001). The nomadic Khoe pastoralists spread their "new technological development" (Deacon in Kinahan 2001: 10) wherever conditions were suitable in the western and southern areas of Africa. Pottery, in particular the presence of large, wide mouthed vessels since 800BP, (Sydow 1967, 1973; Rudner 1968; Sandelowsky & Pendleton 1976; Sandelowsky 1977; Shackley 1985; Kinahan 2001) have been interpreted as indicative of !nara preparation, storage

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<sup>7</sup> There was only limited data available for the compilation of this chapter. In Namibia, recording of history was often closely associated with prevailing politics. The current outline of Topnaar history is based on historical data available to us and may not reflect the complete past reality. In light of this, we emphasise that this written history, like all history reports, bears the danger of shaping the representation of the past.

<sup>8</sup> At the Mirabib Hill shelter the !nara is the best documented staple food (radiometrically dated up to approx. 8000 years old), used for most of the time when Mirabib was inhabited. This supports the geographical model of sub-Saharan Africa by Deacon which suggests that Holocene hunter-gatherer communities exploited one specific plant food adaptively and systematically (Sandelowsky 1977).

and transport (Kinahan 2001). The consistent association of such pottery with bone knives reinforces this interpretation (Kinahan pers. comm.).

The utilisation of !nara by Khoekhoe was first recorded in 1677 by Captain Womba from the Dutch East India Company. He landed with the “Boode” on the West Coast and noted: “These (Hottentots) had left in flight and had left behind... a pot ... with kernels ... from something similar to a pawpaw” (Womba 1918: 51). Womba furthermore mentions evidence of cattle herding, as the “Hottentots” quickly complied to the request for cattle by the ship’s crew. Current mainstays of the rural economy of !Khuiseb Topnaar were thus already in place at least 300 years ago, and possibly have been for as long as 2000 years. Most subsequent reports of travellers and missionaries describing the inhabitants of this part of the West Coast mention !nara consumption and herding (Dentlinger 1983; Moritz 1992; Kinahan 2000). Marine resources were also exploited. They were first recorded in 1793 (Van Reenen 1915), whereas the dating of shell middens in the coastal dunes dates back much further.

The term “Topnaar” is regarded as a Dutch-Afrikaans translation of the name ≠Aoni, but is used by the people themselves. The Nama noun ≠aos means something like “extremity” as in “*far away places and marginal areas of territory*”. From the perspective of other Khoekhoe groups, the ≠Aonin inhabited the far distant northwesterly border of Namaland. The term !Naranin or “!nara people” is also used mostly by other Khoekhoe to describe their dependency on and ownership of !nara, thereby distinguishing the Topnaar from other Khoekhoe (Budack 1977). In contrast to other natural resources, the !nara has been utilised continuously by the Topnaar community. The largest !nara fields are located in the Kuiseb Delta, although smaller !nara fields occur along the river and south of it in the dunes up to Homeb. It has been a long tradition for people to move to the Delta during the !nara harvesting season (December to May).

The traditional reliance by the Topnaar on a specific wild plant is unusual for Nama groups. Another exception was the practice of private ownership over inherited family !nara plots (described by Chapman (1864) in 1855; see chapter 10)<sup>9</sup>. This is in contrast to communal property rights amongst other Nama groups, where every tribesman is allowed to move around freely with his stock.

However these family property rights of the Topnaar “are vested in these

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<sup>9</sup> Budack (1977) added to a list of 27 !nara patches identified by Pastor Moritz, and identified 54 !nara plots and their owners.

bushes, and not in the land...” (Budack 1983: 4). According to Chief Seth Kooitjie pers. comm.), the British, after their annexation of Walvis Bay in 1878, recognised the Protection of Property Rights of !Nara by the Topnaar in Article 5, Clause 7: “The chief is the guardian of the !Nara fields on behalf of the community. Damage, theft or any unknown trading in !Nara products are punishable”. In 1888, documents state the agitation of the Topnaar, “who monopolised the narras”, when there was unauthorised harvesting of !nara by people who were not Topnaar. In 1905, the *Deutsch-Südwestafrikanische Zeitung* wrote about the Topnaar: “They are said to have strong respect for the property rights attached to every single plant” (Budack 1983: 5).

The Topnaar economy has never solely depended on !nara. Kinahan (2000) believes that the Topnaar were involved in trade with foreigners from the late eighteenth century, and probably before. At this time the pastoralists, relying on pastures but also on !nara and marine resources, had extensive links to the interior. These resources and the availability of water and vegetation in the Kuiseb riverbed allowed semi-permanent homesteads at Walvis Bay, which “were part of an established regional trade network that extended to the north and to the central highlands of Namibia with indirect links to the east coast” (Kinahan 2000: 93). By 1770, American whalers had discovered the whaling grounds close to Walvis Bay and trade with the inhabitants at the coast began. These whalers exchanged trade goods such as tobacco, pipes, rum, tin ware, wire, cloth, soap, muskets and gunpowder for water, wood and fresh provisions to replenish their supplies. When the number of whaleships decreased, merchants continued this profitable trade. Logbooks from this time mention trading livestock with pastoralists on the Namib coast (Kinahan 2000).

By the early nineteenth century, another Khoekhoe group, known as Oorlam, had migrated into Namibia from the Cape frontier. By means of technological superiority, Jonker Afrikaner, their leader, established dominance over the other Nama groups and the Herero further north, settled in /Ae//gams (today’s Windhoek) and built a road along the Kuiseb River for the transport of trade goods to Walvis Bay. This accelerated the transportation of trade goods, but also enhanced the contact between the Oorlam in the centre of the country and the Topnaar. The contact with the Oorlam “who acquired a Westernish lifestyle far beyond the other Nama-speaking groups, and the development of Walvis Bay into a notable port had created a basis of Western commerce in which the Topnaar would become increasingly involved as their own resources disappeared or became inaccessible” (Dentlinger 1983: 17/18).

Jonker Afrikaner controlled the activities of traders and missionaries and carried out cattle-raiding forays, some of which were directed against the ≠Aonin community. In 1844, the ≠Aonin community was again raided by Wilhelm Swartbooi, an ally of Jonker Afrikaner. By the end of the nineteenth century the decline of pastoralism in the lower Kuiseb had become irreversible. A variety of reasons, such as restrictions of movements, cattle raids, drought, and commodity exchange, contributed to the collapse of the self-sustaining herding economy. The number of animals throughout the pastoral network had probably fallen, and finally the Topnaar were forced to attach themselves to European merchants and settlers for wage labour<sup>10</sup>. From the middle of the 19<sup>th</sup> century until today, the people along the Kuiseb have only been able to survive because some of them have worked in urban centres and helped to support their families in the Kuiseb Valley (Dentlinger 1983; Kinahan 2001; Chapter 11).

However, the 19<sup>th</sup>-century Topnaar still had access to !nara, marine resources and game, and still owned herds of small stock. Therefore they did not become completely dependent on wage labour or charity for subsistence<sup>11</sup>. The beach with its rich marine resources offered good conditions for impoverished pastoralists and it is likely that, after they lost their cattle, many people moved to the sea. Kinahan (2001) views the differentiation into Khuisenin (“!Khuseb people”) and Hurinin (“sea people”) (Budack 1977) as a more recent social phenomenon to distinguish the rich from the poor respectively, rather than as distinct ethnic entities. Finally, with the development of Walvis Bay into an urban centre and port, the marine resources became largely inaccessible to Topnaars except through employment in fisheries.

In 1884, Germany proclaimed a protectorate over the area ranging from south of Lüderitz to north of Cape Frio. Imperial Commissioners purchased land and mineral rights from chiefs. Piet //Eibib of Walvis Bay also signed a treaty with Dr. Nachtigal, the German Imperial Commissioner. For 20 pounds sterling, he ceded the coastline and 100-200 km of its adjoining land from 26° to 22° S, excluding Walvis Bay, which had already been ceded to the British (Hesse 1905; Esterhuysen 1968)<sup>12</sup>.

<sup>10</sup> The accumulation of wealth in the form of glass beads or other goods from outside the system could not be translated back into cattle when the need arose, as the commodities did not keep their value (Kinahan 2000, 2001).

<sup>11</sup> Köhler 1969 quotes from a report written by Palgrave 1877 that the Topnaar at that time earned their living from the harvest of !nara kernels, fishing and occasional paid labour.

<sup>12</sup> In 1878 Piet //Eibeb had already agreed to the British annexation of Walvis Bay, hoping for protection from the Oorlam (Palgrave 1877).

The treaty recognised the Topnaar’s “private rights” (Sander 1912; Fig. 2.1), which would have included the existing traditional use of !nara.

Die erwähnten Reserven verlangen die Anerkennung seiner, des Kapitäns (Haibib), und der in dem abgetretenen Gebiete sesshaften Eingeborenen Privatrechte und der früher von dem Kapitän Piet Haibib abgeschlossenen Verträge und Kontrakte.

Figure 2.1: Extract of the treaty between Topnaar Captain //Eibib and the German Imperial Commissioner, Dr. Nachtigal. It states: “Die erwähnten Reserven (des Vertrages) verlangen die Anerkennung seiner, des Kapitäns (Haibib), und der in dem abgetretenen Gebiete sesshaften Eingeborenen Privatrechte und der früher von dem Kapitän Piet Haibib abgeschlossenen Verträge und Kontrakte”. Translation by the editors: The above-mentioned conditions [of the treaty] demand the recognition of the private rights of the captain (Haibib) and of the indigenous people resident in the ceded land, and the recognition of earlier treaties and contracts made by Captain Piet Haibib.

In 1907 the Namib Game Reserve was proclaimed by the Germans. It was extended to become the Namib-Naukluft Game Park in 1975, under the South African Mandate. Park regulations were formulated by South West Africa’s Department of Nature Conservation, some of which were in direct conflict with Topnaar traditional land use practices. For example, game hunting and trapping of predators were prohibited, so that the Topnaar custom of !amis (seasonal hunting) was prevented (Botelle & Kowalski 1995). Regulations also prohibited some established practices of !nara management, such as burning dry parts of bushes (Rudolf Dausab, pers. comm.). Furthermore, park regulations did not recognise the residents’ rights of place. In 1992, a socio-ecological report pointed out that “the most important issue for the Topnaar people is the need for government recognition of their rights on the land they occupy” (Jones 1992: 3)<sup>13</sup>.

<sup>13</sup> After Independence in 1990, the Topnaars were officially recognised as a separate Nama tribe by the Government.

More and more, the Topnaar adopted a sedentary lifestyle as a consequence of the park regulations restricting their movement and development. "The continuous cyclical wanderings of the Khoi herders were reduced to an annual migration between semi-permanent settlements, and the crop" (Budack 1983: 6). In the late 1970s the government began sinking boreholes along the river<sup>14</sup>, which contributed to the establishment of permanent settlements in proximity to the water points<sup>15</sup>. This was a response to the lowering of the water table caused by overuse of the aquifer, which is said to have also contributed to the decrease of !nara productivity.

During the latter part of its mandate of South West Africa, the South African government paid pensions to the !Khuiseb Topnaar who were registered in Walvis Bay. Payment of pensions by South Africa to the Topnaar continued even after South Africa handed Walvis Bay over to Namibia in 1994. This is significant, because the South African pension is higher than the Namibian. Today, pension is an important income for !Khuiseb households.

In 1962 a flood barrier was constructed in the Kuiseb Delta to protect Walvis Bay from flooding. The barrier was built on granite bedrock and it blocks the surface flow of the river, thus reducing groundwater replenishment. Consequently, the productivity of the !nara fields along the Delta's northwesterly arm decreased from the 1970s onwards. This evidently led to the discontinuation of private ownership of !nara plots when harvesters from the northern Delta began sharing with harvesters in other areas (Botelle & Kowalski 1995). However, many Topnaar harvesters today still know the owners of the different !nara plots, although it has become common to harvest wherever the fruit are ripe (Rudolf Dausab, pers. obs.; see Chapter 11).

Moreover, the Kuiseb Delta is subject to constant change. Firstly, the !nara plant itself creates new dunes by accumulating sand blown against it. Secondly, the river can do a lot of damage when its water reaches the delta after heavy rains in the interior, and can wash !nara plants away. This happened during the floods of 1934, 1963 and 2000. The loss of !nara plants has been considered disastrous (Köhler 1969) as it could have a significant effect on individual Topnaar harvesters

<sup>14</sup> The Department of Water Affairs installed boreholes at all settlements in the Namib-Naukluft Park not connected to the main pipeline scheme, which supplies the settlements from Swartbank downstream.

<sup>15</sup> These water points, consisting of a borehole with a windmill or diesel engine to pump the water, replaced the traditional hand dug well that was described by von Koenen (1964).

operating in the eroded area. However, flooding promotes recruitment and accelerated growth and productivity (see Chapter 8)<sup>16</sup>.

Budack (1977) stated that the dependency on !nara has decreased under the influence of modern circumstances. He nevertheless described that some individuals and even whole families spend the period from November until April in the Kuiseb Delta harvesting !nara for their own supply and for the sale of the pips<sup>17</sup>. Botelle & Kowalski (1995: 39) found that "virtually all Topnaar families have abandoned the seasonal practice of moving to the delta to harvest the !nara". A new pattern has emerged where individuals, mostly men, travel to the delta for some weeks during each season to harvest the !nara and to get some income from selling the pips. In addition, most families harvest the !nara locally on a much smaller scale (Botelle & Kowalski 1995). The baseline study presented in Chapter 11 indicates that today at least 19% of the !Khuiseb Topnaar are professional harvesters, to whom !nara harvesting is of high economic significance, bringing in over a quarter of their household income. Nearly all members of the rural population do, however, continue to harvest !nara occasionally, either for food or additional cash. Most of these people still consider !nara to be important<sup>18</sup>.

This brief sketch of Topnaar history shows that they have a long association with !nara (Table 2.1). Against a trend of decreasing access to various natural resources by the Topnaar community, access to !nara has been continuous, showing its superiority to all the drastic changes that have occurred during Topnaar history. The !nara is not only economically important, but it also has cultural value, contributing to the self-identification of the Topnaar Community. !Nara is still central to the daily life of the !Khuiseb Topnaar, as it has been for many centuries.

<sup>16</sup> Joh Henschel observed that a lot of !nara plants were washed away by the flood in March 2000. From a low-level fly-over during and immediately after this flood, he estimated that the destroyed area amounted to less than 5% of the southern Kuiseb Delta !nara field. Ground observations showed numerous seedlings sprouting, and it was abundantly clear that these floods were far more beneficial to !nara than they were destructive.

<sup>17</sup> During the 1970s the !nara was not seen as a prestigious item. Dentlinger (1977: 18) states that "On the contrary, being dependent on nara as a source of food was considered degrading, since it implied that one did not have enough money to buy 'the white man's' food, definitely a status symbol".

<sup>18</sup> Gruntkowski (2001) showed that 8 out of 9 Topnaar settlements mentioned the !nara as an important thing in their environment; 5 settlements ranked !nara as one of the three most important things.

Table 2.1: Chronology of significant events in the history of the Topnaar and utilisation of !nara.

Date	Event
since 8000BP	people in the Namib used !nara (Sandelowsky 1974)
since 2000BP	Khoekhoen pastoralists in the Namib stored !nara in narrow pottery vessels (Kinahan 2001)
since 800BP	Khoekhoen prepared, stored and transported !nara using bone knives, fire and wide-mouthed pottery (Kinahan 2001)
1677	first European record of Khoekhoen using !nara fruit (Womba 1918)
1855	first European record of Topnaar family ownership of !nara fields (Chapman 1864)
1878	the British of Walvis Bay officially recognise Topnaar property rights to !nara (Act 5, clause 7)
1884	German protectorate acknowledges Topnaar private rights
1933/34	a strong Kuiseb flood destroys many !nara plants (Köhler 1969)
1946-1999	Flamingo Furnishers of Walvis Bay are the main wholesaler of !nara seeds
1962	construction of Kuiseb flood retention wall, preventing the Kuiseb from flowing into the northern delta, reducing groundwater replenishment and evidently causing the loss of !nara fields in that area
1962	Gobabeb is established as a research station, functions include the coordination of !nara studies
1960s & '70s	several important socio-economic studies by Budack, Dentlinger, du Pisani, Köhler, Moritz, Sandelowsky and others document the Topnaars' current relationships with !nara
late 1970s	the government sinks boreholes for the !Khuiseb Topnaar, who establish 12 permanent settlements near these water points
1975	formation of the Namib Park (later Namib-Naukluft Park) — restricts Topnaar traditional land use practices e.g. burning of old !nara bushes
1975	Rooibank Bulk Water Scheme is established and extracts more groundwater than is sustainable in the Kuiseb aquifer between Swartbank and Dorob, thereby lowering the groundwater level in the Kuiseb Delta
1981	in traditional community elections by the Topnaar, Seth Kooitjie is elected Chief of the Topnaar, and thus becomes the guardian of the !nara on behalf of the community
March 1990	Namibian Independence. The constitution confirms traditional property rights.
1990	Establishment of the Walvis Bay Lagoon Park, further restricting the area where Topnaar traditional land use practices can be carried out
1991-1997	Topnaar, Government, and NGOs discuss the Topnaar's rights to natural resources and their development in the Kuiseb Valley (documented by Andy Botelle & Kelly Kowalski, Rudolf Dausab, Grasveld & Gabriel, Brian Jones, Ruth Jones, Seth Kooitjie, Patricia Skyer, Unam Social Science Division, Veerle van den Eynden et al., Vigne, Thomas Widlok, and others); further archaeological studies provide context (Jill & John Kinahan)
1996	Topnaar Community Foundation (TCF) is formed, with a principal function being socio-economic development of the !Khuiseb Topnaar
1996	TCF approaches DRFN for support concerning ecological and socio-economic aspects of !nara, and DRFN agrees upon getting the blessing of the Ministry of Environment and Tourism (MET)

19 Nov 1997	first !nara workshop – TCF and DRFN address the Topnaar's concerns over !nara; the NARA project begins
1997-2001	NARA project research on !nara socio-economics, seasonal patterns, fruit production, resource allocation, pollination, seed dispersal, seed consumption, seedling development, photosynthesis and transpiration by Conny Berry, Ulrike Büttendorf, Rudolf Dausab, Sarah Eppley, Felix Hebler, Joh Henschel, Birgit & Robert Kartusch, Connie Krug, Caroline Mayer, Petra Moser, Markus Müller, Andreas Shilomboleni, Elizabeth Wenk (see Part II)
May 1998	the Gobabeb Training and Research Centre is formed as a joint venture of MET and DRFN, in partnership with the Topnaar; the Gobabeb Centre mission includes socio-economic training and research
9 Jul 1999	second !nara workshop – feedback on the past, present and planned research
Mar-Apr 2000	strong floods destroy !nara bushes in Kuiseb Delta and initiate regeneration through seedling growth
Apr 2000	Promotion of Indigenous Fruit workshop - !nara is identified as one of six high priority fruits in Namibia
Jun 2001	the Namibian Indigenous Fruit Task Team grants financial support to the Topnaar to facilitate marketing of !nara products and information exchange concerning the NARA project
2001	further NARA field research on cognition of sharing natural resources (Nina Gruntkowski) & perceptions of property rights (Sonja Iwanek)
22 Aug 2001	third !nara workshop with emphasis on management in relation to natural processes, marketing strategies and harvester cooperation
2002	!nara resource management by Topnaars is part of the DRFN programme ELAK (Environmental Learning and Action in the Kuiseb)



also take the unripe fruit. They then either leave these to ripen in the sun or feed them to livestock, chicken and dogs (Dentlinger 1977). More and more, a different harvesting technique is being applied. The harvester, standing outside the !nara brush to avoid contact with the thorny plant, uses a metal hook to pick (hook) the !nara fruit and retrieve it from the !nara plant (Moritz 1992). This technique can damage the plant by breaking branches.

The harvested fruits are used in different ways (Dentlinger 1977, Pfeifer 1979). Ripe, they are eaten fresh, or cooked before extracting the seeds and setting aside the pulp for further use. Green, unripe fruits are buried about 15-20 cm in soft sand to stimulate the ripening process for juice development and sweeter taste, and then used as above. To eat or process the !nara fruit, they are cut in half using a knife (*!aros*), traditionally made of a rib bone from an antelope or livestock (Budack 1977). The flesh is scraped out into a 44 gallon drum, replacing the traditional clay pot. The peels are thrown away or fed to the donkeys. The drum full of !nara pulp is heated for several hours over a fire, stirring it constantly with a twirling stick (*!nobob*) until the pulp is well cooked (Budack 1977). In the past a plaited sieve (*gabiras*) was used to separate the pips from the pulp. Nowadays a small tin with holes in the bottom and sides serves the same purpose. The tin is shaken and twisted until the pips are separated from the pulp. Depending on the preference of the individual, the remaining pulp on the pips may be left or washed or rubbed off in the sand. The pips are then dried in the sun on sand or on a sheet of plastic (Pfeifer 1979) or on the roof of the house, or they are roasted over a fire.

The remaining !nara pulp is processed further (Dentlinger 1977, Pfeifer 1979, Moritz 1992). It may be poured onto a clean patch of sand, where it hardens and is turned until it is dry and all the oil and fat has drained. This forms !nara-cake (*!goa-garibeb*) which can be rolled up as a fruit roll. Alternatively it is eaten mixed with mielie meal as porridge, or as soup.

!Nara-cake/fruit roll is important as an emergency food source for the Topnaar (Pfeifer 1979). The dried !nara pulp, having a leathery texture, is cut into strips, rolled up and can be stored for years (Dentlinger 1977). If the seeds are properly dried, they will also keep well for many years if stored in a dry place. Partly due to problems with suitable storage, but mainly to earn cash, most of the !nara seeds are sold soon after harvesting and only a few bags of seeds are kept for own consumption.

As pointed out in Chapter 2, trade with !nara seeds has a long history. Most of the !nara pips are exported to Cape Town in South Africa, where they are

known as butterpips, and are favoured by the Asian community (Moritz 1970; Pfeifer 1979). They have an almond-like taste and are mainly consumed as a snack, eaten shelled or unshelled, and they are also used as an almond substitute. In the Topnaar tradition, the oil-rich !nara seeds (about 50% oil) also have other functions. Pounded in a wooden mortar (Budack 1977), !nara pips are used in dishes and for baking (Pfeifer 1979). Extracting the oil by grinding or pressing, the pounded mixture was used as a skin treatment and for sun protection (Pfeifer 1979; van den Eynden *et al.* 1992) or hair treatment (Moritz 1992). It is claimed that the fresh flesh of ripe fruit alleviates stomach pain, as does the root juice (Rumrich & Rumrich 1996; van den Eynden *et al.* 1992). By drinking a decoction or chewing the roots, diuresis, venereal diseases, nausea, kidney problems, arteriosclerosis and chest pain are relieved, and crushed roots mixed with fat make an ointment for healing wounds (du Pisani 1983; van den Eynden *et al.* 1992; Rumrich & Rumrich 1996).

Parts of the !nara that have not been reported to be used by people, are the young shoots and fruit peels, although livestock feed on both of these. While the use of roots as a home remedy for numerous ailments is well-known and established practice, the increasing demand for root products on the market (Dausab pers. comm.) poses grave danger to the !nara fields. The cutting of roots kills !nara branches, and it is likely to pose severe constraints on sustainability if this practice increases. To address this issue, it is recommended that the root substance with healing power should be identified. This should be compared with the concentrations of this substance in other parts of the plant, for instance the fruit peel. Use of the roots, and its alternatives, needs to be examined in the overall question of diversification of !nara products, balanced against the need to keep within the limits of long-term sustainability.

The !nara fruit contain cucurbitacins, which can burn the mouth and lips if unripe fruit or too much of the fresh fruit are eaten (Dentlinger 1977; Moritz 1992; van den Eynen *et al.* 1992). Unripe !nara fruit taste very bitter and the pulp is unpalatable (Pfeifer 1979). Dentlinger (1977) was told that raw !nara fruit should only be eaten when cool, otherwise it may make one ill. To eat the raw fruit, it is cut in half with a knife and then the central core, the sweetest part of the !nara, is cut out and eaten from the tip of the knife (Dentlinger 1977). Then the rest of the fruit is consumed in the same way, using the knife for cutting and eating. !Nara fruit also serve a different purpose. Juice of a ripe !nara melon, which has a very high sugar content, is squeezed out and used for syrup or as an ingredient to brew sugar beer, supporting fermentation together with portions of the roots (Pfeifer 1979; du Pisani 1983).

!Nara fruit should ripen fully on the plant to produce the best quality products in terms of sweetness of the fruit and size, taste and oil content of the seeds (Pfeifer 1979). If picked too early, the fruits are small and unripe, bitter, and contain only small seeds. In the past, high quality seeds were guaranteed through the individual property rights of !nara fields. At that time, only ripe !nara fruit would be picked, leaving the unripe ones on the bush for a later harvest. Today, with more or less open access to the !nara fields, the quality of !nara products is deteriorating, because unripe fruit are often picked (Dausab, pers. obs.). But it is not only the ownership of the !nara plants and the quality of products that have changed. Botelle & Kowalski (1994) pointed out that today mainly individuals (mostly men), compared to whole families in the past, live in the !nara fields during the harvesting season. These so-called non-professional harvesters (see Chapter 11) collect just sufficient amounts of fruit to earn quick cash as needed, e.g. for hostel-fees or to buy provisions or goats. Many families only collect fruit from !nara bushes close to their settlements, mainly for domestic purposes. The professional harvesters, in comparison, still depend to a great extent on !nara as a food source and for generating cash income (Fig. 3.1). They spend most of the !nara season (November to April) in the !nara fields (Budack 1977), collecting fruit and selling the seeds in Walvis Bay to earn as much money as possible, as a significant part of their household income.

These changes in harvesting practices have evidently changed the gender roles in the Topnaar communities, too (Botelle & Kowalski 1994). Nowadays, only men tend to go to the !nara fields (with a few notable exceptions), while the women stay at home to take care of the farm and the children and to process the collected !nara fruit. Furthermore, the management of the !nara plants itself has changed. In the past, the Topnaar would burn old !nara bushes, or unproductive, dry parts of the bushes to stimulate growth and fruit production (Botelle & Kowalski 1994; Breuninger & Henschel 1997; Dausab pers. obs.). These practices were forbidden after the areas of !nara fields became incorporated in the Namib Naukluft Park in 1975 and the Walvis Bay Lagoon Park in 1990 (Dentlinger 1977).

In summary, there have been enormous changes over the past years in terms of !nara management, harvesting and uses. Nonetheless, !nara still plays an important role in the Topnaar's present life, be it as food and income supplement to the households of occasional harvesters, or as a major source of income for professional harvesters.

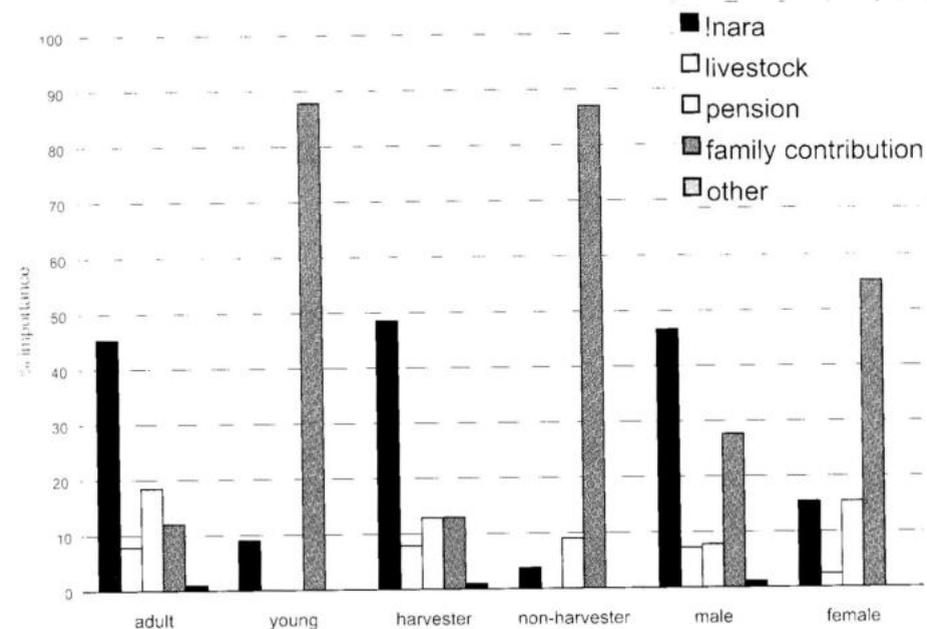


Figure 3.1: Sources of income for various groups of Topnaars.

## PART II : ECOLOGY

### Chapter 4

#### **!Nara ecology – an introduction**

by Joh Henschel & Petra Moser

##### **The !nara plant**

Cucurbits originally arose in tropical zones, but some have adapted to dry environments. One of these is the !nara, an endemic to the western Namib Desert. It occurs virtually along the entire length of the Namib from Port Nolloth in South Africa to Namibe in Angola. The largest concentrations occur in the Lower Kuiseb Valley. There are particularly large fields in the Kuiseb Delta between Wortel, 10 km south-east of Walvis Bay, and Rooibank, with at least 51 !nara fields in this area (Budack 1977; Chapter 2; Fig. 2.2). The Kuiseb !nara fields are most widely known because of the attention given to !nara harvesting and trade by the Topnaar people, but there are also extensive !nara fields along the north coast of Namibia, where Himba people occasionally harvest the melons (Sandelowsky 1990).

##### **!Nara natural history**

Individual !nara plants can grow to a size of 5-10 m high and 10-40 m in diameter, with the plant projecting 0.1-1 m above the large hummock that grows with the plant, covering between 0.2 to 2335 m<sup>2</sup> (Chapter 5). It has been estimated that they may have a life span of centuries (Klopatek & Stock 1994).

!Naras annually produce 20-500 melons of 10-20 cm diameter that each weigh 0.5-1.0 kg and each contain 200-300 seeds (Moritz 1992; Klopatek & Stock 1994; Berry 2001; Chapter 5). On average, dry seeds with shells weigh  $311 \pm 94$  mg (range 157-440 mg, pers. obs.; compared to a figure of 256 mg given by Sepasal 1999), i.e. each melon yields about 50-100 g of dry seeds (Berry 2001). Thus 11-20 melons are required for 1 kg of seeds.

!Nara is a dioecious plant i.e. there are separate male and female plants. Female !naras flower between September and April, peaking in October-November, and

fruit usually ripen between November and April, peaking in February-March (Chapters 5 & 6). Males flower throughout the year, producing a profusion of flowers during most months. The abundance of male flowers supplies sufficient pollen to pollinate the female flowers (Chapter 6). It has been proposed that this may also keep up viable populations of the main pollinators, meloid beetles *Mylabris zigzaga* and solitary bees (Mayer 2000; Chapter 6). Meloids are of particular interest as their populations may depend on the ability of their larvae to consume eggs of the !nara cricket *Acanthoproctus diadematus*.

### !Nara's importance to animals

The fruit, seeds, growing tips and flowers are highly nutritious, while the rugged canopies of both sexes provide shelter to dune animals. The !nara is regarded as a keystone species (Klopatek & Stock 1994): "a direct protein and water source for insects, reptiles, mammals and birds, an indirect food source as a collection site for windblown plant litter that is fed on by many beetles, and a stabilising influence in the dunes and hence a refuge for burrowing animals. In essence !nara forms the basis for a highly diverse and complex food-chain." From several perspectives, the !nara can be considered to be one of the most important plants in the dunes of the Namib Desert, and a key to understanding its ecosystem as well as its indigenous people (Fig. 4.1).

In nature, at least 26 vertebrate species are known to use the !nara in one form or another; there are many more invertebrates. The flowers and growing tips, including seedlings, are favoured food for several herbivores, e.g. meloid beetles, !nara crickets, but also the lizard *Angolosaurus skoogi* (in the northern Namib dunes, Nagy *et al.* 1991), ostrich, oryx, hyaena and springbok (Chapter 7). This herbivory results in the loss of 15% of all flowers (Chapter 6). Domestic goats of the Topnaar apparently don't seek this food, while donkeys favour it highly and have been observed removing many flowers, buds, unripe fruit and seedlings. Due to browsing by donkeys, a large portion of fruit is lost and cannot mature to ripeness (Chapter 6).

Many mammals are major consumers of the fruit and they potentially disperse the seeds with their droppings, but in the case of ungulates (hoofed mammals), the seeds are crushed with the chewing molars, destroying the viability of the seeds. While rodents (mice and gerbils) do eat the seeds, they also cache them in the sand, sometimes a short distance away from !nara hummocks.

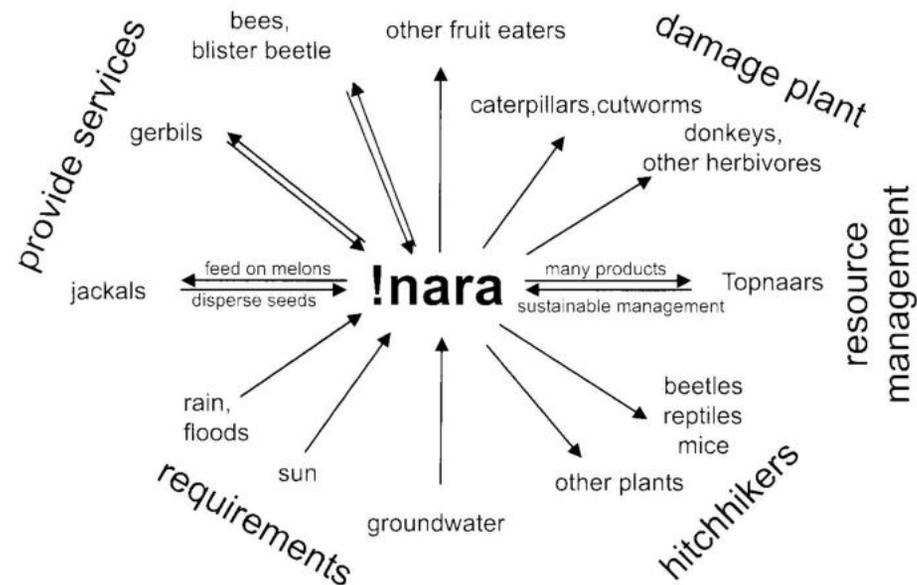


Figure 4.1: Environmental connections of the !nara plant.

### Jackal's importance to !nara

The black-backed jackal *Canis mesomelas* appears to be the best potential disperser of seeds (Müller 2000; Chapter 7), as it does not chew the seeds and tends to swallow them whole. Many seeds pass through the jackal's gut intact. Jackals often eat ripe !nara fruit and deposit their droppings at distances up to several kilometres away from existing !nara hummocks, often at the base of dunes. It is at these low-lying dune areas that the potential for seedling development may be particularly good in the dunes (Chapter 7). Jackal faeces possibly provide a local nutrient supplement to the initial seedling in otherwise very nutrient-poor sand (Müller 2000; Moser 2001). The jackal is therefore considered to be a crucial part of the community ecology of !nara, required for recruitment as well as establishment of !nara in new areas. The distribution of jackals overlaps completely with that of !nara, and it is suggested that the jackal is indispensable for the persistence of healthy populations of !nara fields in their natural condition (Müller 2000). Ironically, the Topnaar consider jackals to be a nuisance as they are capable of killing goats, the Topnaar's main livestock resource.

## Water relations

The !nara is a leafless, non-succulent plant with xerophytic characteristics. The thick cuticle reduces cuticular transpiration, while epicuticular waxes and trichomes (fine hairs) limit the stem temperature. The stomata in the epidermis of stems and thorns lie in grooves that are longitudinal to the stem, so that the chlorophyll-bearing cells lie below these depressions of the stem (Kartusch 1999a). In effect, this means that !nara photosynthesises through its stem. Due to the relatively small surface area exposed to light, rates of gas exchange and photosynthesis are low, but constant (Kartusch 1999b: Chapter 9). !Nara carries out  $C_3$  photosynthesis and photosynthesis does not vary much with variable light intensity. Even in moderate climatic conditions, the ratio of absorbed  $CO_2$  to expired air is 1:500.

Transpiration is high, water use efficiency low, and not much water is stored in the branches. This supports the assumption (Chapters 7, 8 & 9) that !nara needs to be connected to a permanent water source, namely groundwater, as suggested by Herre (1975) and Pfeifer (1979). According to Kutschera *et al.* (1997) the taproots are 100 m long and have been estimated to reach over 50 m deep (Klopatek & Stock 1994). The xylem vessels of the roots are the widest found in any plant (370-1000 $\mu$ ; Kutschera *et al.* 1997) and can hold 2 ml of water per cm of root. It is suggested that the lifting of nutrient-rich groundwater enriches the nutrient-deficient dune environment. Due to its dependence on a good, perennial supply of water, even remote !nara fields in the dunes are situated over relatively shallow groundwater (Chapter 7). A crucial factor for successful seedling establishment is temporarily sufficient surface water and perennial, shallow groundwater. The analysis of groundwater depth in conjunction with abundance of !nara plants indicated that bigger !nara and more !nara plants are found in areas with shallow water table (Chapter 7), thus making the riverbed and its palaeo-channels potentially good places for seedling growth. This dependence on groundwater explains why the highest densities of !nara grow in the Kuiseb Delta, and why these !nara fields appear to be vulnerable to factors reducing the water table.

## Factors affecting fruit production

Constraints on !nara fruit production that have been of concern to the Topnaar, include the following biophysical factors:

1. *water availability*:
  - a) groundwater depth;
  - b) groundwater replenishment;
  - c) water quality (e.g. salinity, nutrient levels);
  - d) surface water (e.g. fog)
2. *herbivores* (of flowers, shoots, fruit):
  - a) insects (e.g. meloid beetles, !nara crickets, aphids);
  - b) small mammals (e.g. gerbils, striped mice);
  - c) large herbivores (e.g. ostrich, springbok, gemsbok, donkey)
3. *pollination*:
  - a) shortage of pollinators;
  - b) lack of pollen
4. *flood material*:
  - a) chemical pollutants;
  - b) inundation with silt
5. *sand-wind-plant interaction* (hummocks):
  - a) inundation;
  - b) exposure
6. *recruitment*:
  - a) availability of seeds for dispersal;
  - b) availability of sufficient seed dispersers (jackals, gerbils);
  - c) conditions for seedling establishment;
  - d) availability of suitable growth sites
7. *population structure*:
  - a) sex ratio;
  - b) age structure (age of maturation and senescence);
  - c) mortality rate
8. *fungi*:
  - a) endomycorrhizal symbiont;
  - b) disease
9. *soil properties*:
  - a) permeability;
  - b) nutrient status;
  - c) pH relations;
  - d) salinity

#### 10. harvesting methods:

- a) traditional method of prudently loosening ripe fruit from the plant by soft tapping;
- b) picking unripe fruit, including use of hooks;
- c) picking all fruit, leaving none;
- d) damaging the plant during harvesting or travelling across !nara fields

#### 11. plant management methods:

- a) supplementation of seedlings with water (e.g. fog);
- b) periodic burning of old material;
- c) new techniques, e.g. pruning, limiting sand accumulation, watering, nutrient supplementation, artificial pollination, selective protection of developing fruit.

### Research on !nara

Since the NARA workshop of 1997 (Chapter 1: Breuninger & Henschel 1997), several biophysical studies have been initiated to improve the knowledge of the !nara plant and to address the problem of reduced yields to Topnaar harvesters. In addition to studies by the TCF and the DRFN (mainly focusing on harvesting, marketing, socio-economics and livelihood, including the baseline study), the NARA programme coordinated eight ecological and two socio-geographic studies between 1997 and 2001, some of which are reported in this book (Table 4.1).

In addition, several researchers have expressed interest in developing further studies on !nara products taking their biochemical, medical and nutritional contents into consideration. Further biophysical studies that have been planned include (Chapter 12) population dynamics, plant dynamics, long-term plant development, water relations, effects of harvesting methods, effects of ungulate herbivores, and agriculture. Furthermore, the community ecology of the !nara as a possible key stone species in the Namib ecosystem also warrants attention.

These ecological, biological and physiological studies of the !nara form one part of the NARA programme and address the first three questions posed by the Topnaar Community in 1997: productivity, sustainability and controllability. These aspects are important in the sense that they concern the resource itself. More knowledge is required to improve the management of !nara as a resource, while simultaneously ensuring the survival of this crucial component of an ancient and unique arid ecosystem, the Namib Desert.

Date	Name	Institution	!Nara Research Subject
Dec 1989-Aug 1992 (published 2001)	Conny Berry	Ministry of Environment and Tourism, Swakopmund	seasonal patterns & fruit production
Aug 1997-Apr 2000	Connie Krug	University of Bonn, Germany	mice on !nara hummocks
Nov-Dec 1997	Sarah Eppley & Elizabeth Wenk	University of California Davis, USA	resource allocation in !nara plants
Sep 1998-Feb 1999	Ulrike Büttendorf, Rudolf Dausab, Joh Henschel & Andreas Shilomboleni	TCF & DRFN	socio-economic baseline study
Oct 1998-May 1999	Caroline Mayer	University of Würzburg, Germany	pollination ecology
Oct 1998-May 1999	Markus Müller	University of Würzburg, Germany	seed dispersal ecology
Sep 1999	Birgit & Robert Kartusch	University of Vienna, Austria	photosynthesis
Oct-Dec 1999	Felix Hebel	University of Gießen, Germany	water & energy ecophysiology
Mar-Aug 2000	Petra Moser	University of Münster, Germany	seedling development
Jan-Apr 2001	Nina Gruntkowski	University of Cologne, Germany	cognition of sharing natural resources
Aug-Dec 2001	Sonia Iwanek	University of Frankfurt, Germany	perceptions of property rights

Table 4.1: Research projects conducted as part of the NARA programme during 1997-2001.

## Chapter 5

### !Nara phenology and fruit production

by Conny Berry

#### Introduction and background

Sadebeck (1899) described !nara in great botanical detail, stating that most plants in the coastal area flowered and bore fruit throughout the year. He also mentioned the high oil content of the seeds, given by Grimmer (1910) as 46% oil and 32% protein. Later, Dinter (1912) recorded individual !nara plants bearing several hundred fruit, weighing up to 1 kg each, and that approximately 200 *Zentner* (10,000 kg) were exported to Cape Town in 1897 for use in the confectionery trade. These early records indicate that researchers have for a long time recognised the importance of linking the utilisation of !nara with the plant's condition in the field.

The objectives of this study were as follows:

- to examine the spacing of plants in a !nara field and determine their sex ratio and size, to be able to quantify the economic value of certain areas,
- to note where and when plants are in best or worst condition,
- to determine the flowering patterns of male and female plants over the course of the year, particularly whether they have definite flowering peaks,
- to determine how many fruit individual plants produce during one year.

#### Study sites

Three separate !nara populations were monitored from December 1989 to August 1992 from the Gobabeb Training and Research Centre. Two of the study sites were situated close to Gobabeb, whilst the third was at Sandwich Harbour on the Atlantic Ocean coast. Sandwich Harbour consists of a saltwater lagoon system with freshwater seeping through under the dune fields. It lies about 40 km south of Walvis Bay. The two inland study sites fall within the climatic "middle zone" of the Central Namib Desert, where average annual rainfall is 21 mm (1962-1992,

Meteorological Services, Windhoek) and average annual fog precipitation is 31 mm (Lancaster *et al.* 1984). The Kuiseb is an ephemeral river, flowing on average for 18 days per year (0-102 days, n=38 years). Since no rainfall or fog precipitation records exist for Sandwich Harbour, figures for Walvis Bay were used, namely 15 mm rain and 34 mm fog precipitation respectively (Henschel 1999).

The first study site was situated in an inter-dune valley (referred to as the "Dunes" site), about 5 km south of Gobabeb. Eleven plants (five males, five females and one that could not be sexed) growing at a dune base on sandy gravel were marked and monitored. The second study site was on the southern bank of the Kuiseb River (referred to as "Visnara"), immediately southeast of Gobabeb, where ten plants, 5 males and 5 females, were marked and monitored. Here, nine plants grew close to the river on sandy, gravelly soils, with one plant, a female, on a dune slip face. Both inland sites were monitored 21 times during the 33-month study period.

The plants in the coastal study site at Sandwich Harbour (referred to as the "Sandwich" site) grew at the base of a dune in the northern part of the lagoon, near freshwater pools. These *!naras* were monitored 12 times during the study period. Some plants in the *!nara* field along the southern part of the lagoon were also examined to obtain more data on sex ratio and nearest neighbour distance. Due to the difficult terrain, it was not possible to determine their size.

#### Plant size and nearest neighbour distance

In the three *!nara* fields, plant size (surface area covered by the plant) was determined, and the distance between nearest neighbouring *!nara* plants was estimated. Both measures showed considerable variation. The surface area of plants varied from 0.2 to 2 335 m<sup>2</sup>, and nearest neighbours ranged from 4 to 300 m apart (Berry 2001; Table 5.1).

Measure	Dunes	Visnara	Sandwich
Average and range of ground surface area covered by plants (m <sup>2</sup> )	194 (0.2-1237)	69 (0.8-393)	944 (252-2335)
Average and range distance between nearest plants (m)	96 (4-450)	104 (13-500)	72 (6-220)

Table 5.1: Plant size and nearest neighbour distance of *!naras* at three locations in the central Namib Desert.

#### Sex ratio

The sex of all study plants was recorded. To increase the sample size, *!naras* in several inter-dune valleys in the southern part of Sandwich Harbour were sexed, as well as at Nara Valley, which lies about 15 km west of Gobabeb in an inter-dune valley, adjoining the south bank of the Kuiseb River. Overall, the sex ratio did not differ significantly from parity ( $\chi^2=0.32$ ;  $P>0.05$ ), nor was there any significant skewness at any site ( $\chi^2<3.8$ ) (Table 5.2).

Location	No. of plants	Male	Female	Unsexed
Dunes	34	14	12	8
Visnara	18	9	5	4
Sandwich study site	10	6	4	0
Sandwich southern site	44	24	13	7
Nara Valley	77	33	42	2
<b>Total</b>	<b>183</b>	<b>86</b>	<b>76</b>	<b>21</b>

Table 5.2: Sex ratio of *!nara* plants at five locations in the central Namib Desert.

#### Condition ratings and flower and fruit production

During the regular visits, *!nara* plants were characterised according to the following parameters: general condition, percentage of dead stems, flower production, flower utilisation, fruit production, utilisation of fruit, size and number of fruit. A subjective rating scale from 1 (very poor) to 5 (excellent) was used for all these parameters, with 0 for no flowers or fruit observed.

Plant condition differed slightly between the sites (Table 5.3). The Visnara site ranked highest for both male and female plants, where a rating of "good" was obtained on 21.4% of the 21 occasions that each of the 10 study plants were examined, followed by the Dunes site (4.8% on 11 study plants). Only one of ten study plants, a female, attained a condition rating of "good" at the Sandwich site. Two plants lost condition in the Dune site and their percentage of dead stems increased from 40 to 90% (unsexed) and 15 to 80% (female). One male plant died in the Visnara site. Although rainfall at Gobabeb was 12.3 mm during 1990 and 18.3 mm during 1991 (Henschel 1999), more plants were rated to be in good condition during 1990 than in 1991 (Berry 2001). However, the ephemeral Kuiseb

River flowed for 19 days in 1990, compared to only 6 days in 1991. This may have favoured the condition of !naras at the Visnara site, but not at the sites in the Dunes or Sandwich. At Sandwich, the condition of all !nara plants in the study site deteriorated noticeably during the study period from a rating of "fair" to "poor". This was presumably due to an increase of the salinity in the freshwater pools and severe attrition of the beach by the ocean.

Parameters measured	Dunes	Visnara	Sandwich
Maximum male condition rating	4 (7)	4 (15)	2
Maximum female condition rating	4 (4)	4 (30)	4 (1)
Maximum male flower production rating	4	4	4
Maximum female flower production rating	2	3	2
Maximum fruit production rating	4	4	5
Maximum number of fruit on one plant	35	77	321
Number of plants examined	10	11	10
Number of times examined	21	21	12

Table 5.3: Rating of condition of whole plants, flower and fruit production of male and female !nara plant at the three locations in the central Namib Desert during 1989-1992. Scale of condition rating: 1 = very poor, 5 = excellent. Figures in brackets denote the number of times a condition rating of 4 (good) or higher was recorded.

### Seasonality of flower production

Maximum flower production by males was rated "good" in all three study sites. Female flower production was highest at Visnara (rating "fair") but was poor in both the Dunes and the Sandwich sites. Graphs for seasonality of flower production (Berry 2001) show that male plants at all three sites flowered at a higher rate throughout the year, whereas female plants showed definite peaks during the summer months, but still produced fewer flowers than males (Fig. 5.1).

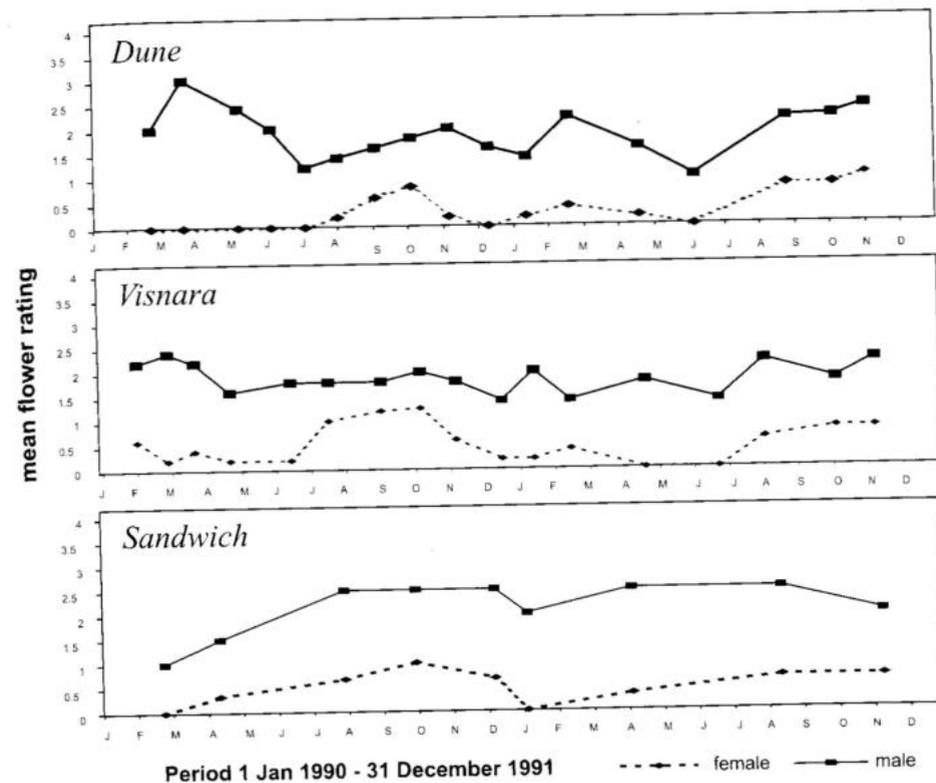


Figure 5.1: Average flower production of male and female !nara plants at Dune, Visnara and Sandwich sites during 1990 and 1991. Scale of production rating as in Table 5.3: 1 (very poor) to 5 (excellent), with 0 for no flowers observed.

### Fruit production

The mass of individual fresh, ripe !nara fruit ranged from 698 g to 1 050 g with an average of 256 seeds per fruit (Berry 2001). Fruit production rate was highest at the Sandwich site with a rating of "excellent" whereas in both the Dunes and Visnara sites the rating was "good". In general, fruit production was highest at Sandwich (mean 125; range 17-321 melons per plant), intermediate at Visnara (31; 12-77) and lowest at the Dune site (18; 11-35). One individual plant at Sandwich bore 321 melons in December 1989 and another 311 melons in October 1990.

### Utilisation of fruit

At both the Dunes and the Visnara sites, the !nara fruit were eaten by seven-

ral species of wild animals, such as rodents, black-backed jackals and gemsbok, as well as domestic donkeys and people. Donkeys were especially noticeable in the Visnara site where numerous tracks and dung showed that these animals spent much of their time in the !nara field and ate the fruit. No domestic animals occurred at the Sandwich site, but occasionally gemsbok and jackals were observed. Jackals were seen frequenting a hoard of approximately 50 fruit husks near one female plant.

### **Discussion and conclusion**

This study was done during a period of below average rainfall. Flow in the Kuiseb River was typically irregular and varied from 6 to 19 flood days per annum. These erratic inputs of water probably benefited only those !naras growing close to the riverbed, as an appreciable increase in their condition was evident compared to !naras in the dunes. At the coast, regular freshwater seepage under the dunes appeared to result in a significantly higher production of fruit. Utilisation of fruit was higher in the inland Visnara and Dunes sites, where the Topnaar harvested, than at the coast. Free-roaming donkeys belonging to the Topnaar spent much of their time in the !nara fields and ate many fruit before they could be harvested. Moreover, their hoof action on the !nara hummocks caused further damage to growing stems. This may compromise the !nara's survival in these locations, but further study is required to elucidate this.

The coastal !naras at Sandwich Harbour were exposed to an unstable, rapidly changing environment in which erosion of the shoreline by wave action caused the ocean to encroach on their habitat. Despite a constant source of fresh water originating from under the dunes, the increase in salinity, coupled with exposure of their root systems, killed some of the study plants. I observed entire !nara plants and the dune hummocks on which they grew being destroyed by the receding shoreline. In the 10-year period that followed my study, I estimate that the sea advanced by as much as 100 m, reaching the base of the dunes where !naras were located. The effect of this dynamic coastline change has been the demise of the once flourishing !nara fields in the northern lagoon of Sandwich Harbour.

In conclusion, the inland !naras have been subjected to increased fruit utilisation by people and donkeys. Although the coastal !naras have the highest numbers and weight of fruit, they have suffered a severe setback following an unpredictable change in the coastline.

## Chapter 6

### Pollination ecology of !nara

by Caroline Mayer

#### Introduction

Pollination, the deposition of pollen onto the stigma for fertilisation, is essential for most plants to reproduce. Pollination may be fulfilled by abiotic vectors such as wind or water, or animals, mainly insects, birds and bats. Other reproductive strategies are to produce fruit via self-fertilisation or without any pollen (apomixis).

Changes in fruit production of the !nara that were suggested by the Topnaar (Chapter 1), could originate due to changing pollinator services, such as pollinator shortages, pollinator inefficiency, or lack of pollen supply. Identification of pollinating vectors is therefore desirable, particularly with regard to eventual cultivation.

Since male and female !nara flowers grow on separate plants, self-fertilisation is impossible. This is important for pollination because pollen-vectors have to cover the distance between plants of different sex, which averages about 60 m in a !nara field (Mayer 2000).

The main aim of this investigation was to answer the questions: how, and at what rate, are !nara flowers pollinated. Further objectives were to quantify fruit yield, i.e. the relation of flowers to ripe fruit, and to identify factors affecting survival of flowers and fruit. Field studies were conducted from October 1998 to May 1999 in the vicinity of the Gobabeb Training and Research Centre.

#### Flower phenology

In order to answer questions on flower phenology, rate of pollination and survival of the flowers, all 1913 buds on 366 marked twigs of 18 female plants, and 83 buds on 15 twigs of three male plants were monitored. Growth, time and duration of flowering, numbers of fruit set and grazing by herbivores was documented regularly. Additionally, flowers and fruit of several plants were counted at irregular time intervals.

Male !nara plants bloomed all year round (Berry 2001), while the female flowering season was from September to April, peaking in October to December. Anthesis (opening) of !nara flowers occurred in the morning between 08h30 and 10h00. Female buds took more time until anthesis than did male buds (156 females:  $20 \pm 4.0$  d; 6 males:  $6 \pm 1.9$  d). On average ten times more male than female flowers were observed. While male blossoms usually shed the day after anthesis, female flowers remained open for several days. Hand pollination ( $n_{\text{total}}=40$ ) revealed that pollination success was greatest on the first two days after anthesis (76% pollinated;  $n=21$  trials) and declined in the next two days (36%;  $n=14$ ). The stigma withered after the fourth day and no more fertilisation was then possible ( $n=5$ ).

### Abiotic pollination vectors

To investigate wind pollination, seven pollen traps were put 1 to 10 m downwind of male plants. They consisted of ten microscope slides spread with insect-lime and fixed on a  $0.25 \text{ m}^2$  pane of Perspex. When these slides were examined under a microscope 24 hours later, single pollen grains were found on only two slides placed 1 m from flowers. Thus !nara does not appear to be pollinated by wind. Pollination by water is not plausible, and was not considered further.

### Biotic pollination vectors

Previous to this investigation, only vague suggestions and anecdotes (Herre 1975; Louw *et al.* 1989) about !nara pollinators existed. The !nara-fly (Ulidiidae), for example, is a common small green fly frequently found on the twigs of !nara-plants and could be a candidate for pollination. Furthermore, the !nara-cricket (*Acanthoproctus diadematus*, Bradyporidae, Heterodinae) is often seen feeding on flowers, and could possibly deposit pollen. This cricket commutes between plants and could therefore potentially transport pollen to female !naras. Another suggested candidate, a blister beetle (*Mylabris zigzaga*, Meloidae), is quite abundant and conspicuous, especially when feeding on !nara flowers.

To identify possible pollinators, flowers ( $n_{\text{total}}=144$ ) were observed between October and February. Five to eight female flowers were observed simultaneously for half an hour. Frequency and duration of stay of the different flower visitors was reported (Table 6.1). On average, 83% of the flowers were visited during flower observations. The most frequent visitors were two solitary bee species, *Amegilla velutina* and *Anthophora auone* (Apidae, Anthophorinae), which respectively visited

37% and 26% of all attended flowers. A third, much smaller bee, *Hylaeus sp.* (Colletidae), visited 17%. The blister beetle, *M. zigzaga*, was observed on 12% of the flowers, the !nara-fly on just 1%. A small fraction (7%) of the flowers was visited by small ants.

Visitor	No. of visits	Duration of stay (min: sec)	
		Mean and SD	Range
<i>Amegilla velutina</i>	92	00:03 ± 00:04	00:01 - 00:25
<i>Anthophora auone</i>	66	00:03 ± 00:01	00:01 - 00:08
<i>Hylaeus sp.</i>	64	02:03 ± 02:31	00:01 - 12:17
<i>Mylabris zigzaga</i>	31	09:55 ± 10:09	00:20 - 30:00
Unidentified ant	18	00:26 ± 00:27	00:02 - 01:51
!nara fly ( <i>Ulidiidae</i> )	1	00:04 ± 00:00	00:04 - 00:04

Table 6.1: Number of visits and duration of stay by insects on flowers. SD = standard deviation.

Pollen checks were conducted on potential pollinators that were caught at female plants (2 *A. velutina*, 8 *A. auone*, 15 *Hylaeus sp.*, 149 *M. zigzaga*). After cooling them to immobility they were checked under a hand lens for adhering pollen. Pollen samples were taken for further microscopic identification. Insects were marked before release to avoid recapture. All checks on anthophorine bees were positive for !nara pollen. Besides !nara pollen, two bees also contained pollen from *Salsola kakile* (Chenopodiaceae) and *Acacia erioloba* (Mimosaceae) indicating that !nara is not their only pollen/nectar source. Half of the pollen checks (53%) on *Hylaeus sp.* were positive for !nara pollen, although 86% of these carried only very small amounts. *Mylabris zigzaga* was positive for !nara pollen in 44% of the checks, with 56% of these individuals carrying high to medium amounts of pollen.

To test their pollinating ability, flower-visiting insects were captured at female plants and put onto “virgin” female flowers ( $n_{\text{total}}=150$ ) that had been covered with gauze bags to prevent natural pollination. After at least half an hour the insects were again removed. The anthophorine bees were difficult to catch and did not behave naturally when enclosed in the gauze bags. To test bee pollination, the bags were removed for half an hour so that bees could freely visit the blossoms. Only flowers that had been visited by a single species were monitored further. Growth of the ovary was interpreted as successful pollination. In several cases it could not be determined whether pollination had taken place, because the flowers were aborted before any growth of the ovary was recognised. The results of these tests are shown in Fig. 6.1.

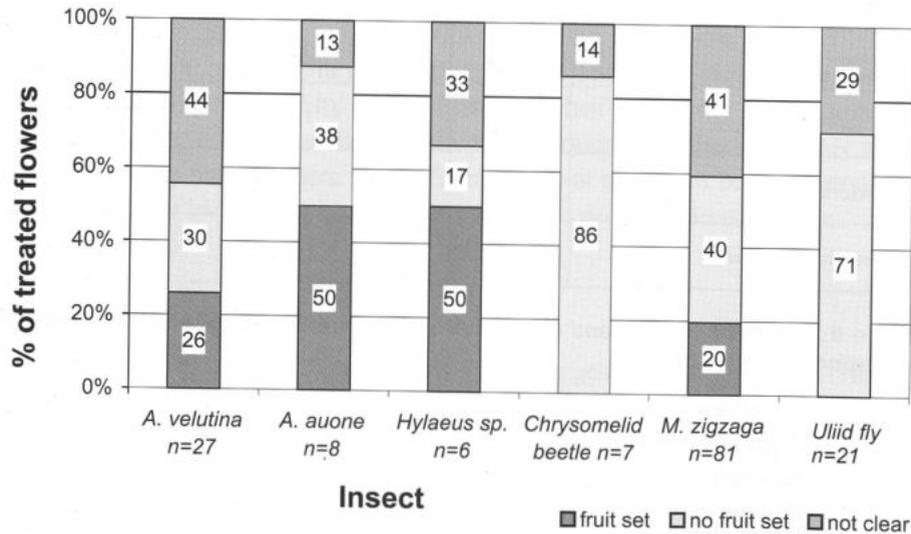


Figure 6.1: Results of gauze bag experiments with possible pollinator species: percentage of pollinated (= fruit set) and unpollinated (= no fruit set) flowers.

Two of the initially suggested candidates are probably not involved in pollination of !nara: the highly abundant !nara-fly was hardly seen visiting blossoms (Table 6.1). Neither were any pollination experiments positive (Fig. 6.1). The !nara-cricket was soon excluded as a candidate, because it totally destroyed the reproductive organs while browsing flowers.

A third candidate, the blister beetle *M. zigzaga*, proved to play a role as pollinator. This beetle also fed on petals (25% of female and 52% of male flowers) and pollen, but usually the reproductive organs stayed intact (80% of the cases).

Behavioural observations revealed that *M. zigzaga* regularly commutes between !nara plants and even between different !nara fields (Mayer 2000).

The most effective pollinators, although they forage on different plant species, were the anthophorine bees *Amegilla velutina* and *Anthophora auone*. They were abundant, transported large quantities of pollen, moved quickly among flowers and made pollination most probable by landing directly on anthers and stigmata. *Hylaeus sp.* on the other hand transferred small amounts of pollen and often landed on the petals before crawling into the interior, making pollination less effective.

To look for nocturnal pollinators, 21 female buds were wrapped in gauze bags. After the flower opened the bags were removed for the night. Before diurnal insect activity began the next morning, a sample of the stigmatic surface was taken with the help of Scotch tape and examined under a microscope. Almost all (90%) of the flowers had been visited by moths during the night, as indicated by scales and hairs. However, only two stigma samples (9.5%) contained single grains of !nara pollen, indicating that moths were not important pollinators. By comparison, all samples taken from control flowers ( $n=7$ ) that had been visited by bees during the day contained large quantities of !nara-pollen. Although nocturnal pollination does occur, indications are that its influence on reproductive success is negligible.

### Other reproductive strategies

To investigate whether asexual reproduction (apomixis) occurs, 44 flowers were totally excluded from pollination with gauze bags. None of these set fruit. So we can conclude that *autonomous* apomixis (no pollen necessary) is not a reproductive strategy of the !nara. The experimental design did not test for *pseudogamous* apomixis (activation of ovum by pollen hormones; van Dijk & van Damme 2000), and it is theoretically possible that this occurs. However, as the latter also requires pollen to be transported, the vectors would be the same as the pollinators described above.

## Degree of bud-flower-fruit development

Only 42.6% of the 1913 observed buds bloomed (Fig 6.2). Of these, 27.1% initiated fruit (=fruit set). However, only 13.6% of the fruit set matured. This gives a fruit yield in relation to flowers of 3.7%, which is extremely low, especially in comparison with another wild (annual) cucurbit, the buffalo gourd (*Cucurbita foetidissima*), which achieves fruit yields of 50% (Winsor *et al.* 2000). The low rate of fruit maturation, rather than failure to pollinate (see above), appears to be responsible for this low fruit yield.

Over half (54.3%) of all buds, flowers and unripe fruit aborted, while 25.1% withered. The high abortion of buds, flowers and even small fruit could be a result of resource competition among them. Many plant species produce a surplus of flowers and fruit and natural levels of pollination exceed fruit set (Stephenson 1981). A small proportion of flowers were lost through parasitism (2.5% in total, but especially pollinated flowers with 11.8%), lice (2%) and fungi (0.1%).

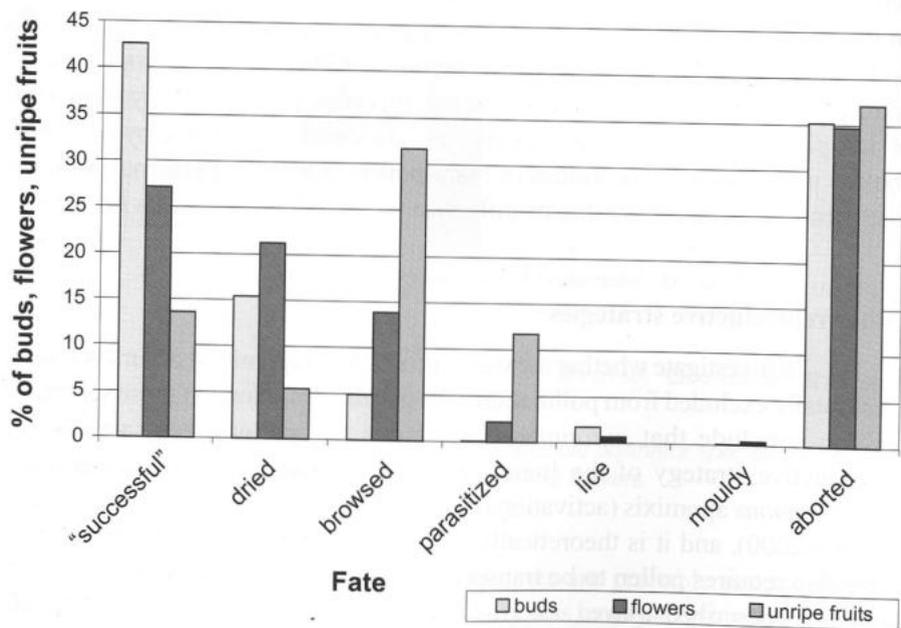


Figure 6.2: Fate of buds, flowers and unripe fruits of *Inara* plants that were monitored. "Successful" denotes buds that bloomed, flowers that set fruit and unripe fruits that matured.

## Herbivory

Almost one-sixth (15%) of all flowers (closed, open, or pollinated) were lost due to herbivory, while almost one-third (31.7%) of immature fruit were lost in this way (Fig. 6.2). Damage by different herbivores is shown in Fig. 6.3. The effect of the *Inara*-crickets was negligible. Almost one quarter (23.7%) of all browsed buds, flowers and fruit were eaten by striped field mice (*Rhabdomys pumilio*) and gerbils (*Gerbillurus* spp.).

However, the most important herbivores were the free-roaming donkeys of the Topnaar, which were responsible for 50% of the loss of flowers and fruit (Fig. 6.3). Two incidents illustrate their heavy impact. At one plant at Visnara, over 90 immature fruit were counted, while two days later, after donkeys had visited this site, only 24 small fruit were left. Another plant, close to Soutrivier, bore 76 fruit. After browsing by donkeys, only 12 were left. Most of the fruit were just bitten off and not even eaten, probably because of their bitter taste.

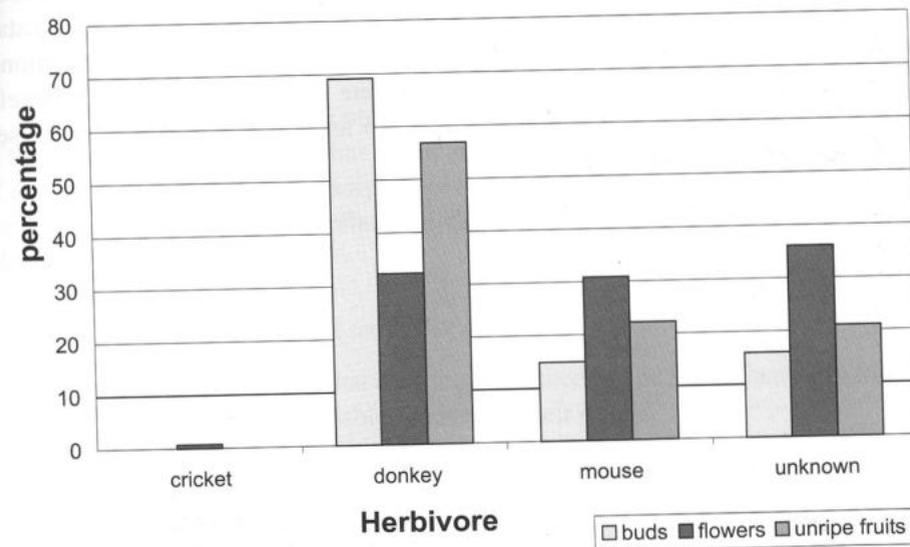


Figure 6.3: Percentages of *Inara* parts (buds, flowers and unripe fruits) browsed by different herbivores.

## Conclusion

This study indicates that pollination does not appear to be a limiting factor to !nara. However, further studies over longer time periods and in different areas are necessary to confirm this. !Nara flowers are bowl-shaped, making their rewards, e.g. nectar and pollen, easily accessible to any kind of insect visitor. The pollination system of !nara appears to be a generalistic one with pollination being possible as long as visitors are capable of moving among plants of different sexes. I do not believe that fruit production suffers due to insufficient pollination.

Fruit loss due to donkeys appears to be the most significant factor reducing fruit yield. If one could keep the donkeys off the !nara fields it would theoretically be possible for more than 10% of the flowers to develop ripe fruit, provided that flower and fruit losses caused by water shortage, parasitism, and other factors remained proportionally constant. A first hint of this is given by one plant in Visnara, part of which stands inside a fence. For over 15 years, the fenced part has yielded many more ripe fruit than all other female plants at this site (Henschel, pers. comm.). It is obvious that penning up donkeys and feeding them with commercial food would be impractical for the Topnaar. But maybe they could be herded to stay away from !nara fields, at least until !nara melons are ripe. In present conditions, fruit loss due to damage by donkeys is a complete waste, as not even they benefit from it. It would be a revealing experiment to fence some female plants to see whether fruit yield increased.

## Chapter 7

### Seed dispersal ecology of the !nara melon

by Markus Müller

#### Introduction

Dispersal is a central aspect of the ecology of plants. Dispersal ecology includes all questions regarding the transfer of a plant seed from the position on the mother-plant to a new place. Some of these questions are:

- How is the seed moved from the mother-plant to a new site?
- What risks do seeds experience on the way there, i.e. how many die and how do they die?
- What is necessary for successful germination and establishment at the new site?

Knowledge about these processes is important for a general understanding of the ecology of !nara. It also has implications for the management and treatment of existing plants, and is necessary for planning possible cultivation. To provide insight to some of the issues related to dispersal, the following questions were addressed:

- In which way are !nara seeds dispersed?
- Which of the animals that are thought to feed on the !nara plants and fruit, take up and disperse viable seeds with their dung?
- Does digestion have any influence on the germinability of seeds?
- How many of the dispersed seeds are taken up by consumers and what factors influence this?
- When examining the existing plant population, can characteristics of favourite sites be deduced and are all potential growing sites for !naras occupied?

The research was conducted between October 1998 and April 1999 mainly in the vicinity of the Gobabeb Training and Research Centre. Additional data were collected at Sossusvlei and Wortel in the Kuiseb Delta, which is known to be the most important harvesting area for the Topnaar (Budack 1977; see Chapters 2 & 3).

### Primary consumption of seed

Oryx (*Oryx gazella*), springbok (*Antidorcas marsupialis*), black backed jackal (*Canis mesomelas*), spotted hyaena (*Crocuta crocuta*), ostrich (*Struthio camelus*) and domestic donkeys are known to commonly feed on !nara plants and fruit (Grimme 1910; Stuart 1975, 1976; Moritz 1992; Rumrich & Rumrich 1996). I was able to observe all of these animals feeding on !nara, except for jackals and hyaenas. It was possible to deduce that jackals ate !nara melons from fresh tracks and remains of !nara peels in the sand, close to fruit-bearing adult plants. To find out whether intact seeds survive the passage through the digestive tract of animals, I systematically collected droppings of donkeys around Gobabeb, Wortel, and Armstraat and collected jackal faeces wherever they were encountered. Near Gobabeb (including Nara-Valley) and Wortel, 256 samples from 60 heaps of donkey dung, 31 jackal scats, and several springbok droppings were collected, ground up between the fingers, and searched for !nara seed shells or intact seeds. Droppings of all other animals mentioned above were collected at Sossusvlei on transects of 4800 m length, covering different habitats (dune, vlei, transition) at different distances from !nara plants (inside !nara fields, and up to 500 m away from fields). On these transects, every dropping encountered within 1 m left or right of the walking line was collected. For oryx, ten pellets were taken from each dung heap. In Sossusvlei, altogether 800 pellets from approximately 80 heaps of oryx dung, 12 ostrich droppings, 1 hyaena scat, and 32 jackal scats were collected and examined as above.

Just over half (58%) the oryx faeces sampled contained very small pieces of !nara seed shells, sometimes in high concentration. Not a single intact seed or even a shell piece half the size of a seed could be found. It is therefore obvious that oryx do not disperse viable !nara seeds. The same appears to be the case for ostrich. The single hyaena scat also contained only numerous small pieces of shells. It is clear that springbok droppings will never contain intact !nara seeds, because their droppings are significantly smaller than the average !nara seed. In the only observation of springbok feeding on !nara, the animals didn't touch any fruit, although many ripe fruit were available.

Of the donkey faeces, 43% contained remains of !nara seeds. All were broken or damaged and none contained any remnants of the seed embryo. In general

the pieces were much bigger than those contained in oryx faeces. Several feeding observations showed that donkeys do not differentiate between ripe and unripe fruit before tasting them. As a result, they sometimes deplete the entire fruit set of a big plant without actually consuming much.

Jackal faeces from both study sites contained both broken shells and unbroken seeds (Gobabeb: 10 of 31; Sossusvlei: 32 of 32). If a sample contained broken shells, intact seeds could always be found. Other contents were mainly plant material, fruit flesh, termites and bones of mice at Sossusvlei, and tenebrionid beetles, plant material and mouse bones at Gobabeb. Unbroken seeds were later tested for vitality using chemical and germination trials.

To get an idea of how far seeds are carried by jackals, I offered portions of dog food that contained coloured cotton threads as markers at different places around !nara patches. The bait was put out in the evening, and if it was missing in the morning, I followed the jackal track in order to find the faeces containing the markers. I did the same with !nara fruit, i.e. followed jackal tracks from where they had eaten !nara melons and looked for seeds in fresh jackal scats along their paths. Only 4 of 36 baits were taken by jackals. After some kilometres, all attempts at tracking jackals became futile because other tracks crossed the ones being followed, causing confusion. I had the impression that jackals moved over much greater distances during one night than I could follow them (longest 8.5 km), which indicates a potential for long-distance dispersal of !nara seeds by these animals.

### Secondary consumption of seeds

In this context, secondary consumers are those animals that feed on dispersed seeds. I conducted experiments to determine if secondary consumption depends on the distance from !nara patches and if it is influenced by seeds being located in jackal scats compared to lying bare on the surface. Seeds were placed at different distances from !nara patches. Seeds in scats were compared to bare ones, and seeds placed on top of the sand surface were compared to seeds covered with sand (n=300).

Gerbils *Gerbillurus paeba* and *G. tytonis* (identified according to Griffin 1990) were the only consumers of dispersed seeds. On and close to hummocks (average of 40 m away) the consumption rate was very high. This turned out to be mainly related to plant cover and position in relation to landscape structures. Sand cover also significantly reduced consumption. Gerbils more often found seeds in faeces than bare ones, but this difference was not statistically significant

(Kolmogorov-Smirnov-test for two samples  $p > 0.1$ ).

The consumption trials revealed another aspect that could be relevant to the population dynamics of *!nara*. During four experimental nights, several piles, each of about 50 seeds, were put out in a central place frequented by gerbils. The next morning, the surrounding area in a radius of 200 m was examined for tracks of gerbils that could indicate hoarding behaviour. Altogether, 32 hoards that each contained 3-4 seeds were found. On average, these were buried about 3 cm deep. I followed the further fate of these scatter-hoards, and found that most were emptied during the next night and all were emptied within four nights. Even though none of the observed hoarded seeds survived, it indicated that gerbils are scatter-hoarders. This hoarding strategy brings seeds into very good positions for germination and even if only a very small proportion of the hoarded seeds remain in the ground (forgotten or left behind), gerbils could function like gardeners for the *!nara* (as is known from scatter-hoarders from other regions, e.g. Hulme 1998).

### Germination

It was necessary to establish a reliable germinating method before being able to test seeds from faeces for germinability. *!nara* seeds are reputed to be very difficult to germinate, probably requiring two years of primary dormancy. I therefore conducted trials under several different conditions.

Ninety-six seeds were kept in different types of water (brackish water, fog water, distilled water, a mixture of salty and distilled) and different light and temperature regimes (hot: 35 -55°C, full sun; 25 °, indirect light) in petri dishes in sand or on tissue paper over a time span of 10 weeks. Only one seed germinated, showing that germination in artificial conditions such as immersed in water is unsuccessful.

To simulate more natural conditions, *!nara* seeds were placed at depths of 2 and 7 cm in the ground inside protective pipes of about 15 cm diameter and 20 cm length, covered at both open ends with chicken wire as protection against seed consumers. Thirty pipes each containing two seeds were positioned on hummocks, while another 30 were positioned at distances of 10-50 m from *!nara* plants, to test if distance from adult plants had any influence on the chance of a new plant becoming established.

All seeds used were from the previous year's harvest (7-12 months old), collected out of the flesh of ripe fruit by the traditional Topnaar method of dissolving

the flesh in water. Twenty seeds showed a 100% viability in two tetrazoliumchlorite analyses<sup>19</sup>. Before being planted, all seeds were soaked for 24 hours. Upon being positioned in the field, seeds were watered every 2 to 3 days with 250 ml, depending on the rest moisture level, controlled via reference pipes that were similarly treated. After 50 days, the pipes were only watered sporadically. The pipes were dug up after 70 days and seeds were searched for any signs of germination or consumption.

In 52% of the seeds found, there were traces of germination, such as outstretched radicula or rests of cotyledons, but all had dried out and died. Significantly more seeds germinated at a distance from hummocks than on top of them (Fisher exact test:  $p = 0.011$ ;  $\chi^2 = 6.95$ ). The most obvious reason appeared to be that termites consumed the seeds only on hummocks, probably because they occurred there at higher densities. No evidence was found for adult plants chemically killing seedlings in their vicinity to prevent crowding. In general, seeds that were buried deeper had higher germination success (Fisher exact test:  $p = 0.0049$ ;  $\chi^2 = 9.16$ ). One of the likely reasons could be higher and more constant moisture content at greater depth (Robinson & Seely 1980).

A second trial was conducted with similar protection pipes at the edge of a flat dune. In this case, 20 pipes each contained one normal seed, collected as described above, and one seed that came from jackal faeces. Seven pipes got lost. The germination success in both kinds of treatments was identical: 5 of 13 seeds germinated, indicating no influence of digestion on germination.

The most successful germination method was found by accident and could later be proven through controlled trials. Forty seeds of different origin (seeds from last year's harvest, harvested less than a month previously, and seeds out of jackal faeces) were placed into 8 jam glasses (½ litre). These were filled up to a quarter with different kinds of water (brackish water, fog water, and a mixture of both) and kept in half shade at around 25°C. After 24 hours the glasses were filled up with sand of different origin (sand from adult hummocks, dune sand and river silt) until the water was totally absorbed by the sand. The glasses were put in the shade at 25°C and kept moist over 50 days. The glasses were examined for germinated seeds after 2, 4, 8, 16, 23 and 50 days. The first germination movements (shells opening and the tip of the radicula visible) appeared after 2 days. After 50 days, a germination rate of 54% was reached. All kinds of seeds germinated in all combinations of sand and water without any significant differences between them.

<sup>19</sup> Tetrazoliumchlorite analysis is a technique that uses chemicals to determine whether seeds can germinate.

This method is simple and brought the highest and fastest germination success. It showed again that seeds from jackal faeces don't change in terms of germination viability.

In addition, seeds out of jackal faeces were tested with tetrazoliumchlorite for viability, and 77 of 100 seeds tested were undamaged. As comparison, seeds were heated up to different temperatures and tested with the same method. I found that seeds were killed only at temperatures between 100° and 110°C.

### Groundwater relations

Herre (1975) and Klopatek (1994) mentioned in their work that the !nara is thought to be able to grow only in places where groundwater is available. The fact that a part of the !nara population at Wortel is in very bad condition and several plants are dying, is being blamed on the building of the flood retention wall at Rooibank and the increasing abstraction of groundwater. To find out about the relationship between groundwater and !nara growth, I compared patterns of !nara distribution in the dunes near Gobabeb with the distribution of groundwater using specific information from the Department of Water Affairs of Namibia (Lenz 1995). Using mapping software (GIS), the position of all !nara plants around Gobabeb in an area of 6780 ha was plotted onto a map of the palaeo-channels under the dunes (Fig. 7.1). It became obvious that the size of !nara plants is closely related to the depth at which groundwater is located, up to a depth of about 60 m.

Taking this a step further, I compared the location of all !naras in the study area with the conditions regarding groundwater, surface structure and ground composition. At least 1% (67 ha) of the places around Gobabeb with the best establishing conditions on the surface and the best groundwater situation, contain no !nara plants. Similarly, 15% of the places that can be classified as potentially very good growing places (groundwater available at 1-40 m depth) do not have !naras growing on them. This surprising result can have many reasons. One could be the fact that in the rare years with suitable conditions for establishment of new plants, not enough seeds are available in the best places.

The method of GIS-analysis of groundwater conditions to identify available sites could be used in other regions. In potential establishing years, such places could be sown with !naras and seedlings protected until they reach a certain size.

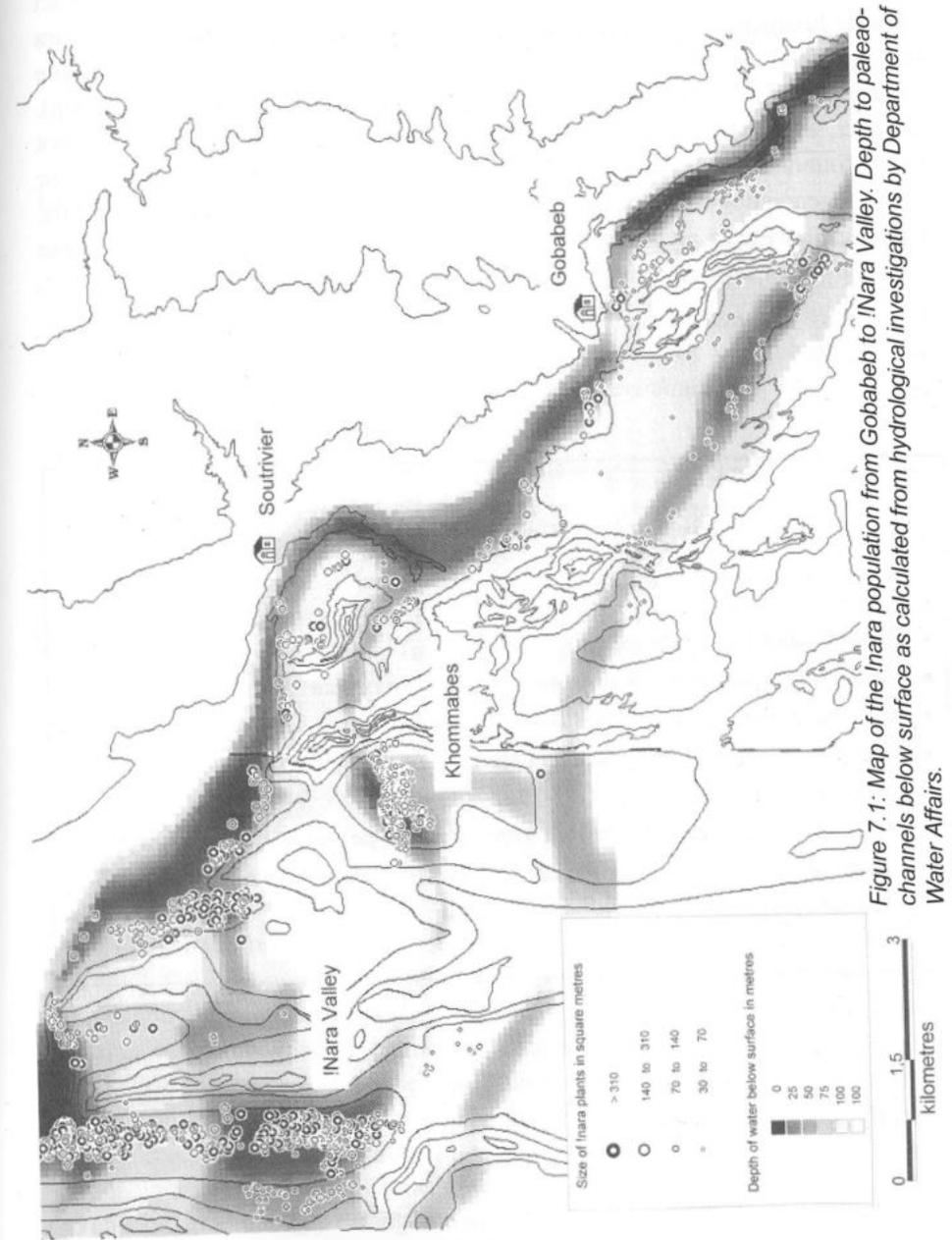


Figure 7.1: Map of the !nara population from Gobabeb to !Nara Valley. Depth to palaeo-channels below surface as calculated from hydrological investigations by Department of Water Affairs.

It can be concluded that jackals are the most important long distance dispersers for !nara seeds, while gerbils, as secondary consumers of seeds, also act as scatter-hoarders, and probably play an important role on a local scale. The !nara plant appears to require specific surface and underground conditions to become established, the most important criterion being shallow groundwater (<40 m deep). However, even where suitable conditions appear to be available, !naras are not always found. This possibly indicates a depletion of seeds that are necessary for natural regeneration of the population. Leaving more fruit for jackals and gerbils, as well as sowing in identified places where conditions are right, could become part of sustainable management and cultivation of the !nara plant.

### How to successfully germinate !nara seeds

- Germination can be started in a glass jar.
- Fill it with water and soak the seeds for 12-24 hours.
- Fill the jar with sand until all water is absorbed.
- Place the glass in a warm place (between 20 and 30 °C) and keep the sand moist.
- The first roots should appear in 7-10 days.
- The seedling can then be removed gently from the jar and planted in a suitable location. Care must be taken as the roots are very fragile and easily broken, which would kill the seedling.

### Root and shoot development of !nara seedlings

by Petra Moser

#### Introduction

Only structurally and physiologically adapted organisms are able to permanently colonise extreme environments (Louw & Seely 1982). The leafless cucurbit plant, !nara, is one of them. To fully understand the ecology of !nara it is necessary to study the effect of availability of water on !nara seedlings, as seed germination and seedling establishment are the most vulnerable phases in the life of a plant (Fenner 1987; Huang & Gutterman 1999).

Adult !nara plants are found in the nutrient-deficient dunes and interdunes (Seely & Louw 1980; Louw & Seely 1982) and also in the Kuiseb riverbed, an ecosystem with relatively more energy and resources (Wharton & Seely 1982). This study was designed to increase the knowledge about !nara seedling growth and !nara recruitment, therefore obtaining information on growth conditions for future !nara cultivation by the Topnaar. Root and shoot development of !nara seedlings were studied under watered and unwatered conditions in two different habitats of the Namib Desert, the interdune and the riverbed.

#### Shoot development

The length of the main stem of !nara seedlings was measured on a regular basis over a period of 16 weeks. The !nara seedlings were situated at two study areas, in the interdunes and riverbed at Gobabeb and in the riverbed at Rooibank. The study fields were selected according to accessibility, substrate characteristics and whether they could be protected from large herbivores (such as donkeys). For the latter, the plants in the interdune were enclosed with a strong fence, while the seedlings in the riverbed (Gobabeb and Rooibank) remained unprotected. For the majority of the seedlings the development of one stem with or without branches was recorded. Recordings from seedlings that died during the observation period were included throughout if damaged vegetation points were previously recorded (no change in stem length during two successive measurements). The observation

period of the seedling shoot development differed between the experiments due to different times of planting. A total of five experiments were conducted (Table 8.1).

Experiment	Sample size		Study area	Water provided	Damage by animals monitored	Shoot growth measured	Root growth measured
	planted	analysed					
E 1	10	9	Gobabeb interdune	Regularly	Yes	Yes	
E 2	10	5	Gobabeb interdune	No	Yes	Yes	
E 3	10	10	Gobabeb riverbed	No	Yes	Yes	
E 4	10	10	Rooibank riverbed	No	Yes	Yes	
E 5	50	30	Gobabeb riverbed	No			Yes

Table 8.1: Design of experiments with *Inara* seedlings.

The stem growth of the watered *Inara* seedlings of *E1* and the unwatered seedlings of *E2*, both growing in the interdune, was slower than that of the seedlings growing in the riverbed of *E3* & *4*. Nevertheless, except for the unwatered seedlings in the interdune (*E2*), all the seedlings showed strong growth in the beginning followed by a slow-down and interrupted stem growth towards the end of the measurement period.

The *Inara* seedlings of all experiments showed similar patterns of stem development. After emergence of the seedlings, a large increase in stem length at an average rate of 0.7 cm per day during the first weeks of growth was followed by cessation of growth (Fig. 8.1). The growth pattern suggests that for the first few weeks the available water and nutrients were sufficient to support growth, and that these became limited in the course of the observation period.

It was estimated by Noy-Meir (1973) that 25–75 mm annual precipitation are necessary to maintain vegetation in arid environments. At Gobabeb 36 mm rain had fallen from February to April 2000 (Henschel pers. comm.). Nonetheless, the unwatered plants in the interdune showed the weakest plant development throughout the observation period (Fig. 8.1).

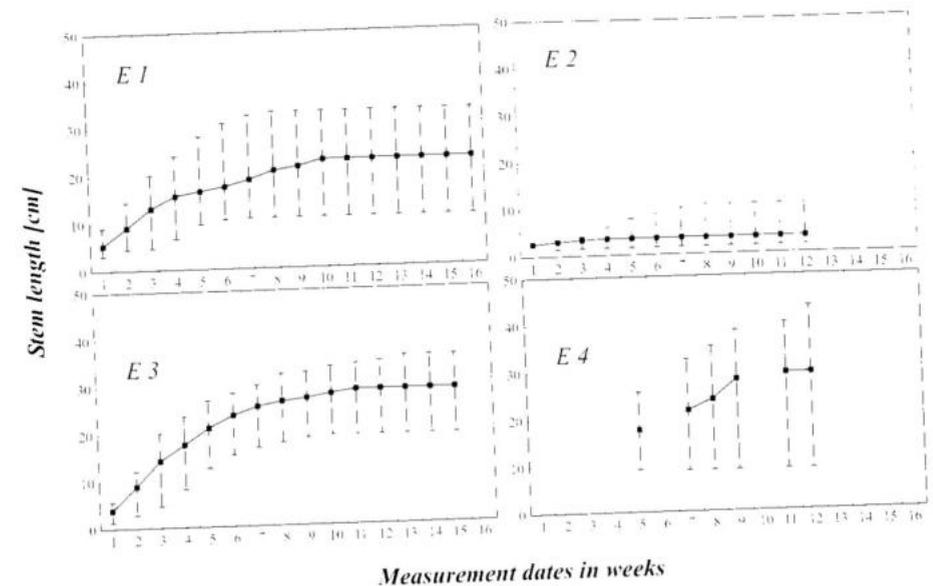


Figure 8.1: Results of Experiments 1 - 4: stem growth (cm) of *Inara* seedlings at weekly intervals, showing median, minimum and maximum recordings.

The watered plants in the interdune that each received 47.5 mm over the entire observation period sustained growth better than the unwatered seedlings there, but displayed weaker seedling development than the riverbed plants. Here the moisture from the recent floods was of great importance and advantage for *Inara* seedling growth. Furthermore, the water availability and storage capacity of a recently flooded loamy and silty riverbed is better than that of the interdune substrate. Therefore, the riverbed, which is richer in nutrients, generally provides better growth conditions than the interdunes, which have been found to be deficient in major nutrients such as nitrogen, phosphorus and potassium (Louw and Seely 1982).

### Root development

Over a period of 68 days, *Inara* seedlings, which were grown from seeds in the moist riverbed at Gobabeb without any extra watering, were harvested at regular intervals to determine the maximum length of their taproots (Fig. 8.2).

Until day 39 a linear growth increase was recorded while the measurements of days 54 and 68 indicated a slowed growth rate. The average daily root growth varied between 0.7 and 1.2 cm.

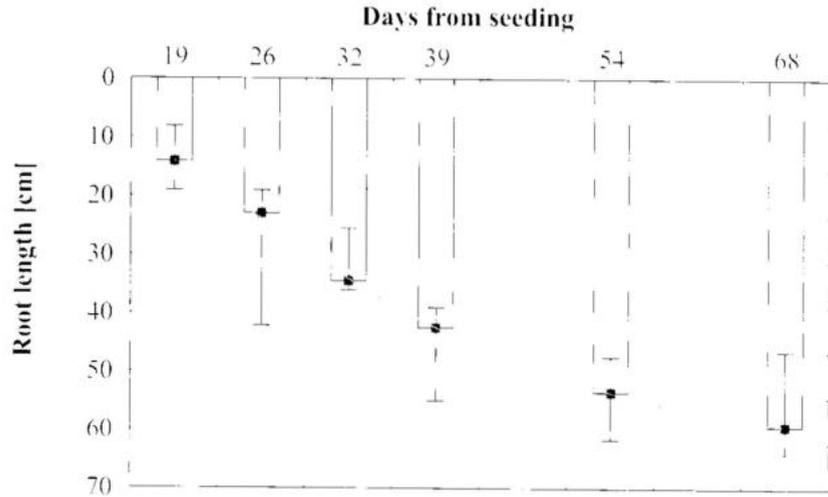


Figure 8.2: Results of Experiment 5: taproot length (cm) of !nara seedlings in the riverbed at Gobabeb with increasing time from seeding. Data points show median, minimum and maximum recordings.

The radicle of the !nara seedlings showed a more or less vertical penetration at a rate of an average of 0.8 cm per day, which is much slower than many other plants. For two African woody savannah species (*Acacia nilotica* and *Mundulea sericea*), an average daily root penetration of more than 2 cm (40 cm in 15 days) was measured (Wilson & Witkowski 1998). Taking into account that !nara seedlings have to ensure their establishment with only limited water supply, it is surprising that the taproots develop at a relatively slow pace. Nonetheless, !nara taproot growth rates were similar to the taproot penetration of another Namib Desert plant, *Welwitschia mirabilis*. According to von Willert (1994), a *Welwitschia* taproot grows at a rate of 1 cm per day, and slows down as soon as permanently moist substrate layers are reached. For !nara seedlings, the slower taproot elongation after day 39 (Fig. 8.2) may be attributed, on the one hand, to the constant moisture regime the roots have reached in the soil or, on the other hand, to fast geotropic penetration of secondary roots (Mitchell & Russell 1971). Considering the observed vigorous growth of the secondary roots, which penetrated deeper than the primary

root in the same timespan, it can be assumed that the secondary root system is responsible for depth penetration, securing the water supply as Klepper (1992) postulated for other species.

### Seedling damage by animals

Table 8.2 shows damage by animals that influenced the growth and survival of !nara seedlings. The feeding of caterpillars (Noctuidae) on 51% of !nara seedlings (18 of 35) was observed, which destroyed one seedling completely. Due to the feeding of an unidentified cutworm on the inside of the hypocotyl, 9% (3 of 35) of the affected !nara seedlings died. One plant was eaten by a large herbivore. In arid environments, water and food for animals are very scarce, therefore !nara seedlings are an attractive target from the time of their first appearance.

Experiment	Grown seedlings	Caterpillar		Cutworm		Large herbivore	
		affected	killed	affected	killed	affected	killed
E 1 - interdune	9	9					
E 2 - interdune	6	2	1				
E 3 - riverbed	10	2					
E 4 - riverbed	10	5		3	3	1	1
<b>Total</b>	<b>35</b>	<b>18</b>	<b>1</b>	<b>3</b>	<b>3</b>	<b>1</b>	<b>1</b>

Table 8.2: Results of observations on insect and large herbivore damage to !nara seedlings.

The caterpillar of an unidentified moth (Noctuidae) mainly fed on the cotyledons of !nara seedlings but also invaded stems and branches. Most of the !nara seedlings survived the damage inflicted by these caterpillars. Nevertheless it is interesting to note that in the interdunes, caterpillars from surrounding grass attacked the !nara seedlings, while in the recently flooded Kuiseb riverbed there was no grass, so the number of caterpillars, and their impact, was lower.

In comparison, when the hypocotyl of a !nara seedling was hollowed out by an unidentified white cutworm (possibly a beetle or moth larva), affected plants always died (Table 8.2). This evidently interrupted the water supply, causing death

within one day. This presents a major danger for the survival of !nara seedlings. Protection from this insect will be difficult to achieve.

Large herbivores in general and donkeys in particular present a constant threat to !nara plants, and can influence !nara recruitment (Shilomboleni 1998). The free-moving donkeys in the Namib Desert preferably feed on young shoots of adult !nara plants and also on tender !nara seedlings. Therefore, when !nara seedlings are planted in a habitat in which large herbivores exist, protection is necessary, especially at times when freshly grown grasses are not available. Mesh wire fences around individual seedlings would be one way to achieve protection.

## Conclusion

The main findings of this study are:

- Water is the main limiting factor for successful seedling growth, reflected in the stem development.
- Over the course of time, the different growth conditions in terms of water and nutrient availability in the interdune compared to the riverbed became increasingly more important.
- The slow growth rate of !nara seedling taproot corresponds to that of *Welwitschia mirabilis*. Slow-down of !nara taproot growth can be related to the establishment of an adequate secondary root system. The natural variability of developing roots, and consequently the plasticity in root depth and root development, may be a key attribute of !nara's adaptive strategy.
- Caterpillars (Noctuidae) and an unidentified white cutworm are the main animals responsible for !nara seedling damage or death.

For seedling growth and establishment, the riverbed provides more advantageous growth conditions than the interdune because of more generous water and nutrient provision. The root system of !nara seedlings growing in a recently flooded riverbed will more easily reach permanently moist substrate layers than the roots of seedlings in the interdune. At Gobabeb for example, the groundwater table in the riverbed was measured 4 m below the surface after the high floods in March and April 2000 (Shanyengana pers. comm.) and the floods moistened the substrate at shallower depths. In contrast, in the dune and interdune habitat, !nara seedlings depend on surface water, e.g. rain or artificial watering, to reach perma-

nently moist substrate layers, e.g. the groundwater. Here the groundwater table can be up to 30 metres below the surface (Lenz 1995), making it difficult for the !nara roots to reach it.

These findings are supported by the fact that the biggest !nara fields are located in the Kuiseb River Delta. Occasional floods allow natural recruitment in the riverbed while recruitment in the dunes and interdunes depends on heavy precipitation. In general, cultivation projects of !nara will be more successful in the riverbed than in the interdune, especially after floods. Nonetheless, individual plants in the interdunes and dunes, as can be seen from established adult !nara plants, are able to find suitable growing conditions there, too. Successful seedling establishment is therefore not only restricted to the riverbed habitat. With sufficient watering, successful cultivation should be possible in the interdune. The seedling development of the watered plants in the interdune indicates that regular watering over three months supports seedling growth. From the unwatered plants it can be concluded that the amount of 36 mm rain in addition to 2 litres of initial watering was not sufficient for successful seedling development. An adequate watering scheme, which still needs to be developed in detail (e.g. supplemented with fog-collecting screens; Henschel *et al.* 1998), in addition to the application of suitable fertilisers to balance the deficiency of nitrogen and phosphorus, should enable !nara seedlings to become successfully established at designated agricultural development sites (e.g. near Topnaar settlements).

## Chapter 9

### **Water, photosynthesis and transpiration of !nara**

by Felix Hebeler, Christiaan Botha & Aart van Bel

#### **Introduction**

Early approaches to understanding the ecology of desert plants assumed that water conservation was the key issue in the ecophysiology of plants that grow in very dry conditions. After the 1970s, the insight grew that not merely saving water, but optimising photosynthetic rates and regulating the energy balance are crucial for the adaptation to a desert environment, and explain many structural and physiological features (Gibson 1998).

There appear to be two basic survival strategies for plants in a desert environment. One is to minimise transpiration and maximise the photosynthetic efficiency, so that plant growth is possible with low water loss throughout the year. The other is to be "opportunistic", with plants photosynthesising under favourable conditions (e.g. after rainfall) but not during less favourable times, thus minimising transpiration at the cost of no growth (carbon uptake).

Other typical features of xerophytes are small leaves, a high proportion of sclerenchymatisation (tough, mechanical tissue to counter wilting effects) and succulence (having water-storing tissue). The root systems may be shallow and extensive (Larcher 1994) to maximise the water uptake after rare precipitation events, or alternatively, plants may develop tap roots to enable them to reach deep aquifers. The strategies employed by desert plants vary with the climate they are adapted to and the ecological niche they occupy.

In this study, transpiration, photosynthesis and water relations of !nara were monitored in field studies and in the greenhouse. We correlated these with anatomical and morphological features which could have direct bearing on their physiological functions.

## Features and effects of stem anatomy

It is known that *!nara* can support an extremely large biomass for a long time span, even though it lives only in areas with less than 50 mm average annual rainfall. Microscopic observations show that *!nara* exhibits a number of anatomical adaptations, characteristic of desert plants, to support its survival in this harsh habitat. Some of these features are described in Table 9.1.

<i>Feature</i>	<i>Effect</i>
Thick wax layer (cuticle) on stem and thorns	<i>Reduction of transpiration</i>
	<i>Absorption of UV light and prevention of damage to photosynthetic cells</i>
Waxes on the cuticle (see above) and fine hairs on stem and thorns (trichomes)	<i>Reduction of stem temperature through reflection and or absorption of infra-red radiation</i>
High number of stomata (small surface openings) on stem and thorns	<i>Rapid CO<sub>2</sub> uptake when stomata are open under favourable conditions</i>
Furrowing of stem	<i>Increased photosynthetic area, maximising net photosynthetic rate</i>

Table 9.1: Anatomical features of *!nara* and possible ecophysiological effects.

## Water potential

In dry conditions with limited water, plants expend a lot of energy to obtain water. This is reflected in a very low water potential. Typical water potential measurements for desert plants lie around  $-5$  to  $-8$  MPa.

The water potential for *!nara* was exceptionally high for a desert plant and showed little variation during the course of the day (between  $-0.8$  MPa and  $-1.5$  MPa (Hebeler 2001, Fig. 9.1). These values are more characteristic of plants of temperate climates (mesophytes) than for xerophytes, and suggest permanent water availability for the *!nara* plant.

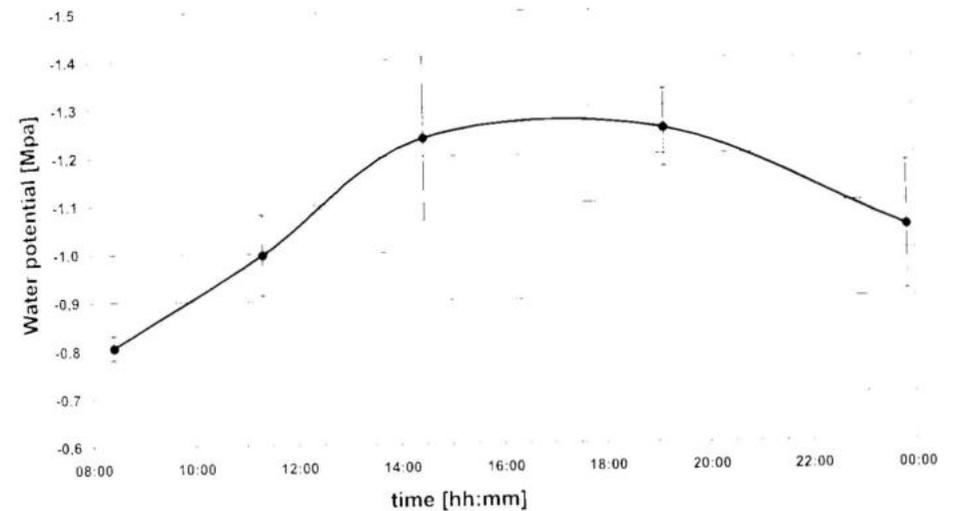


Figure 9.1: Diurnal course of plant water potential (mean) recorded during gas exchange measurements on a *!nara* plant in Khommabes valley on 23 December 1999. Data points show mean  $\pm$  SD.  $n=5$ .

## Photosynthetic rate

Opportunism could be involved in the relatively high water potential of *!nara*. By using the available water source in concert with a low overall transpiration rate, water potential could be kept high, allowing the plant to maintain constant growth. If water is plentiful, it would be assumed that *!nara* would take advantage of this, resulting in high assimilation rates. In both cases, one would expect the rate of photosynthetic carbon assimilation to be rather high. The large biomass sustained by the plant and the fast growth rates (up to  $0.8$  cm/h; Hebeler 2001) do, indeed, suggest this.

Contrary to our expectations, the results demonstrate that *!nara* has a low overall rate of photosynthesis of between  $2$  and  $5$   $\mu\text{mol}/\text{m}^2\text{s}$  under dry conditions (Fig. 9.2 & 9.3). These assimilation rates are among the lowest recorded for desert xerophytes, which typically average  $10$ - $15$   $\mu\text{mol}/\text{m}^2\text{s}$  of net assimilation. However, the measured photosynthetic rates of *!nara* in the field might be lower than the actual values for a number of reasons. Firstly, the experiments were conducted during the flowering and fruiting season. Secondly, it was not possible to select shoots for measurements that did not have any axillary growth cells (meristems).

of which some might have already been activated (a problem also reported by Louw *et al.* 1980). If this was the case, then respiration might have been high, thus effectively lowering the recorded net assimilation rate.

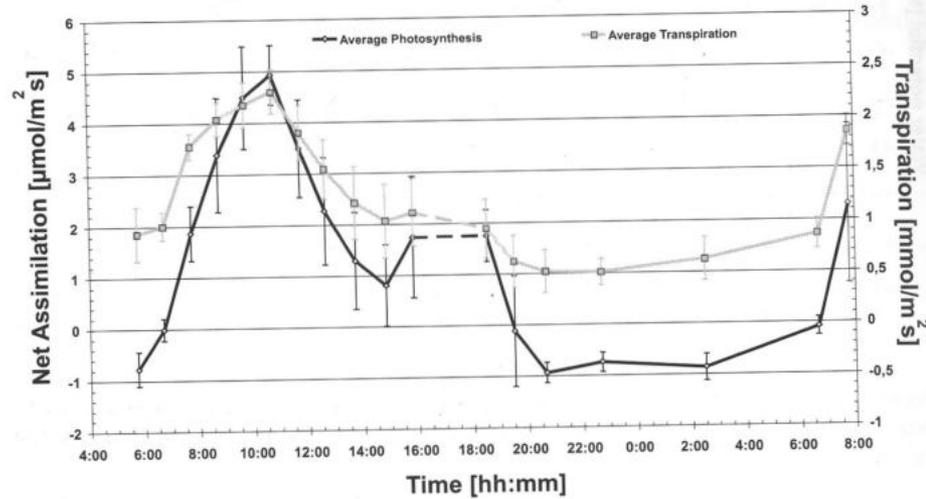


Figure 9.2: Diurnal course of absolute net assimilation and transpiration. Measurements were conducted on plant A in the Khommabes valley from 23-24 December 1999. Data points show mean  $\pm$  SD,  $n = 8$ . Note that transpiration at night is still  $\sim 25\%$  of maximum daytime transpiration.

Interestingly, and supportive of the argument for !nara being an opportunistic plant, the replenishment of the groundwater after a 7-day flood of the Kuiseb River consequently improved the plant water status, which resulted in a significant increase of net assimilation of 50% and more during later measurements. However, average photosynthesis was still low at  $8.2 \mu\text{mol}/\text{m}^2\text{s}$  with an absolute maximum of  $11.3 \mu\text{mol}/\text{m}^2\text{s}$  (Fig. 9.3).

### Transpiration

Together with net photosynthetic rate, measurement of transpiration is an important tool to determine the ability of plants to use the available water in the ground. For the !nara plants it was observed that transpiration rates were high compared to the rates of net photosynthesis, which resulted in low rates of water use efficiency (WUE) (between 0.5 and  $2.2 \mu\text{mol}/\text{mmol}$ ).

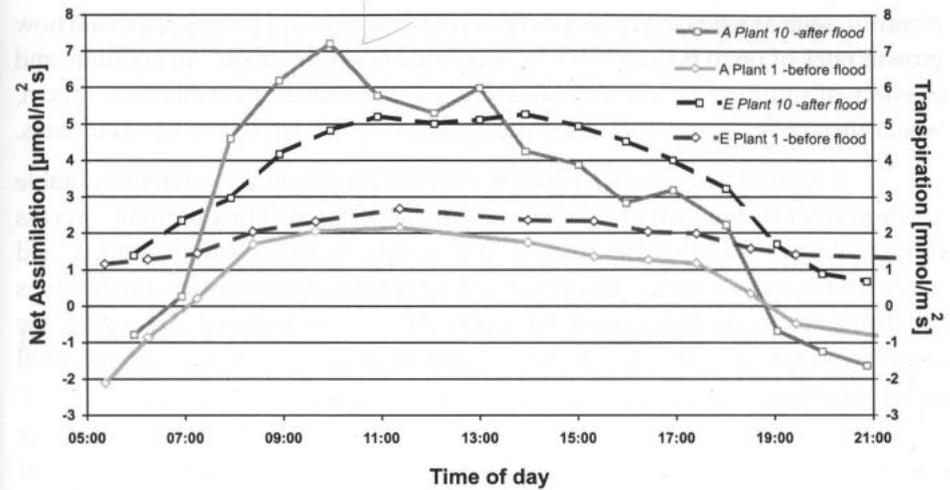


Figure 9.3: Diurnal course of net assimilation (A) and transpiration (E) of two plants near the riverbed before (16 Dec. 1999) and 10 days after replenishment of groundwater (29 Dec. 1999) by a flood in the ephemeral Kuiseb River. Note the 3-fold increase in maximum assimilation rate, accompanied by doubling of transpiration. Data points show mean,  $n=8$ .

### Discussion

Low rates of (leaf) photosynthesis are exhibited in other desert plants, such as the creosote bush *Larrea tridentata* which occurs in North American deserts, as well as in !nara. In *L. tridentata*, low photosynthetic rates during drought mirror low transpiration rates (Rundel & Sharifi 1993). In principle, the ecophysiological strategy of *L. tridentata*, which displays maximum photosynthetic rates under optimal field conditions, might be the same as in !nara. Such an opportunistic strategy, i.e. minimising assimilation and transpiration during drought and maximising carbon gain at the cost of higher transpiration under favourable conditions, is common for plants of dry habitats with periodic (regular, e.g. annual) precipitation (Gibson 1998, Larcher 1994).

While many opportunistic desert plants sometimes lose a substantial part of their biomass in order to reduce their transpirational surface during drought, e.g. by shedding their leaves (Gibson 1983), !nara might trade in the high transpirational water loss during drought for steady (though low) growth throughout the year, enabling it to maintain all of its large biomass. This, in turn, allows a massive boost of carbon uptake with a doubled to tripled net assimilation rate as soon as water is

plentiful, such as when the ephemeral Kuiseb River flows. This could explain how growth rates of up to 0.8 cm/h can be supported in single shoots. In addition, and possibly of significance, is the maintenance of an extended stem and root system, which also creates a potentially large storage capacity for starch, water and nutrients.

It appears that !nara has traded in effective photosynthesis under favourable conditions for steady carbon gain throughout the year and during drought. Access to groundwater could enable !nara to follow this “water-wasting” strategy and become what appears to be a mesophyte with xerophytic characteristics. Implications for management are that a plentiful supply of water is required. However, the extremely high growth rates under optimal field conditions support potential agricultural use.

## PART III: RESOURCE MANAGEMENT

### Chapter 10

#### !Nara property relations

by Thomas Widlok

##### Introduction

The Topnaar (or ≠Aoni) of the !Khuiseb are identified through their association with the !nara and also with the specific property regime that regulates the way in which the plant is being used. Schapera gave the following summary about the ≠Aoni system of ownership of !nara:

“The only instance recorded [for Khoisan peoples] of recognized private ownership of land or its resources occurs even to-day in the Nara bushveld of the Khuiseb regions behind Walvis Bay. Here each Topnaar family has an hereditary claim to certain !nara bushes and their fruit. Trespass by other members of the tribe is reported to the chief and dealt with by him; but if the thief is a Bergdama or a Bushman, he is tracked and simply shot down, the chief as a rule taking no notice at all of such cases, and, where he does, never siding with the party of the thief. In the other Nama tribes there seem to have been no private rights of this nature.” (Schapera 1930:290-291)

Schapera’s synthesis illustrates that the notion of “regime” is very fitting here. Private ownership of !nara is not simply an isolated cultural trait. It touches on issues of ethnic identity, social organisation into families and chiefs, and social relationships of inheritance. For Schapera the !nara property regime was remarkable because it differed from the communal system of land ownership among other Khoisan groups. He also contrasted ownership of !nara and other items such as huts, livestock, and utensils among Nama people with the European infatuation of communism “in the sense of all men having equal, free, and unconditional access to all goods and privileges” (Schapera 1930:319).

His account of the !nara property regime contains some ambivalence because the objects of ownership seem uncertain: Are they “land” or “its resources”, “!nara bushes” or “their fruit”? The exact nature of the ownership also remains unclear. “Private” is not understood as “individual” nor strictly in

opposition to “communal” since a whole family has ownership rights. It appears to be in contrast to “public,” “open access” and “centrally owned by an individual chief”.

The primary object of the property regime of the ≠Aoni was !nara plants and their produce, rather than plots of land, as is sometimes suggested. The statement (repeated by several administrators and ethnographers) that named !nara fields were owned by named families suggests that ownership could be traced to individual heads of families. In fact, family names were probably used by ≠Aoni as a short cut to establish ownership relations. However across time there was no stable relationship between family names and field names, nor was the circle of people possessing a family name fixed. This was partly due to demographic shifts, as some families grew and others declined. But it was also due to the system followed by the ≠Aoni, in common with the general Khoekhoe practice, of cross-sex naming (Hoernle 1985, see Widlok 1999, 2000). In this system a son would carry his mother’s surname while a girl would receive the surname of her father. It is therefore to be expected that individuals with different family names would form a property-owning group, and the same name could indicate ownership rights in a number of fields. Budack’s map of 54 !nara fields recorded in 1975 contains examples of both cases (see Figure 2.2).

When asked about the family unit that would legitimately own a field, ≠Aoni have usually referred to the *!hao-!nas* (lit. “in the tribe”), i.e. a division below the level of the ethnic group but above that of a family household. This unit is made up of related families that do not all carry the same name but can be identified as a “clan.” A *!hao-!nas* encompasses more individuals and families than an everyday economic unit among the ≠Aoni. The social system as it has been described by ethnographers suggests that relatives belonging to one’s *!hao-!nas* were potential partners in the exploitation of a !nara field and that a sufficient basis for trust and common ground existed to pool efforts with them. The shared efforts could involve forming a harvesting party or sharing !nara products and exchanging them for other economic pursuits such as livestock herding. Little is known about the patterns of incorporating members of other ethnic groups into ≠Aoni society, but it seems that recruiting these people into a *!hao-!nas* went hand in hand with accepting them as partners in !nara harvesting.

The decline of the traditional property regime is playing a major part in the social changes that concern the harvesting and use of !nara. Although the

length of the harvesting season has been extended, less ≠Aoni are harvesting !nara now than in the past, and less ≠Aoni families depend on !nara products. The system of recognised and protected family-fields is largely defunct and families harvest freely in a number of different fields. At the same time ≠Aoni complain that now the !nara is virtually an open-access resource, as town-dwellers who are not ≠Aoni also harvest in the !Khuseb delta. !Nara trade has also changed. In the past it was dominated by long-standing partnerships between harvesters and trading shops where harvesters would also receive credit and enter what may be called a patron-client relationship. Today a new kind of entrepreneur has emerged and short-term interests tend to outweigh long-term commitments.

There are different assessments of the current situation and its causes. Much of the confusion seems to result from the fact that the object of property regulations and relations is not clear. While the Ministry of Environment underlines its rights over the land on which the !nara grows and on which the ≠Aoni live, other parties such as Water Affairs, mining companies and urban authorities are primarily concerned with the underground water resources. The traditional concern of the ≠Aoni, the !nara plants, is changing now as the rights to manage the !nara comes to stand for land rights more generally, including rights to various potential resources and uses. Furthermore, the social relationships that govern ownership among the ≠Aoni are distinct for the !nara fruit and the !nara plant. As people begin to realize that the land of the !nara has much more potential than harvesting the !nara for food many more interested parties make their claims.

I suggest that an analysis of the !nara property system in terms of layers (Widlok 2000, 2001, in press), namely cultural values, cultural regulations, social relations, and social actions, can account for these diverging assessments of the situation. As a first step for arriving at a more dynamic and realistic picture of the !nara property regime, I will break up the statements about “privately owned plots” into these four components.

### Cultural values

The key cultural values in the !nara property regime are its exclusiveness with regard to the ≠Aoni as an ethnic group and its inclusiveness with regard to all ≠Aoni families. Each and every !nara field in the !Khuseb area was claimed

by some ≠Aoni family, leaving no residual area for the use or ownership of others or for open access. At the same time, every ≠Aoni family had some ownership right in a !nara field. Both ideals, that of a comprehensively divided world of !nara plants and that of a complete provision for all ≠Aoni families, are maintained up to this day, even though the ideal can no longer be realized. The ≠Aoni chief is often named as the guarantor of these values but the !nara property regime does not rely exclusively on the chief's authority. More generally, there is a shared recognition of the principles of ≠Aoni social organisation, in particular its identity as an ethnic group and its internal make-up based on family groups. The property regime was not installed from above but was anchored in the web of ≠Aoni social relations, which prevented it from collapse in the absence of chiefs. There was no support from external authorities for ≠Aoni cultural values with regard to ownership since the colonial administrations considered ≠Aoni land to be state land, and their ownership claims as spurious.

### **Cultural regulations**

The system of appropriating the !nara for the ≠Aoni and of guaranteeing access to !nara for all ≠Aoni families was integrated into a more elaborate cultural system which has been called the !nara field or "plot" system. !Nara fields were demarcated with "beacons" which served as a cultural sign indicating the individual entitlements of families (Budack 1983:4). These beacons applied to !nara plants and not to plots of land, taking into account the fact that !nara plants grow and that the tendrils of individual plants may easily get entangled with one another.

There was another cultural tool for detecting trespassing even when it was not directly observed. Individual owners claim to recognise the !nara pips of their own field by their taste. Although this may appear to be a mystical skill, there is no doubt among ≠Aoni that tasting pips in order to determine their origin is a legitimate means for an owner to establish the origin of pips. This is the cultural background for understanding ≠Aoni complaints about "!nara pirates", who threaten the monetary value of !nara as a ≠Aoni product but also the cultural value of the !nara as an ≠Aoni good.

### **Social property relations**

It is important to go beyond the static cultural map of !nara "plots" and to consider all relevant social relationships involved in the !nara property regime. The benefits of !nara ownership were distributed in social relations within and between families. Firstly, inheritance of !nara fields seems to have been fairly unproblematic, judging by the absence of reported conflicts. There is no indication that ≠Aoni sought to sell or buy plots, or that they received prestige or status by owning a particular plot, or that there was any way of accumulating ownership rights in order to make a profit. There are, however, many indications that *use* rights were complex and subject to manoeuvring and negotiations. These included relations between owners and harvesters, as well as between harvesters and traders.

The composition of harvesting parties was probably always flexible. This is certainly presently and recently the case (Dentlinger 1983). Although harvesters would in most cases be related through ties of kinship or marriage, the kinship system did not determine who may join a harvesting party in future. Relations between harvesters were informal in the sense of not being predetermined, just like relations between co-residents who form the main consumption unit and, indeed, between co-habitants who form the reproductive unit of the ≠Aoni. Owners of !nara fields engaged with others in a co-operative harvesting team or they sent out any kinsperson or a non-≠Aoni, usually a Damara person, as a worker in the !nara fields. The returns would then be shared with these workers. The most common strategy seems to have been to split the household during the !nara season so that yields from inland livestock herding and coastal !nara harvesting could be pooled or exchanged by members of the household.

### **Social action**

The most influential individual choice in the context of the !nara property regime concerns the intensity of !nara use. The ≠Aoni never subsisted solely on !nara but relied on gathering other plants, hunting (no longer possible), keeping livestock (now less intensive than in the past) and wage labour (now more intensive). Harvesting !nara was only one constituent of their mixed economy and it had to be kept flexible in order to account for demographic changes and irregular ecological changes that would affect the supply of !nara. Other forms of income are now being sought by ≠Aoni and those who continue

working in the !nara fields seek to earn money by selling !nara to traders in town, for instance to help families pay their children's school fees (see also Botelle & Kowalski 1995). This shift of interests is recognised by the ≠Aor; themselves who often take this as their starting point for explaining the processes of change in which they are involved. In the pursuit of a "quick buck", individuals harvest randomly across the !nara fields, disregarding the traditional property regime. In the process they also harvest unripe !nara, use iron rods which can harm the plants, and disregard management skills (such as burning or cutting unproductive plants). All these developments may contribute to the decline of the !nara and its fruit and may affect the yield for traditional harvesters.

## Conclusion

Dissecting a property regime into institutional layers allows us to view dynamics in terms of how changes in one layer impact others. For instance, discontinuing one action, such as burning old !nara plants, or letting one aspect of the social organisation, such as the *!hao-!nati* (clans), fall into disuse, have different impacts on the whole institution. A description that accounts for the state of affairs at the various layers promises a more realistic and clear representation of the complexities of the property regime. It is more realistic in that it allows for internal tensions and contradictions that emerge as the system changes. Some aspects of the institution have changed (especially at the layer of social regulation and social action) while other aspects seem to have been altered much less (mostly at the layer of values). Other aspects are currently undergoing fundamental change (at the layer of social relations) but these changes do not affect all people in the same way. To make a distinction across the board between "past tradition" and "present change" would therefore be a misrepresentation.

When analysing the benefits of a !nara field it is necessary to distinguish between !nara harvesters (holding user rights, possessing harvested !nara pips) and !nara owners (holding ownership rights to a !nara field, being able to exclude non-owners from the plots). Even in the traditional system (as far as we know it) it was possible to be a legitimate user of !nara fruit without ever owning a !nara field. Also, those who procured !nara through their harvesting work relied on the owners to exclude others from harvesting and on traders to buy their produce. In other words, the !nara property regime – in the past as well as in the present – relies on the relationships between people with the capacity to work

(harvesters), people with the capacity to convert (traders) and people with the capacity to exclude appropriation (owners). The different capacities may be held by different people but can also be combined in one. It is through the relationships between these capacities that a !nara harvest materialises. The profits arising from !nara are distributed to others such as those who look after livestock or who have moved into wage labour, through the relationships within and between families.

Being an owner of the harvested !nara fruits also depends on the relation between harvesters and traders. It would be misleading to think of traders as coming in only after the harvest is completed. When harvesters enter long-term exchange relations with traders, they are continually indebted to them so that traders can make claims to the !nara even before the seasonal harvest has started. When new traders evade long-term exchange relations and ignore ownership claims this affects those who are hoping to continue the established practices.

The relationships that constitute the "!"nara harvester" seem to be as relevant as the relations which are hidden behind the term of "!"nara owner". The complex relationships within and between named "families", which are usually given as the traditional owners of a !nara field, was always based on a web of relations that included those who did not move to the !nara fields but who stayed behind in the settlements and looked after livestock (subsistence herders) or who had moved into wage labour. !Nara (or profits arising from it) were exchanged between harvesting parties and owners who did not participate directly in the !nara harvest. However, they connected the harvesters with the owners and thereby with other spheres of the economy, in particular the livestock economy and wage labour.

People living in and around the !Khuseb have, through their actions, changed the world of this property regime. In the political debate about land rights, owning !nara plants has become more important than possessing fruit, so that the object of ownership now consists of the !nara fruit, the plant, the land, and the underground water it needs. It also changes the relative weight of the social relationships hidden behind these different aspects. Some !Khuseb people who were not the direct beneficiaries of the !nara harvest, increased their income through various forms of wage labour. The relationships between traders, harvesting parties, and non-harvesting owners are no longer as tight as they were before, and may be cut off altogether. This means that links of cooperation and exchange are weakened and that competition increases. The

reduction of the volume of !nara harvest does not, as one might expect, lead to closer co-operation between traders, harvesters and non-harvesters in the fields that remain.

The picture at large also changes since the building blocks that make up the property regime are no longer the owners paired with !nara users, but pairs of !nara users in competition with one another. Furthermore, since clearly demarcated !nara fields no longer exist, it is more appropriate to talk of nested relationships between different users of a single !nara field. In an emerging open access system, any new user who enters the scene gets into a relationship with previous users, all nested in one another. The direction into which the !nara property regime will evolve in the future will therefore depend on a number of questions concerning external acknowledgement of ≠Aoni rights but also concerning processes of change and continuity involving cultural values and regulations as well as social relations and social action.

## Chapter 11

### Community-based resource management of !nara: a baseline study

by Desert Research Foundation of Namibia & Topnaar Community  
Foundation

#### Introduction

Within the framework of the NARA programme, TCF and DREN conducted an initial socio-economic and market study in the Topnaar Community during 1998 and 1999. One of the goals was to address a key question identified by the Topnaar Community at the NARA workshop of 1997, namely, "How can the rural Topnaar community obtain an appropriate and predictable income through !nara?". Furthermore, to assess the future market potential in relation to sustainability, another goal was to address the question "Has !nara fruit production changed?" by examining the historic and current trade volume.

In this study, we investigate the commercial potential of !nara products and how this can remain compatible and sustainable in terms of the environmental, economic and cultural development of the !Khuseb Topnaar. We analyse relevant features of the former and current !nara market by focusing on the task environment<sup>20</sup> as well as the macro environment of the !nara supplier, the rural Topnaar community. With this analysis, we examine whether the use, management and marketing of !nara require adjustments so as to improve their sustainability and development.

!Khuseb Topnaar currently exist in a marginalized socio-economic situation. Besides !nara, their livelihood is largely based on livestock, pensions, and remittance from town-employed members of their extended family. These rural lifestyles and standards of living are in stark contrast with those in the nearby coastal towns of Walvis Bay and Swakopmund. Rich marine resources, which used to be a mainstay of the !Khuseb Topnaar, have now become part of modern industry, and have only indirect benefits on rural livelihood. While there appears

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<sup>20</sup> Task environment = market participants who affect the market value, e.g., suppliers, traders, competitors, consumers. Macro environment = larger setting, including demography, economics, natural resources, technology, law, politics and culture (Kotler 1980)

to be little potential for economic growth based on livestock husbandry in this extreme desert, provision of services and facilities for ecotourism in a spectacular rural setting are currently appearing as strong potential growth points. As this study demonstrates, management of !nara resources is another potential growth point that could to some extent complement tourism.

Harvesting patterns and trade structures of !nara have not changed significantly since the beginning of the 20<sup>th</sup> century. Until 1999, one principal wholesaler of !nara seed determined the price, and income for harvesters was low (e.g. in 1999 harvesters obtained N\$6.00 – 6.50 per kilogram of dry seeds, requiring about three hours of hard manual labour). This condition lacks appropriate work incentives for young Topnaar, who therefore tend to seek wage labour in town. Unless this changes, the future of the socio-economy based on natural resource management looks bleak for the !Khuiseb Topnaar.

However, the potential for development on the basis of !nara could be high. As described in earlier chapters, the !Khuiseb Topnaar and !nara have a well-established, unique and specialised interrelationship. This provides a good foundation for development and suits the existing cultural, natural and economic setting. The main question is whether it will improve rural livelihood standards.

The commercial potential of !nara has been explored several times during the past decade. In 1992/3, a feasibility study of “Kuseib Delta Nara Products” was conducted, backed by the United Nations Development Program (UNDP) and Body Shop, an international cosmetic company. Another study in 1995 was conducted by the Social Science Division (SSD) of the University of Namibia on behalf of the Directorate of Rural Development of the Namibian Ministry of Agriculture, Water and Rural Development. This was followed by an investigation by Centre for Research Information Africa Action (CRIAA SA-DC), a Namibian NGO that provides services in terms of community liaison and development of products and markets. These projects did not progress, mainly due to lack of funding for !nara products with rather limited volumes (relative to national or global markets). Another constraint was the unresolved question of jurisdiction of the land on which !naras grow (individual harvesters, the community in general, government or the Municipality of Walvis Bay). Furthermore, lack of cooperation between individual Topnaar concerning dealing with potential trade partners created confusion and uncertainty. A final problem was that the feasibility studies by UNDP, SSD and CRIAA were carried out independently of each other and did not share data and learn from each other’s experiences, nor did they communicate their findings directly back to the rural Topnaar community. Recognition of the constraints are the main

lessons learnt from these attempts.

The current study, founded on a Topnaar community initiative (the NARA programme), endeavours to inject new vigour into the planning and discussions concerning the efficient management, utilisation and marketing of !nara. In this chapter we collate, revise and update information from the literature, including a recent socio-economic survey by Government, and incorporate existing and new data sets. This is an initial approach towards analysing the !nara market and its future potential.

Survey and market analyses represent the focal point of this study. Here we investigate the availability and condition of natural, technical, human and financial resources. This chapter examines the potential for developing sustainable resource management of !nara by the Topnaar community. Study participants include a cross-section of Topnaar community members, primary wholesalers, secondary wholesalers and retailers, as well as relevant government institutions and NGOs. Against the background of the NARA project, history, and utilisation (Chapters 1-3), this chapter draws on the theoretical background for small-scale enterprises outlined by Büttendorf (pers. comm.), !nara property relations described by Widlok (Chapter 10), as well as the biological and ecological background (Chapters 4-9) that forms the natural basis of sustainable resource management.

*Objective:* Which sustainable management approaches towards !nara harvesting and marketing will benefit the development of the Topnaar community?

*Questions:* Following the guidelines of Community-Based Natural Resource Management (CBNRM), the following questions are addressed:

- Are there enough **biophysical and technical resources** available for harvesting, processing and marketing !nara in the long run without causing permanent land degradation in the Lower Kuseib Valley?
- Are there enough **human resources** available, including educational background, entrepreneurial spirit, skills, solidarity, and cultural values, to stimulate socio-economic development of !nara management within the cultural setting of the Topnaar?
- Are there enough **financial resources** available to sustain sufficient growth of the !nara market in such a way that it provides the !Khuiseb Topnaar with appropriate income in a market economy system, without incurring economic imperialism?

### Definition of terms

- Harvesting season refers to the period between November and April, and the resulting sales refer to the months that follow.
- Professional harvesters normally spend most of each harvesting season as members of harvesting teams in the !nara fields, and normally generate a substantial quantity of their food and over a quarter of the annual income for the household from !nara. They usually apply traditional techniques for picking and processing.
- Occasional harvesters are not professionals, and do not form stable teams for the occasional picking and processing of !nara for quick cash income, often using non-traditional techniques.

### Methods

*Socio-economic survey of Topnaar* A cross-section of the !Khuiseb Topnaar population was interviewed, drawing people from each each of eight villages between Soutrivier and Armstraat<sup>21</sup> (Fig. 2.2). Villages east of Soutrivier were excluded as there were relatively few !nara harvesters this far from the Delta. All permanent residents in these villages participated in the study, defined as those persons who permanently stayed in the rural households and relied on the common household budgets. Although schoolchildren<sup>22</sup> lived in hostels for much of the time, they were counted as members of those households on which they depended financially. The study participants (Table 11.1) comprised 215 permanent residents, of which 40 were professional harvesters organised into 1 to 3 member-teams, and 175 were occasional harvesters. There was a fair balance between villages (Table 11.2), and study participants consented to be named.

<sup>21</sup> The small neighbouring villages of Dawe-draes and Goâ-danab were treated together.  
<sup>22</sup> Children younger than 14 years old (National Planning Commission 1991)

Village	Permanent residents			Professional harvesters		Occasional harvesters
	total	adults	children (<14y)	individuals	teams	
Soutrivier	22	11	11	3	2	19
Klipneus	18	6	12	3	2	15
Swartbank	37	15	22	6	4	31
Ituseb	31	15	16	3	2	28
Ururas	34	15	19	6	4	28
Dawe/Goâ	30	20	10	10	6	20
Armstraat	43	24	19	9	5	34
<b>Total</b>	<b>215</b>	<b>106</b>	<b>109</b>	<b>40</b>	<b>25</b>	<b>175</b>

Table 11.1: Details of study participants in Topnaar villages

Village	Professional harvester	Casual harvester	Not harvesting	Adult	Young	Male	Female	Adult male	Adult female	Young male	Young female	Adult harvester	Young harvester	Total
Soutrivier	1	2	2	3	2	2	3	1	2	1	1	1	0	5
Klipneus	3	1	0	2	2	2	2	0	2	2	0	2	1	4
Swartbank	2	0	1	2	1	1	2	1	1	0	1	2	0	3
Ituseb	2	1	1	3	1	2	2	2	1	0	1	2	0	4
Ururas	2	0	1	2	1	2	1	2	0	0	1	2	0	3
Dawe-draes & Goâ-danab	3	0	1	3	1	2	2	2	1	0	1	3	0	4
Armstraat	5	0	1	3	3	4	2	2	1	2	1	3	2	6
<b>Total</b>	<b>18</b>	<b>4</b>	<b>7</b>	<b>18</b>	<b>11</b>	<b>15</b>	<b>14</b>	<b>10</b>	<b>8</b>	<b>5</b>	<b>6</b>	<b>15</b>	<b>3</b>	<b>29</b>

Table 11.2: Categories of Topnaar interviewed

Quantitative and qualitative information was exchanged voluntarily, using structured questionnaires as a guideline. In personal interviews (between interviewee, interviewer, Nama-English translator), it was possible to discuss complex and sometimes personal and possibly sensitive information that might not have been exchanged so efficiently in group meetings. The personal approach enabled possible inconsistencies to be cross-checked, and facilitated continued motivation by the respondent during the 90 minutes that it took to complete an interview.

The main questionnaire (Appendix A) concerned the task environment of a !nara supplier. For young participants without harvesting experience, questions relating to harvesting and marketing of !nara were omitted, and questions concerning households and family planning were modified. The questions had either standardised answers (dichotomous or multiple-choice) or enabled open answers<sup>23</sup>. The questionnaire was tested in Soutrivier before minor changes were made. Some of the data were ordinal, using rank order scaling, i.e. the respondent was asked to select three alternatives and rank them with respect to some criterion. All structured questions with categorical answers were assigned numerical codes at the outset. Answers to open questions were coded after all answers were examined.

*Personal interviews with primary wholesalers in Walvis Bay* During November 1998, a detailed unstructured questionnaire was used to obtain information on the supply and demand of !nara products, and marketing details such as price, product type, communication and distribution policies. In order to obtain data on the quantity of !nara seeds purchased annually, in comparison to the available harvest, all three primary wholesalers in Walvis Bay were approached, but only two agreed to participate. These were Flamingo Furnishers (Mr. John Webster, the former owner, Mrs. Brits, the present owner, and Mrs. Owens, chief accountant) and Mr. Yon. We found no records of the amount of seeds sold directly by the Topnaar to consumers in the suburbs of Walvis Bay.

*Fax interviews with secondary wholesalers and retailers* Ten companies were found: Five well-established secondary wholesalers in Cape Town, three recently established secondary wholesalers and private retailers in Lüderitz, one retailer in Walvis Bay and one in Swakopmund. During February 1999, interviews were conducted by telephoning these companies to explain the purpose and subject of the project before faxing them structured and pre-coded questionnaires. Completed questionnaires were returned by four wholesalers from Cape Town (Abraham-

se & Sons, Atlas Trading, Gheewala & Sons, van Wyk) and one wholesaler from Lüderitz (Martins & Sons). Partial answers were returned by one private seller from Lüderitz (Sneuve), and one retailer from Swakopmund (Granny's).

*Fax interviews with potential future retailers* In February 1999, the potential for developing the local market was explored by faxing fully structured pre-coded questionnaires to retailers of home-made, indigenous and natural products in Swakopmund, namely pharmacies, cosmetic stores, craft shops and delicatessen. The project was introduced during a personal visit to the first six such companies encountered and the questionnaire was later faxed to them. Data about the respondents' interest in cooperating with the Topnaar in terms of developing and marketing !nara products were collected. Completed questionnaires were returned by four retailers, Baumgart delicatessen, Out of Africa coffee shop, Save the Rhino Trust craft shop and a pharmacy that did not wish to be named.

### Current and potential !nara harvest volume

The annual harvest volume of !nara melons and its variability are one of the most important parameters in the discussion of improving community-based !nara resource management by the !Khuseb Topnaar. A sustainable and sufficient harvest volume in quantity and quality is the major criterion for profitable marketing of !nara products and for the establishment of a successful and sustainable marketing strategy, including the involvement of business people. Table 11.3 summarises published data of sales volumes. Changing currencies and different units of weight and volume to which various authors refer make comparison and interpretation difficult.

Dentlinger (1977), Moritz (1992) and Grasveld & Gabriel (1993) mentioned 35 to 40 kg seeds per bag, and one can calculate 44.6 kg from Budack's (1977) figures<sup>24</sup>. We observed that 50-kg bags from a malt brewery were used, but these were normally not filled to capacity with !nara. In our calculations, we used 37.5 kg for a bag.

The sales volume of seeds to the Cape ranges between 5,000 and 12,000 kg<sup>25</sup> !nara seeds per season. The sales volume by the Topnaar reported for 1957 of 44 bags (Köhler 1969) and 55 bags (Böhm) seems to be very little. More realistic

<sup>24</sup> 269 bags were equivalent to 12,000 kg

<sup>25</sup> This is based on the assumption that almost the entire sales volume of Flamingo Furnishers went to Cape Town.

<sup>23</sup> Open questions don't suggest an answer.

data on the total sales volume in the 70s was gathered by Budack in 1975 during a comprehensive survey of all !nara dealers in Walvis Bay. He gave 12,000 kg as a sale volume of Flamingo Furnishers, which corresponds with the statement of John Webster, former owner of Flamingo Furnishers. Budack's results furthermore indicate that the total !nara sales volume was 24,212 kg, and that Flamingo Furnishers dealt with about half of the sales volume. This crudely corresponds to the figure given by the Topnaar harvesters. When questioned about their past harvest volume during the current study, the harvesters' estimates ranged between about 19,600 and 33,500 kg<sup>26</sup>.

Year	Volume of !nara seeds (kg)	Data source	Remarks
1883	5 000	J.A. Böhm	sales volume to Cape Town
1890	15 000	M. Viehe	sales volume to Cape Town
1900	10 000	Dinter	sales volume to Cape Town
1954	20 000	R.F. Logan	
1970	11 000	W. Moritz	sales volume of Flamingo Furnishers
1974	5 000	U.Dentlinger K.F.R. Budack	sales volume of Flamingo Furnishers
1975	24212	K.F.R. Budack	sales volume of Topnaar
1975	12 000	K.F.R. Budack	sales volume of Flamingo Furnishers

Table 11.3: Sales volume of !nara seeds in the past (after Köhler 1969, Logan 1969, Budack 1977, Dentlinger 1977, Moritz 1992).

Questioned about trends in !nara productivity, 83% of 18 interviewed professional harvesters and 41% of 11 other Topnaar interviewed stated that the general trend was a decline (Fig. 11.1). It is the common opinion (Dausab pers.

<sup>26</sup> In Sep1998 the harvesters gave an average minimum of 13 and maximum of 49 bags (488 – 1,838 kg) per harvesting team in a season. In Dec1998/Jan1999 the figures were 21-38 bags (788 – 1,425 kg). A !Khuseb Topnaar household uses an average of 47 - 81 kg seeds for self-consumption independent of the total yield of the harvest.

obs.) that, in addition to the loss of !nara fields<sup>27</sup>, there was a decrease in !nara productivity by more than a third during the last 10 to 20 years. However, it is interesting that the only two professional harvesters who mentioned that the general productivity is stable were Piet Bees and Salmon Khurisab, belonging to the most highly professional teams.

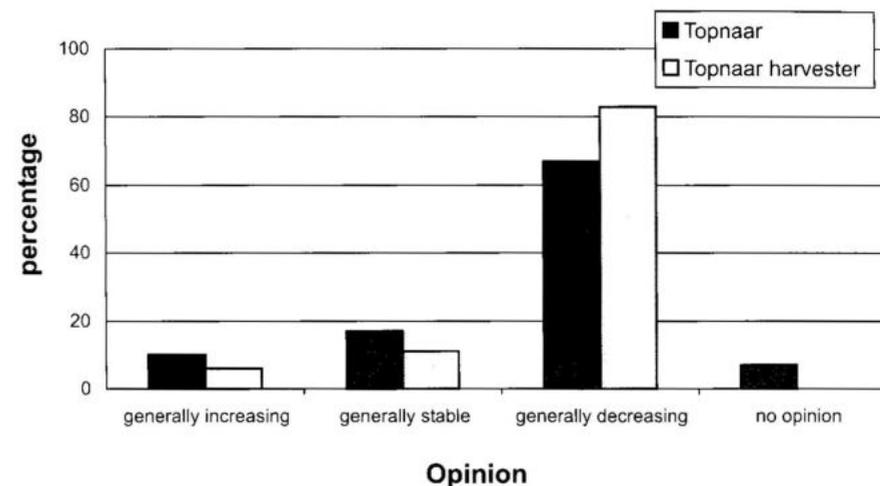


Figure 11.1: Opinion of interviewed Topnaars concerning !nara productivity.

Flamingo Furnisher was the only permanent dealer from 1946 until it closed down in 2000. It had an estimated 50-80% of the highly fluctuating !nara market. During the 70's and the 80's Flamingo had an average trade volume of 10,000 to 12,000 kg per season<sup>28</sup>. Since Namibian Independence, a decrease towards a sales volume of approximately 5,000 kg in 1997<sup>29</sup> was recorded (Fig. 11.2). It would be expected that the sales volume of the secondary wholesalers would correspond with the primary wholesaler. Yet not all old records were available, and before 1990 the records indicated a sales volume of the secondary wholesalers that was lower than what was supplied to them. Recent figures of the 1990s matched better.

<sup>27</sup> Some !nara fields declined in the northern Kuiseb Delta after the flood protection wall was built in 1962 to prevent the river flooding Walvis Bay.

<sup>28</sup> Exceptions were 1986 and 1988. In 1986 the Topnaars did not supply Flamingo because payment was too low. In 1988, Flamingo bought more than 14,000 kg after they raised payment and the Topnaars sold their cached stocks.

<sup>29</sup> This does not take the sales volume of Mr. Yon into account, as he became a primary wholesaler only in 1996 and trades only about 550 kg annually.

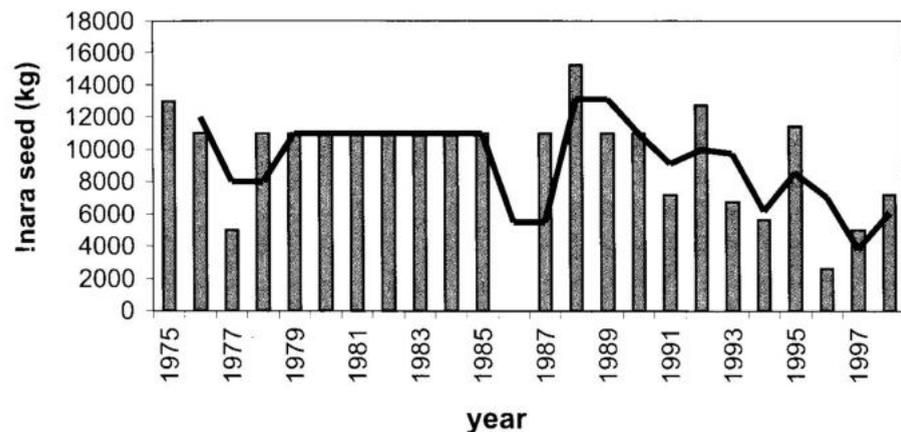


Figure 11.2: Change in Inara seed trade volume by Flamingo Furnishers during the past 30 years, showing actual figures and trendline.

In summary, until the 1990s the average Inara yield ranged around 26,000 kg and its sale volume around 24,000 kg. Of this, approximately 50% (11,000 to 12,000 kg) was traded by Flamingo Furnishers. The Topnaar consumed about 6% of the total volume, about 1,500 kg, while the rest was probably sold locally. This situation changed in the '90s. The sales volume of Flamingo Furnishers decreased to 5,000 kg in 1997 and 7,200 kg in 1998 and ceased in 2000 when the company closed down. Considering the estimated harvest volume of 15,130 kg by the Topnaar in the 1998 season and the fact that Flamingo usually bought half of the total harvest (7,200 kg in 1998), the proportions of harvest, sales, and self-consumption remained the same. Therefore it appears that the total harvest volume declined by 30% during the 1990s. This substantiates the harvesters' perceptions (Chapter 1).

There may be several underlying reasons (Dausab pers. obs.). The decrease could possibly be due to the declining interest in Inara business caused by lack of market incentives for the harvesters (Chapter 12). Other reasons could be the postulated decline in Inara productivity (see Chapter 4), changing management patterns, including non-traditional harvesting methods, and the shift from private ownership to a communal commodity (Chapter 10).

#### Availability of human resources

Human resources in a manufacturing and business process comprise physical (manpower, health, age), social (cultural background, education, integrity)

and psychological (motivation, interest, identification, accountability) qualities of people. Applied to the situation of Inara resource management, two questions were examined:

1. Can the small !Khuseb Topnaar community provide enough manpower?
2. Can the younger generation be recruited?

Professional Inara harvesting requires a group of two or three strong, healthy, dedicated people. They have to be able to endure the strain of collecting Inara melons through hot temperatures, long distance walks and four months of 11-hour workdays in the Inara fields away from the home village. The harvesting and processing work is not only carried out by men. Women either accompany men into the field or process the Inara melons into juice, cake and seeds at home, temporarily suspending their normal household tasks.

The following evaluation gives an idea of how many harvesters are needed to manage the harvest volume, how many Topnaar were recently involved in the Inara business, and what the availability of harvester manpower is now and should be in the future. Our study did not take the work carried out by the support team of harvesters into account. It should be kept in mind that the processing of Inara requires many more hours of work than calculated here.

*Required and actual manpower* The average input of man hours by harvesters per kg Inara seeds (mh/kg) amounts to 2 hours in good seasons and 4 hours in poor seasons. In an average year it is estimated to be 3 hours. To fill up one 37.5 kg bag with Inara seeds, a group of 2-3 professional harvesters needs approximately 3 days (2.61) in a good season and 5 days (5.16) in a poor season. On average, a harvester spends 11 hours (11.24) a day, 5 days (5.41) a week and about four months (17 weeks) a year harvesting and processing Inara. The majority of the professional harvesters (83%) also keep livestock and spend some days per month in town or in their homesteads, while 17% live close to the fields and return home every day.

The man hours required for the whole seasonal harvest volume, ranging from a minimum of 19,800 kg in a poor season to a maximum of 33,500 kg in a good one, amounts to about 79,000 mh in a poor and 67,000 mh in a good season. Although double the amount of time is needed to produce one kg of seeds in poor years, the harvesters are still prepared to invest an additional 12,000 hours of work

per season in order to compensate for at least a part of the poor yield. According to these calculations, approximately 85 harvesters are required in a poor season, while in a good season the total harvest can be managed by 72 harvesters<sup>30</sup>.

Considering that the *actual number* of all professional harvesters reported by the Topnaar is 40, the calculated number of required harvesters seems to be too high. There may be several explanations for the discrepancy. First, the estimated minimum and maximum harvest volume may not apply to the present situation, but rather to conditions 20-30 years ago. Second, there are an additional 175 occasional harvesters whose efforts cannot be quantified as they vary so much.

*Current and future availability of manpower* The median age of the 18 interviewed harvesters was 42 years. Considering that the life expectancy of Namibians is less than 59 years (Hansohm & Mopotola-Sibongo 1998), we take half of this age, i.e. 30 years, as the delineation between young and old adults. Only 4 (22%) of the interviewed 18 harvesters were younger than 30. The high risk of disability through old age, accompanied by the high risk of illness, typical for marginalized areas with limited access to urban health centres, could lead to a sudden loss of one harvester and could result in a whole harvesting team becoming dysfunctional. In 1998, two of the 18 interviewed harvesters stayed at home due to illness, and one because of the lack of team partners. The unavailability of partners is a frequent reason given for reduced harvesting activity. For example, Botelle & Kowalski (1994) quoted "Now when I come down to the !nara fields there is no one around to help. I long for the past when there were many people coming to the delta. We helped each other in the harvesting process and by sharing food. These days, I am so lonely, I cannot even work." The same concern was also voiced at the second NARA workshop in July 1999 (Iwanek *et al.*, 1999).

The current number of professional harvesters is too small to meet the objective of the NARA project to stimulate the harvest and market volume of the !nara seeds. How the number of available harvesters will develop in the future depends on several demographic factors, such as increasing old age and disability of the current harvesting community, and recruitment rate of younger rural Topnaar to become harvesters. Currently, the younger Topnaar tend to try to make their

<sup>30</sup> Manhours in a poor season:  $19\ 812.5\ \text{kg} \times 4\ \text{mh/kg} = 79\ 250\ \text{mh}$ ; number of harvester:  $79\ 250\ \text{mh}/17\ \text{weeks}/5\ \text{days}/11\ \text{hours} = 85\ \text{harvesters}$   
 Manhours in a good season:  $33\ 468.75\ \text{kg} \times 2\ \text{mh/kg} = 66\ 937.5\ \text{mh}$ ; number of harvesters:  $66\ 937.5\ \text{mh}/17\ \text{weeks}/5\ \text{days}/11\ \text{hours} = 72\ \text{harvesters}$

living by means other than farming and harvesting. Yet, the potential of future harvesters and the development of a sustainable and successful !nara marketing strategy will depend on the availability and readiness of young Topnaar to continue the harvesting tradition of their elders.

In 1991, the population and housing census determined a natural growth rate of 2.40% for all Namibia and 2.62% for its rural areas. Currently, a total rate of about 3% is estimated, and may correspond to that of the Topnaar. However, the rural !Khuiseb Topnaar population may have experienced less net growth in the last 20 years, given that many people leave the area. During our fieldtrip in 1998/99, 73% of the young Topnaar (n=11, 12-25 years old) and 27% of the adult Topnaar (n=18, older than 25 years) said that they would prefer living in an urban centre. While the adult Topnaar feel bound to their ancestral homes, the younger generation hope for social change (Fig. 11.3). Most of the younger respondents described the rural life as boring and complained about the lack of jobs and of facilities like electricity, shops and bars. This corresponds with the upward trend of general migration to the nearby centre of Walvis Bay, from 2.8% in 1992 to nearly 8% in 1999, shifting from working in rural areas to employment in industry or service sectors. This was also clearly expressed by the !Khuiseb Topnaar (Fig. 11.3). Our study covered three successive generations. It became clear that there is a trend of hoping to move from agricultural work (including !nara harvesting), currently done by the older generation, to services, preferred by/for the next generation, to higher education by/for the third generation.

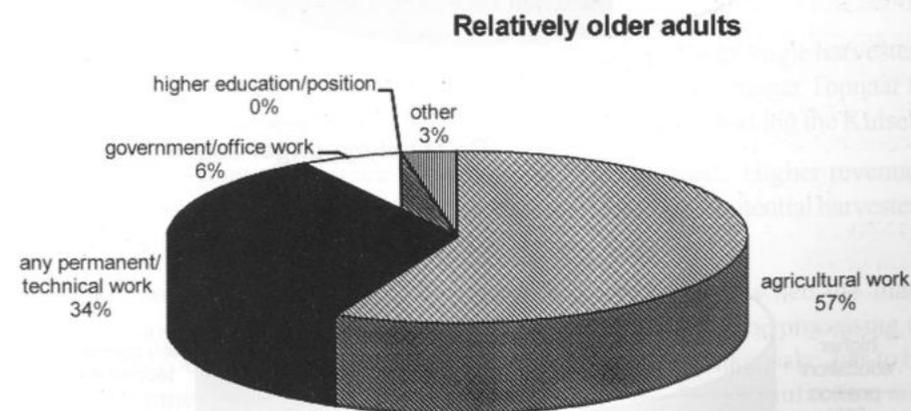
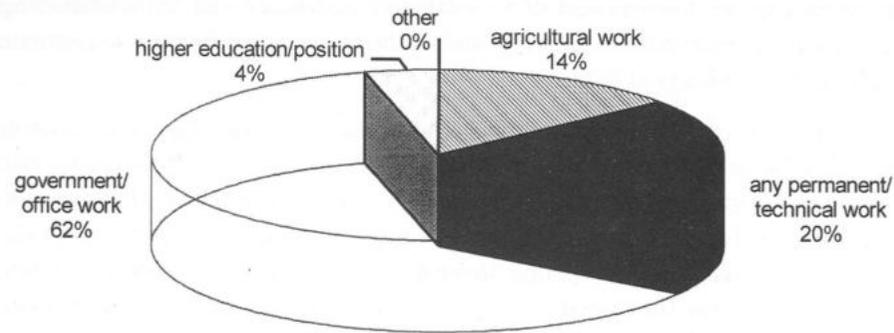
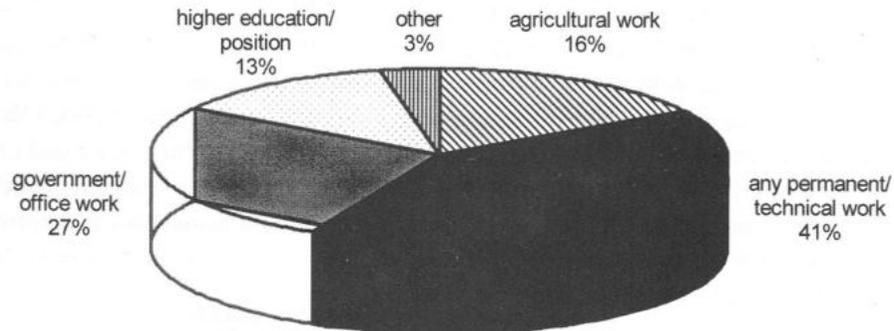


Figure 11.3: Responses to the question: "Which occupation do you prefer and which occupation do you prefer for your children?", directed at relatively older and relatively younger adult Topnaars.

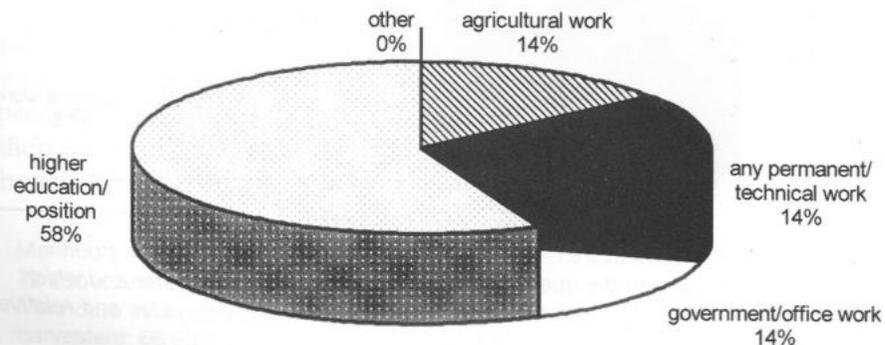
### Relatively older adults' children



### Relatively younger adults



### Relatively younger adults' children



However, there are some young and old people who are starting to recognise the advantages agricultural work could offer, e.g. nature, space, independence and self-determination. One interviewee said "In town there are too many people". An investigation in 1996 of Topnaar households that were relocated from Mile 4 south of Walvis Bay to the suburb of Kuisebmond by the South African Government in 1986, reveals a similar attitude (Municipality of Walvis Bay 1997): 6 of the 33 relocated Topnaar who were interviewed wished to be resettled to the Kuiseb valley. Their living conditions have not improved in town, but have become worse in many respects.

The résumé of all data enables us to make several recommendations to improve the availability of manpower during the harvesting season.

1. The efficiency of harvesting with 2 to 4 man hours/kg seems to be too low. A precise investigation of current harvesting techniques may offer possibilities for improvements in terms of how to reduce the most time-consuming processes.
2. The existing group of professional harvesters, comprising 40 members at a median age of 42 years, is too small with too few young members. Although a growth rate of more than 3% for the rural population is forecast, the majority of the next generation intends to migrate geographically and socially. The ability to recruit enough manpower in future by attracting the young generation to stay, by soliciting the urban Topnaar to return to the Kuiseb, and by stimulating economically inactive !Khuiseb Topnaar to take up work in the !nara field again, may benefit from improvements:
  - Better transportation and communication facilities could help single harvesters to join or establish functional teams and would enable the younger Topnaar to enjoy some of the benefits of urban life without completely leaving the Kuiseb.
  - Better marketing of the !nara harvest has to be introduced. Higher revenues will be one of the most important factors that could mobilise potential harvesters and motivate the current harvesters.
  - Continuous income needs to be assured in the off-season, when the !nara harvesting and immediate processing has been completed. The processing of !nara by cooking the flesh, drying the seeds and preparing !nara cake, has to be done immediately after the melons are collected. But manufacture and marketing of products such as oil, cosmetics, liquors, and even handicrafts for attractive packaging could enable continuous income generation.

- In the long run, domestic supply of water, shopping possibilities, electricity, and easier access to health care will further diminish the gap between rural and urban infrastructure and will facilitate a self-controlled business approach towards !nara marketing. This requirement needs to be addressed at higher levels (local, regional or national government). Implementation of such infrastructure is currently largely beyond the control of the !Khuiseb Topnaar and alternative !nara resource management patterns can be put into operation before this ultimate upgrading is implemented. However, steps are already being made in this direction, e.g. the planning of a water committee.

### Situation Analysis

Does the current social, economic and environmental situation of the Topnaar community and their indigenous setting in the Kuiseb valley warrant the modernisation of !nara resource management? Is the revival of !nara business the right starting point to stimulate self-sustaining rural development? Will it enable the Topnaar to reach their three identified goals: developing from subsistence to market economy, from marginalization to integration, and from uncontrolled to sustainable use of natural resources? We suggest that revitalising the !nara business with a different approach is worthwhile, because:

1. A country like Namibia, whose economic development is restricted by history and extremely variable climate, should encourage development of any available local potential in order to reduce importation of foreign products and processes (since importation tends to alienate people from their local environment, resources, traditions and skills).
2. The !nara plant is a Namibian resource with many features that could benefit from successful implementation of Community-Based Natural Resource Management in the Kuiseb valley. There is a conspicuous lack of exploiting the cultural and natural potential of the !nara for economic benefits, although these qualities could contribute significantly to its potential to support the livelihood of rural Topnaars (Fig. 1.1). In the last few years, the scientific importance of this plant has been highlighted, contributing to the understanding of !nara ecology, ecophysiology, dispersal and regeneration. Besides elucidating possible constraints affecting !nara productivity, such studies provide a substantial background that can also benefit the 'nurturing' or supportive function of !nara. In recent years, the "Topnaar Community Tourism Enterprises" has been planning incorpor-

ation of cultural and natural information into their ecotourism programme in order to generate income whilst conserving and controlling the fragile environment. Lauberville (Fig. 2.2), conveniently situated at the edge of the largest !nara fields, is being set up as a self-sustaining community-based tourist camp (Bruce & Dausab 1998). Considering the high popularity of the endemic Welwitschia plant, which is a must on most tourist programmes in Namibia, the !nara probably has a similar high potential, currently still latent. Furthermore, the unique flavour and high nutritional value of healthy, natural and indigenous !nara products can facilitate the development of several new local market niches. The Topnaar have a gem on their doorstep, even more so as its story is their own.

3. As the !nara triad of nature-culture-nurture (Fig. 1.1) illustrates, *synergistic effects* should be developed between these three facets. The joint effects of the provision of diverse job opportunities, training by building on existing skills, and conservation of the Kuiseb environment can enable this rural community to build up a stable, socio-economic, self-sustaining network.
4. Community-Based Natural Resource Management in the Kuiseb valley shows several advantages compared to industrial investments in urban centres, if cost-benefit aspects are considered. Development programmes for marginalized Topnaar therefore appear to be less risky in rural conditions.
  - a) !Khuiseb Topnaar enjoy better living conditions. They have !nara and livestock for subsistence, enough living space, less danger of infection by diseases, no debts for rented houses, social security in the extended family and probably more self-confidence and self-esteem. The majority of adults prefer living rurally, and several urban Topnaar wish to move back to the Kuiseb. Only 37% of the young !Khuiseb Topnaar wish to continue living rurally, as they develop different social and economic values than the current traditional ways offer. However, urban development does not necessarily improve the lot of the Topnaar community. For example, after relocation from Mile 4 to Kuisebmond in 1986, only one of eight urban households received regular income and was able to pay accounts for municipal services and rentals. Of 33 adults interviewed (Municipality of Walvis Bay 1997), only seven were employed, the rest lived on pensions and rental of out-buildings on their premises. Conditions were unhygienic, tuberculosis widespread, and food was partly collected at dump sites. This was attributed to "lack of education and skills, abuse of alcohol, lack of self-discipline and lack of interest to obtain jobs in order to provide for themselves" (Muni-

ciality of Walvis Bay 1997, p 3). !Khuseb Topnaar avoid the brunt of these problems.

- b) There is good potential for !Khuseb Topnaar to develop through *economy of scope*, although efforts following *economy of scale* have been unsuccessful. The assessment that small-scale and variable production would not be cost-effective and unable to compete on international markets caused a British cosmetic company and the UNDP to withdraw interest in 1992. However, instead of relying on mass production, reliance on flexible, adaptive production of highly diversified products enables satisfaction of individual consumer preferences at any time. In the *economy of scope*, !nara is processed and marketed as different products for different markets. Such diversified small-scale production can benefit from various experiences and skills of Topnaar community members, it can provide work for all family members and strengthen their existing system of distributing work among various members of their extended family. It is also less risky because of its small, controllable size.
5. Investment in !nara business with higher revenues for the !Khuseb Topnaar could improve the currently low image of a !nara harvester compared to that of livestock farmers. This may alleviate reliance on livestock under the constraints of limited resources in the Kuiseb valley.
6. The idea of improving !nara resource management is not new. Comprehensive information from research in various disciplines, representing a substantial investment of capital and effort, is already available and has been integrated with traditional knowledge. The development of alternative designs of Community-Based Natural Resource Management in the lower Kuiseb valley can thus tap a substantial body of existing knowledge to facilitate success.
7. Flamingo Furnishers, the most important dealer of !nara seeds and the most reliable business partner of the Topnaar, suddenly closed business in early 2000. A large proportion of the traditional marketing chain is now disrupted. There is now a great opportunity for the Topnaar themselves to fully take over and redesign the marketing of !nara.

### Different models of !nara resource management

We describe several possible marketing strategies that take advantage of the !nara's high potential. In view of restricting factors limiting the yield of !naras, there are two options for the Topnaar to achieve appropriate income. Either allocate the current income from !nara sales to a reduced number of harvesters, or increase the monetary value of the !nara seeds to the Topnaar by improving the efficiency of !nara marketing. The latter alternative is preferred, but it should be emphasised that in this case the income for every harvester should increase considerably. The failure of many rural development projects is not caused by "conservative, uneducated indigenous workers" (McDonald 1994), but more likely because of the lack of incentives and appropriate rewards.

For choosing an efficient marketing strategy, several controllable variables should be optimised (the concept of marketing mix; Kotler 1980). The marketer differentiates between four basic variables: product, distribution, price, and communication (Table 11.4).

As price and communication policies mainly result from production and distribution strategies, the following recommendations will only discuss alternatives of the latter, concentrating on the variables that are underlined in Table 11.4.

Product	Distribution	Price	Communication
<u>Quality</u>	<u>Channels</u>	List price	Advertising
<u>Features</u>	<u>Target consumer</u>	Discounts	Personal selling
<u>Options</u>	<u>Coverage</u>	Allowances	Sales promotion
<u>Style</u>	<u>Locations</u>	Payment period	Publicity
Brand Name	Inventory	Credit terms	
Packaging	Storage	(Costs)	
Sizes	Transport		
Services			
Warranties			
Returns			

Table 11.4: Marketing variables that could be manipulated. The ones with most critical effects are underlined (adapted from Kotler 1980).

*Topnaar as subsistence farmers* Subsistence farming in drylands is a highly skilled survival system, using a minimum of resources so that a stable symbiosis of people and nature develops. Ideally, this symbiosis can continue indefinitely, as it is most sensitive to the conditions of the natural environment. With regard to social conditions, it would strengthen the existing structures of extended families by integrating handicapped and old people and by reviving the partially dysfunctional communal supply system. However, the increasing population of Topnaar, the high migration rate of young community members from the rural to the urban environment, and requirements for money due to the increasing integration in market economy, schooling, and adoption of western consumption patterns preclude the re-adoption of former living conditions.

*Topnaar as communal farmers* In contrast to subsistence farming, development towards communal farming is more market-orientated, but still far from a profit-maximising commercial system. The surplus of agricultural products is sold or bartered to community members on local markets in the vicinity in order to pay for basic needs such as school fees. Similar to a subsistence household, the whole family serves as a productive unit around which multiple activities like food and clothing production are organised. The Topnaar have lived in such a self-sufficient system for hundreds of years, maintaining a steady trade of !nara against goods brought by passing vessels from or to the Cape and later with general dealers in Walvis Bay. However, the proximity to prosperous, modern industrial centres such as Walvis Bay and Swakopmund has attracted people away from the Kuiseb valley, causing deprivation of rural labour reserves. Furthermore, lack of control by the !Khuseb Topnaars of essential natural resources, such as water, increases vulnerability.

*Topnaar as rural entrepreneurs* Modern "bottom up" strategies for sustainable development of rural peripheries involves the reactivation of market-orientation. The idea of so-called "autocentric development" maintains that through comprehensive utilisation of all local resources, the basic needs in that region can be satisfied. It implies that dissociation from urban manufactured goods will stimulate the development of existing secondary, non-farming activities (building, sewing, weaving, pottery and modern activities e.g. repairing bicycles) to primary tasks in the form of micro-enterprises, as has already occurred in the craft sector elsewhere in Namibia. Such an evolving diversified structure in light industry and agriculture could initiate the establishment of small regional economic circles. In this model of increasing labour division only some of the Topnaar would concentrate on !nara harvesting, while other community members specialise on non-agricultural products or services which they could exchange against food on local markets.

Although this concept sounds promising for integrating sustainable social, environmental and economic development, its application to the development of the Kuiseb catchment may be difficult. Cheap manufactured products are available in nearby Walvis Bay. This leads to the existing situation that the demand, the image, and consequently the price, of !nara products are too low in the suburbs of Kuisebmond and Narraville.

In the past, Topnaar harvesters reacted to this low and unreliable local market potential by ceding the marketing and trade to intermediaries, restricting their roles to that of suppliers of raw material without any control on the final consumer price and the overall !nara market development.

*Topnaar as suppliers of raw or pre-processed material* In the current !nara market, the Topnaars' role is restricted to that of suppliers of raw material, and they are not involved in further processing, value-adding and profit-making which are achieved elsewhere (Cape Town). In a highly competitive market of daily food, the price for current !nara products is determined by the consumer, and there is no potential for extending the trade margin besides reducing production costs or the number of intermediaries. Production costs are already on a low level and Topnaar are dependent on their intermediaries to facilitate the international distribution. One possibility for achieving better income in !nara business is to expand the harvest volume. From an ecological point of view, more intensive harvesting could exceed the carrying capacity of this wild, uncultivated plant and could lead to its demise. We therefore conclude that increasing !nara business by increasing the harvest volume and trying to increase consumption will not be of long-term benefit to the Topnaar. Such increases would rather aggravate current problems.

An alternative scenario is cooperation between the !Khuseb Topnaar and external contract partners, companies that promote ecologically and socially responsible business behaviour. In exchange for permission to market an indigenous export product, the local people receive employment, training, equipment and access to a worldwide distribution system, know-how and capital.

*Topnaar as small-scale manufacturers* Product and market diversification would enable Topnaar to become small-scale manufacturers. This strategy targets consumers from the middle-to-high income group outside the Topnaar community as well as international tourists. !Nara products would not be chosen for daily consumption but as a speciality, e.g. as a regional delicacy, a gift or a souvenir from the Topnaar of the Namib Desert. Positioning the !nara products in the food or cosmetic

branch with features like "traditional", "indigenous" "and healthy" would not only meet the evolving demand of the world-wide "green" and "alternative" movement, but also the development from the supermarkets offering mass products to specialised retailers (special-line shops) as is already occurring in Swakopmund with shops and cafés such as Aroma & Health Therapy, Out of Africa and Delicatess Baumgart. The tourist, primarily interested in obtaining a typical souvenir, will prefer those products that are packaged appealingly and reveal something about the Topnaar and their culture concerning !nara. The type of product, !nara as a rare snack, healthy body lotion or as tasty confection, will then play a minor role. In this case the price results from the additional cultural value rather than from the pure material value, and higher prices can be set than by marketing !nara as a daily food product.

From the economic point of view, this marketing strategy offers the possibility to optimise value-addition without requiring a higher volume of !nara raw material. The processing of storable goods will help to reduce seasonal fluctuations of income. Overall, this proposal encompasses all requirements of implementing an appropriate technology: it is capital extensive, work intensive, low cost, and maximises the use of local skills and resources. It will stimulate the process towards more advanced market-oriented farming and would promote the development of self-operated, self-sustaining, small-scale !nara business.

Direct marketing, or at least cooperation with one market intermediary (retailers in Walvis Bay or Swakopmund), diminishes the number of middlemen. To back up a new marketing strategy, the trade to South Africa, although not efficient, should be continued as it is stable and could reduce the risk of introducing a new marketing concept in the beginning. The character of this integrated programme will also meet the current economic priorities of the Namibian Government that aim at developing micro-enterprises to fill gaps in the private sector between formal and informal markets in Namibia.

With regard to environmental aspects, the pressure on !nara productivity will be reduced, first, because the !nara market volume is determined by supply and not by demand, and second, because the main part of the product value will be achieved by processing and not by the raw material. Nevertheless a long-term comprehensive monitoring system would be needed to avoid negative impacts on the !nara plants.

## Conclusions

The most promising model for the future of the !Khuiseb Topnaar appears to be their development towards becoming small-scale !nara manufacturers under the auspices of a Community-Based Resource Management Project. This development is extremely sensitive to developments of social aspects. The small-scale !nara manufacturing business model enables the impoverished and marginalized community to start from the current stage and initiate social change without abruptly abandoning traditional life. It provides the possibility of building indigenous, small enterprises that neither depend on external guidance, nor on alien processes and products. It includes extensive opportunities for training and recruitment from within the community, thus enabling the community to improve its livelihood.

## Part IV: FUTURE OUTLOOK

### Chapter 12

#### NARA: Which way forward?

by Topnaar Community Foundation & Desert Research Foundation of  
Namibia

#### 1997 Objectives

What has been achieved so far? The following were the questions developed by the NARA project in 1997:

1. Has !nara fruit production changed, and, if yes, why?
2. How can harvesting be sustainably managed?
3. How can the !nara plant be cultivated without depleting other natural resources?
4. How can the !Khuiseb Topnaar obtain an appropriate and predictable income through !nara?

As this book shows, there has been significant progress, particularly in terms of understanding some of the proximate (but not the ultimate) factors affecting !nara productivity, recruitment and initial factors involved in cultivation (Chapters 4-9). However, even the proximate factors are not understood completely, and there has been little more than speculation on some of the ultimate factors affecting productivity. The important question of sustainability has not yet been addressed directly and will need urgent attention in view of progress with Objective 4 concerning !nara business development.

The baseline study and several workshops represent outputs under Objective 4. While initial planning by the !Khuiseb Topnaar and some training to community members are the most important activities that have occurred under this objective, actual implementation has not commenced. The economic situation of the !Khuiseb Topnaar has not improved during the project so far. Developments have, however,

led to the situation where it is poised to do so in the near future if several conditions are met, as described below.

In this chapter, we summarise the future plans, as stated by the Topnaar community at a workshop and in the baseline study, and as perceived by the Topnaar's principal NARA partners: DRFN and CRIAA.

### Current perspective of the Topnaar community

Feedback on the NARA project was given to, and, in turn, obtained from the Topnaar at a community workshop that took place at Lauberville on 22 August 2001 (Moser *et al.* 2001). Of the 55 people who attended, 45 were Topnaar, seven from DRFN, two from CRIAA, and one from the University of Frankfurt. Several leaders attended, including the Chief of the Topnaar, Seth Kooitjie, and TCF Councillor Rudolf Dausab. The first feature was feedback by DRFN on !nara research that had been conducted since the first workshop in 1997. Oral presentations made use of Afrikaans posters prepared from summaries of Chapters 4-9 & 11 of this book. This was followed by a stimulating discussion of future possibilities concerning marketing and processing of alternative !nara products by CRIAA.

Feedback from the community was obtained in the form of written statements on cards that groups of community members discussed and formulated.

We want to...	In other words, we want to...
keep !nara business going	continue with !nara in such a way that it benefits our and the !nara's future
further develop !nara business	develop the most suitable management, processing and marketing procedures
run the !nara business in Namibia ourselves	establish !nara marketing as Topnaar business and develop an appropriate local market
work together	cooperate with each other in the community and households
have cooperative leaders	have good, cooperative management for the !nara business
establish a Topnaar !nara co-op	establish a !nara co-op of Topnaar harvesters, processors and marketers
obtain direct economic benefits	improve our livelihood through appropriate income and financial security

Table 12.1a: Summary of the Topnaar Community's responses to the question: "How do you want to proceed?"

Two questions to the Topnaar guided their discussions: 1. "How do you want to proceed?"; 2. "What do you expect from us (TCF, DRFN, CRIAA, others)?". A total of 56 statements were received and sorted into clusters (Appendix C), which are summarised below (Table 12.1a & b).

We request you to...	In other words, we request you to...
provide needed support	aid and assist us to improve !nara management, !nara business, and explore market alternatives.
improve our self-sufficiency	Temporarily help us to become more self-sufficient
stimulate us to work together	advise us on how Topnaar can optimally work together
cooperate with us	become good partners with us and foster cooperation and trust with us
help us develop a !nara factory	assist us in establishing a factory of the Topnaar !nara co-op
TCF to build mutual trust with us	TCF to develop a good relationship of trust in managing our financial affairs in our best interests, and to keep us well-informed
continue relevant research	DRFN to conduct research to improve !nara management, and CRIAA to conduct research on product development and marketing
provide knowledge and training	exchange information with us on !nara, and provide more training to us in modern methods of plant, product, and market management

Table 12.1b: Summary of the Topnaar Community's responses to the question: "What do you expect from us (TCF, DRFN, CRIAA, others)?"

This shows that the Topnaar community is determined to develop the !nara business, while remaining sensitive both to their own cultural tradition concerning !nara and to the requirements of !nara itself. Their boldest proposal entails forming a co-op of professional !nara harvesters and processors, that would bring the entire chain of !nara business, including plant management, harvesting, processing and wholesaling, into their own control. Fundamentally, they hope to achieve this by pledging cooperation towards each other, requesting both their own leaders as well as partner institutions to assist them in achieving this.

An efficient co-op<sup>31</sup> of harvesters, !nara craftsmen/women, marketers, and effective partners could fulfil nearly all of the aspirations stated in Table 12.1a & b. It would require and ensure Topnaars trusted each other and worked closely with each other, including with the leaders, and serve as a focal point for partner institutions. A co-op would ensure equitable distribution of income based on a mutually agreed upon system, and would reduce the existing economic uncertainty of individual harvesters. One written statement submitted by the Topnaar at the workshop sums this up (Appendix C):

“We need to have an organisation for the harvesters, which registers its members. The organisation must be formalised before the next season. It must include: the Chief or a Councillor, the Foundation and Harvesters, CRIAA, DRFN, GRN and other organisations to help the community until such a time that they become positive (i.e. self-sufficient, profit-making). All information and research must guide the process until this Topnaar !nara organisation can sustain itself.”

To sum up several other submissions (Appendix C): the Topnaar want to establish a !nara co-op, consisting of registered Topnaar harvesters who sell !naras only to the co-op, as well as Topnaar who process and market !nara products. The co-op should allocate !nara fields to harvesters and collect the produce from them. “!Nara factories” would be the focal points of the co-op. By “factories” are understood possibly several places for !nara processing, such as “home industries” as far as technical facilities allow (e.g. every household can cook !nara jam, but maybe there is only one oil press). Several submissions made it clear that workable and acceptable methods of sharing income among co-op members will need to be agreed upon.

The most striking event at the workshop was the eager appreciation of suggested small-scale, quick (but significant) economic solutions that may get the !Khuseb Topnaar out of the current tight, economically-constrained “corner”. The demonstration that “Saamwerk” (cooperatively working together) could immediately increase the earnings of harvesters in the existing !nara harvest, and could bring many-fold increases in benefits through further processing of products (!nara oil

<sup>31</sup> “co-op” (short for cooperative): a business that is owned collectively and managed for joint economic benefit, through cooperative use of the means of production and distribution.

was demonstrated as an example), gave agreeable resonance. The rural people, used to extremely hard work (but currently for poor returns), concurred that by working together for mutual interests, rather than individually for own interests, much more could be achieved.

The workshop participants applauded the idea that cooperation among harvesters as sellers of !nara raw material could immediately bring the current market to South Africa into Topnaar control, as a first step in further market development. Furthermore, the workshop participants showed great appreciation of the demonstrated samples of fresh !nara oil, at first impression being a fine oil of high quality especially for cosmetic purposes. !Nara oil represents a quantum jump in value addition. It was obvious at the workshop that the Topnaar want to do this themselves. A basic requirement was echoed many times in the feedback: the Topnaar community members need to trust and cooperate with each other. *Saamwerk!* \*

The call for more research and more sharing of knowledge at the workshop reflects the deep appreciation and quick grasping of the significance of research findings. In a sense, the presenters were “preaching to the converted”. Based on the existing appreciation of !nara representing culture, nature and nurture, research serves to confirm, elucidate, and test some of the challenges facing the Topnaar. Research can also help to find a way out of conflicting constraints that face the management of !nara plants in its changing natural environment, and is fundamental to understanding factors that affect sustainability.

Lastly, and most importantly, the request by workshop participants for Topnaar to receive training in modern techniques of plant, product and market management, signals readiness to acquire additional skills required to facilitate the development and improved self-sufficiency of the !Khuseb Topnaar.

### **Small-scale !nara product manufacturers**

The Topnaar are already the world’s best experts in managing !nara and processing its fruit. Several constraints currently impede the growth of the existing !nara business, most important being the harvester’s dependence on the demand at the far end of a market chain with middlemen that the Topnaar cannot control. Several other constraints, even the rather limited supply of !nara raw material, could fade into insignificance by turning the tables: make the market supply-driven. This presents an opportunity for the Topnaar to become small-scale !nara product manufacturers. Given conditions of the !Khuseb Topnaar, self-sufficient !nara

manufacturing and marketing can probably be more efficiently implemented by forming a co-op, instead of having many separate, competing family enterprises. A co-op can minimise the social risk of a small business while keeping the activity dispersed in homes.

The idea of a !nara co-op had already emerged during the interviews of the Topnaar in the baseline study. It is thus not a new idea to the Topnaar and had formed the focal point of previous efforts (e.g. Grasveld & Gabriel 1993; Dausab pers. obs.). By !nara co-op is understood a company that is obliged to cede management, control and organisation to its Topnaar "home industries" after a period of introduction and training. The co-op can set the sales price of !nara products and does not depend on market intermediaries. It enables the Topnaar to fully exploit their monopoly as !nara suppliers, provided that all !nara harvesters participate and do not attempt to undercut prices by selling privately. To ensure that the executive management acts according to environmental and social goals and not according to self-serving interests, an independent control body, representing the Topnaar, NGOs, and government, whose members are elected by the main stakeholders, should be implemented.

A co-op can minimise the danger of unequal distribution of revenues. It could support the Topnaar dealing with income in a reasonable way by offering saving and credit systems, health and social insurance. Training in calculation, harvesting techniques and general business skills is essential to smoothen the way for establishing small and self-owned !nara enterprises. All household members can participate in such home industries in the rural settlements of the !Khuseb Topnaar. This will reinforce the productive unit of the extended family system, thus maintaining the traditional way of life. Thus, implementation of a co-op could result in an increase in living standards, democracy, education, social cohesion, and cultural identity in the !Khuseb Topnaar.

The need for the !Khuseb Topnaar to cooperatively work together is the single most important fundamental prerequisite for !nara business development to proceed. Mechanisms to ensure continued *Saamwerk* need to be developed by the Topnaar Community itself.

### Market development

!Nara lends itself to product and market diversification. While continuing to form a staple food for the !Khuseb Topnaar themselves, actual or potential marketable !nara products that were identified during the baseline study include:

- dried or roasted seeds, with or without adhering flesh
- various bakery products
- oil, body lotion
- dried fruit flesh, jam, juice, liqueur
- medicinal products: root or stem extracts
- souvenirs: fruit peels made into jewellery or packaging, seed shells in jewellery, attractive packaging with patchwork, woodcarving, pottery and home-made labels of any of the above products
- images: value can be added to all of the above products by images such as:
  - *romantic cultural tradition*
  - *clean, healthy plant and environment*
  - *genuine indigenous Namibian product*
  - *supporting rural people in harsh desert conditions.*

This range of products remains to be fully introduced into the market. Several Namibian retailers have already expressed interest in cooperating with the Topnaar in this respect. Initial indications are that the tourism industry and health shops could be potential market outlets. A proper market survey and test introduction of products is required to gauge this potential.

The Topnaar currently monopolise !nara products, a position they should secure legally to prevent foreign companies from taking business initiative away from them as soon as new market opportunities are opened. Immediate registration of "!"nara" (and its word derivatives, such as "nara" and "narra") as a !nara product trademark belonging to the Topnaar Community would secure such legal rights.

### Future research on !nara

Simultaneously to focusing on the market and socio-economic ramifications, the !nara plant itself requires continued attention. In order to use this natural resource optimally, it is necessary to understand more fully the factors that affect its sustainable production. While this book indicates that much is already known, it also reveals crucial gaps in our knowledge. These gaps currently still prevent us from being able to make predictions on the future production of !nara fruit, how to best manage plants in the field, and how to cultivate !nara.

We suggest that the following research topics are important:

- *!nara population dynamics*: understanding the natural functioning of !nara fields; recruitment rate; ultimate factors affecting recruitment; factors affecting longevity; natural variation in population size, sex ratios, and age structure
- *!nara plant dynamics*: growth and decline of branches within individual plants, factors affecting small-scale resource allocation in subsections of plants
- *long-term monitoring of individual !nara plants*: annual fruit yield; growth and development over years
- *!nara water relations*: mechanisms of connection to groundwater; ideal conditions of groundwater in terms of depth, replenishment and quality; ability to use surface or near-surface water; tolerance of saline water
- *herbivory*: extent and effect of herbivores on !nara branches and flowers: insects, donkeys (e.g. experiments with exclusion of herbivores, simulation of damage)
- *harvesting methods*: effect of alternative methods of harvesting and plant management on plant productivity (e.g. experiments with harvesting once vs. harvesting all fruit vs. no harvesting, harvesting ripe vs. unripe fruit; several kinds of mechanical damage on plant; burning vs. not burning)
- *!nara cultivation*: further investigations towards requirements for the management of seedlings to adult plants; methods of stimulating development and productivity (e.g. various kinds of water, fertiliser, pruning methods, grafting); sand binding characteristics

## Recommendations

In summarising the different models of !nara resource management, we recommend the adoption of a strategy that enables the !Khuseb Topnaar to build up their own small-scale !nara enterprise. In our opinion, this seems to be the best way that would lead to full integration in the market economy and Namibian society, while the development occurs through a self-guided process with minimal external intervention. NARA, as a Community-Based Natural Resource Management Project, entails cooperation within the Topnaar Community as well as between the community and partner organisations, such as the DRFN, CRIAA, MET, MAWRD, and the business community.

In its further development, the NARA project should involve:

- agreement on full cooperation by all professional harvesters and their household members
- formulation and implementation of mechanisms to ensure !Khuseb Topnaar cooperatively working together
- continued feedback between harvesters/processors and researchers/stakeholders
- Topnaar taking full control of all !nara wholesale operations
- Topnaar securing exclusive legal rights on !nara product supply by obtaining a trademark
- formation of Topnaar co-op based on a business plan
- formation of a !nara advisory board
- identification of funding needs
- obtaining funding to assist specific initial business development and research
- !nara product development research
- !nara product market research
- determining training needs for !nara business
- further training to Topnaar in !nara plant, product and market management, as required
- Topnaar participating in monitoring fruit production and plant growth
- research on biophysical and socio-economic factors affecting !nara productivity
- design and implementation of appropriate harvesting and management strategies
- project monitoring, evaluation and redesign
- gradual discontinuation of financial support as business becomes self-sustaining.

## Future objectives

Although extensive progress has been made in addressing the NARA project objectives of 1997, none of them have yet been fulfilled. In reviewing them, we have rephrased the original objectives and find that they still encompass what NARA endeavours to achieve in the coming years:

1. to understand and control factors that affect !nara fruit production
2. to manage !nara sustainably
3. to cultivate !naras without depleting other natural resources
4. for !Khuiseb Topnaar to obtain appropriate and predictable income through !nara.

## PART V: LITERATURE & APPENDICES

### Chapter 13

#### Literature Citations and Bibliography on !Nara and Topnaar

collated by Joh Henschel, Inge Henschel & Petra Moser

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## Glossary

!, /, //, ≠	symbols representing clicks, typical in the Nama language
abiotic	non-living component of an ecosystem
albedo	proportion of insolation that is reflected back
anthesis	time of flowering in a plant
anthophorine bee	solitary bee
apomixis	asexual reproduction in plants
assimilation	plants consume energy (light) and turn it into substance
biotic	living component of an ecosystem
C <sub>3</sub>	a form of the chemical process of photosynthesis which uses a three-carbon pathway.
C <sub>4</sub>	a form of the chemical process of photosynthesis which uses a four-carbon pathway.
CAM plants	CAM stands for Crassulcean Acid Metabolism, and indicates a method of photosynthesis that is used by Crassulaceae, a family of succulent plants.
chlorenchyme	plant tissue containing chlorophyll
chloroplast	green pigment in plants, needed for photosynthesis
CO <sub>2</sub>	carbon dioxide gas from which plants obtain carbon
cotyledons	germination leaves
cuticle	thin, waxy, protective layer covering the surface of leaves and stem of plants
diaspore	seed that functions in dispersal
dioecious	sexes separate (male and female plants)
endemic	species occurring only in a particular geographic region
endosperm	structure in a seed, stores food materials used during germination
epicuticular wax	a thin wax layer on the outside of the cuticle, serves as insulation
epidermis	outermost layer or layers of cells in a plant
gas exchange	measurement of CO <sub>2</sub> uptake and oxygen release
hypocotyl	plant part between roots and germination leaves
inundation	completely covered, buried underneath
meristem	cells that can split indefinitely, being responsible for plant growth
mesophyll cell	specific cell layer in a leaf
mesophyte	plant adapted to an environment that is neither very dry nor very wet

microphyllly	very small leaves
palaeo-channel	ancient river course that is no longer functional but still contains groundwater
PAR	photosynthetic active radiation: light that is used for photosynthesis
phreatophyte	plant using groundwater
polylectic	foraging on different plant species
radicle	first roots of a germinating seed
Scholander bomb	equipment to measure water potential
sclerenchyma	fibrous or woody tissue in a plant that provides mechanical support
solitary bees	bees that do not live in colonies
stigmata	reproductive organ of a female flower
stomata	small openings in stem or leaves that allow CO <sub>2</sub> and water vapour to enter the plant and oxygen and water vapour to escape
transpiration	evaporation of water through a plant's leaves and stem
trichome	fine hairs on leaves or stems of plants
water potential	way of measuring the energy needed to take up water; the more negative this is, the more difficult it is to take up water
WUE	water use efficiency: ability of plant to use available carbon assimilated per unit water transpired
xerophyte	plant that grows in very dry conditions and is able to withstand periods of drought
xylem	plant cells that transport water and dissolved substances upwards

# APPENDICES

## Appendix A: Questions during interviews of Topnaars during the baseline study

### 1. Description of the study field

- Name of homestead
- Infrastructure (nothing, water, road, radio, transportation facilities, electricity, phone, shop)
- Distance to next village
- How many households are situated here in this settlement?
- What are the names of the heads of these households, how many adults, how many children including schoolchildren live there permanently?
- How many regular harvesters live in this settlement?

### 2. Date of respondent

- First name/last name
- Sex
- Age/age group (0-25, 26-60, > 60)
- Origin (Topnaar-Aonin, which Aonin group, thu otherinin, !Khuisenin, !Gomen, !Namixan, mulin.; other)
- Place of main residence
- Level of education (highest level)

### 3. Family/Household

- How many people permanently live in this household? (f-m >60, f-m 26-60, children 0-25)
- How many children of the household are yours?
- How many of them do you still send to school?
- Who is head of your household?

### 4. Household structure and wealth ranking for the whole settlement

- How many households are situated here in this settlement?
- What is the name (of the head) of these households?
- How many persons are permanently living in this household? (f-m >60, f-m 26-60, children 0-25)
- How many persons belong to his household but only come periodically at holidays, weekends? (f-m >60, f-m 26-60, children 0-25)
- Are there rich and poor households in your settlement? Why are they rich, why are they poor?

## 5. Occupation

- What is your main current occupation (during !nara season, outside !nara season)?
- Which occupation would you like the most? (Please name five occupations and rank them. On top of the stick please put the occupation you like the most, at the bottom which you like least of your chosen occupations. - Items prepared: pensioner, employee as car mechanic, office worker, nurse, waitress, etc., housekeeper, self-employed as a businessman, livestock farmer, !nara harvester, casual worker, ...)
- Which occupation would you like for your children? Please name five occupations and rank them. On top of the stick please put the occupation you like the most, at the bottom which you like least of your chosen occupations. - Items prepared: pensioner, employee as car mechanic, office worker, nurse, waitress, etc., housekeeper, self-employed as a businessman, livestock farmer, !nara harvester, casual worker, ...)

## 6. Harvesting

- To which fields do you usually go for harvesting, please show them on the map!
- In former times, every !nara field belongs to a particular Topnaar family. Who is or was the owner of these fields?
- Did you personally change your harvest areas in the past? If yes, what was the reason for this change?
- Are there other harvesters in these fields? – how many are regular harvesters, how many occasional harvesters?
- How do you deal with harvest newcomers in the field where you normally harvest? – I let them stay – I chase them away – I ask the Topnaar council chief for help – other.
- Do you know some fields where normally nobody is harvesting? – Why is nobody harvesting there?

## 7. Harvest volume/expense in manpower

- In which months do you normally harvest?
- Which months normally have a very high, which normally a low fruit production?
- How many kg or how many bags of seeds (50 kg) do you normally harvest in those months?
- How many days/weeks do you normally harvest in those months?
- In a month with normal productivity: how many days do you have to work to fill one 50 kg bag with pips?
- Please describe your time schedule while you are working in the field? (hour you get up, time you have lunch, hour you finish work)
- How was the productivity of !nara fruits in the past? Which were the years with the highest productivity and which with the lowest? What was the highest harvest volume and the smallest?

- Which other year do you remember very well? Perhaps the year when 0-15, 15-25, you got married, your first son was born, one of your children got married, 1936 big flood, 1962 DERU was founded, 1974 long flood, 1981 Chief Seth Kooitjie, 1990 Namibia Independence, 1994 Walvis Bay turned Namibian, 1994 visit of Prime Minister Geingob?
- How would you describe the development of the yearly productivity over the years? (stable, stable - but decreasing, stable - but increasing, unstable, unstable - but decreasing, unstable - but increasing)

## 8. Utilisation of different parts of the !nara fruit

- Which part of the !nara do you use today?
- How do you process them?
- For what are they used?
- For whom are they prepared?
- At least how many kg or bags of pips do you need to care for your family (self-consumption)?
- How long can you store !nara pips and how long does the stored amount normally last?
- In a very poor season you could only harvest some bags. Did you immediately sell them all or did you keep them all at home?
- If the price for !nara pips will increase a lot, would you sell more?
- Let's refer to the last year: How many kg bags did you harvest last year? – How many bags you kept home? – How many bags you sold last year? – How much did you use for exchange with other goods last year?

## 9. Trade structure

- To whom do you sell your pips or to whom do you give them in exchange with other goods?
- Do you know to whom Flamingo Furnisher, Mr. Yon, Mr. Schweikardt sell the pips afterwards?
- What do you think they charge for one bag of !nara pips to the purchasers in South Africa?
- What do you think is the price you should get to match your work input and your need to sufficiently care for your family?
- Do you have any idea by what means you might get a higher price for !nara pips?
- Did you try to find a more lucrative possibility to sell !nara pips in the past? If no – why not?
- Do you have any idea why the people in Cape Town know your !nara pips and how the trade was introduced to SA?
- How did your ancestors deal with !nara pips?

- Did they also deal with other !nara products?

#### 10. Household structure/finances

- Who normally makes the decisions about expenses, income, etc. in your household?
- Does the budget of your household include all household members, that means all persons who are permanently living here and those who only come for holiday?
- On what do you normally spend your monthly money? Name all main expenses per months and rank them.
- Please name all of your different sources of monthly cash income.
- If you consider all these different income sources, how much money do you then have at your disposal every month?
- If you receive your salary on pay day, the money for the !nara sale or other cash income, how do you deal with this money at that moment? Position the amount you normally spend at once in town on the scale.
- Do you have savings?
- Do you have a banking-account?
- Do you have credits?
- Do you sometimes buy things in town on account?
- What would be an appropriate monthly income for you to sufficiently care for your family?
- What do you think is the amount of income of: -a qualified car mechanic in WB, an office assistant in WB, a nurse a servant?

#### 11. Socio-economic features

- Tell me something about your favourite meals and drinks.
- What would you like to do after work in your free time?
- What do you like the most about your life as a harvester in this settlement? And what do you like the least?
- What do you like the most/makes you proud about living as a member of the Topnaar. What do you like the least, what makes life difficult?
- Are you an active member in groups, councils, etc. in the Topnaar community?
- If somebody will give you a large amount of money, e.g. 4-5000 N\$. What are you going to do with this money?
- You are a !nara harvester and you are dealing with !nara pips, so what qualities should a good harvester have to be successful?
- Whom would you ask for support?

#### Appendix B: Present and future marketing situation of the Topnaar

	<b>communal farmer</b> <i>(current situation of the Topnaars)</i>	<b>small-scale manufacturer of !nara products</b> <i>(possible future situation of the Topnaars)</i>
<b>marketing strategy</b>	sale of surplus	selective specialisation small-scale production (economy of scope) diverse product programme
<b>branch</b>	food	food, cosmetics, souvenirs
<b>market location (macro)</b>	national	national
<b>market location (micro)</b>	local rural, partly local urban	regional urban and tourist sites
<b>target consumer</b>	own household members (self-consumption). other residents in the Kuiseb vicinity and in the suburbs of Walvis Bay	residents of the regional urban centres like Swakopmund and Walvis Bay. tourists in the urban centres or in tourist sites, e.g. in the Namib-Naukluft Park
<b>product types</b>	for sale: <ul style="list-style-type: none"> <li>• dried or roasted seeds (pips)</li> <li>• dried fruit flesh (!nara cake)</li> </ul> for self-consumption: <ul style="list-style-type: none"> <li>• fresh !nara juice (!nara milk)</li> <li>• crushed seeds as fat or oil</li> <li>• tea of roots (medicine)</li> </ul>	<ul style="list-style-type: none"> <li>• food dried or roasted seeds, oil, jam, liquor, juice, dried fruit flesh, confection, various bakery products</li> <li>• cosmetics body lotion, oil</li> <li>• souvenir, crafts jewellery out of !nara shells (packaged in patchwork or woodcarvings)</li> </ul>
<ul style="list-style-type: none"> <li>• <b>product features</b></li> <li>• <b>product style</b></li> <li>• <b>product use</b></li> </ul>	<ul style="list-style-type: none"> <li>• home-made, not manufactured</li> <li>• no intended style</li> <li>• for satisfaction of daily needs</li> </ul>	<ul style="list-style-type: none"> <li>• home-made, indigenous, eventually partly manufactured, emphasis on packaging as a present, as a souvenir</li> <li>• image of originality, uniqueness, healthy, typical for the Topnaar culture</li> <li>• for satisfaction of non-daily wants</li> </ul>
<b>distribution channel</b>	harvester (Topnaars) – primary and secondary wholesaler - consumer	harvester and manufacturer (Topnaars) – (wholesaler)- consumer
<b>number of intermediaries</b>	one or two intermediaries	one intermediary or direct marketing

## Appendix C: Answers to workshop questions

### HOW DO YOU WANT TO PROCEED?

#### *We want to...*

- **keep !nara business going**
  - we want to continue with the !nara business
  - we must gather the !nara pips
  - !nara is the basis of our development, for future generations
  - we want the !nara to be managed in the traditional manner so that we can ensure the !nara's future
- **further develop !nara business**
  - today we have seen that !naras have different kinds of meanings, and that we can use them for different purposes or products, for example oil
  - we want to process !nara products
- **run the !nara business in Namibia ourselves**
  - we have now seen that foreign companies make more money than we and don't want this to continue like that
  - we, as the community, are opposed to the !naras being exported to Cape Town, and we want to process and sell !nara products here in Namibia
- **work together**
  - we must always work together
  - we must all work together
  - help each other to carry our burdens
  - stand together and work together
  - each household must work together
  - it will be very good if we stand together as community
- **have cooperative leaders**
  - we want us, as community, to communicate with the traditional Council
  - we expect there to be cooperation between the leaders and the community so that we can continue with the project
  - we would like Councillors for the !nara business, just as we have a traditional council, where we can discuss problems
- **establish a Topnaar !nara co-op**
  - let us establish a !nara organisation
  - the !nara workers must work together and sell !naras to the Topnaar Community Foundation
  - large companies should be established where !naras can be processed and sold

- a !nara company should be founded under which we can work
- we want to establish a co-op and sell !naras to the co-op
- people should store !nara at their homes, and when they are finished with the processing, they notify the Foundation to come and fetch it
- we want to establish an organisation concerning !naras
- every harvester should be registered and allocated !nara fields
- there must be an organisation that helps with the work
- We need to have an organisation for the harvesters, which registers its members. The organisation must be formalised before the next season. It must include: the Chief or a Councillor, the Foundation and Harvesters, CRIAA, DRFN, GRN and other organisations to help the community until such a time that they become positive (i.e., self-sufficient, profit-making). All information and research must guide the process until this Topnaar !nara organisation can sustain itself.
- obtain direct economic benefits
- we expect cash

### WHAT DO YOU EXPECT FROM US (TCF, DRFN, CRIAA, others)?

#### *We request you to...*

- **provide needed support**
  - we require aid to continue with the project
  - help us to help ourselves, thank you!
  - we would like you to temporarily provide us with an outlet where we can sell !naras
  - you must help our community to do something with the !nara root, because we use it as traditional medicine
- **improve our self-sufficiency**
  - the organisations that assist us must continue until we can carry out the project independently
  - conduct research and help us until we become self-sufficient
  - they must strongly assist and support us as much as possible until we can stand on our own feet and can dig in, i.e. become well established
- **stimulate us to work together**
  - DRFN: must continue with research and to stimulate the community to work together so that the work becomes easier
- **co-operate with us**
  - we want you and us to work together and that there should be trust amongst us

- I hereby want to say thanks to the people involved at this meeting, especially Pierre from CRIAA, as well as the students and the DRFN staff, and everybody who attended. From the Topnaar community: Thank you!
- **help us develop a !nara factory**
- CRIAA: we expect you to develop a !nara factory together with us in the Kuiseb, and that this factory recruits Topnaars
- we expect more help from CRIAA to assist us with founding a factory that will create more jobs for the Topnaars
- DRFN: we ask DRFN to help develop a !nara factory
- **TCF to build mutual trust with us**
- TCF: must keep us better informed
- TCF: must pay cash to the people who deliver !naras
- TCF: cash helps us to help ourselves, only then other affairs should be attended to (thank you BIGAS?)
- **continue relevant research**
- we ask DRFN to do all the necessary research
- DRFN: must continue with research and to stimulate the community to work together so that the work becomes easier
- conduct research and help us until we become self-sufficient
- CRIAA: should do further investigations for us
- we would like you to help us to ensure that the !nara becomes more productive and to earn more income
- **provide knowledge and training**
- DRFN: we would like the DRFN to give us more knowledge
- we ask that you continue to give us more information on the !naras
- we personally request DRFN, TCF & CRIAA to provide us with more of the knowledge that you have on the !nara plant itself, in other words, what you find out in research on the plant
- DRFN: must in future provide much knowledge to us so that we may learn more
- we would like somebody to show us how to obtain and make quotations to improve the !nara business
- we request that you build a training centre for us, where we can learn
- you should assist us, the Topnaar Youth, with workshops so that we can grow stronger