Putting Knowledge on *Prosopis* into Use in Kenya

Pioneering Advances in 2006

Acknowledgements

The Department of International Development (DFID) through the Forestry Research Programme (FRP) are acknowledged for having the foresight to recognise the potential value of the original research, supporting the publication of project outputs from R7295 and for funding several project extensions.

For pioneering the application of this knowledge in Kenya, thanks are due to many individuals and organisations. For funding, we appreciate grants from the FAO (TCP/KEN/3002), KOA (Kennington Overseas Aid) from the UK, and grants made by the Government of Kenya via KEFRI. Special thanks are due to support from the KEFRI Director Dr Paul Konuche, and many staff including Mr Joel Imbuye and Mr Peter Koech at KEFRI, Marigat, and Mr Mohamed Sheikh at KEFRI, Gede.

Thanks also to the many Farmer Field School facilitators and members for sharing and learning, and taking this knowledge out to the wider community – your role has been priceless and it is hoped that you will continue to be involved in future activities. We appreciate also the support of District Officers and those from the Forest Department and NEMA for their interest and involvement in the various training and demonstration courses, and Dr Carlos Sere and Mr Joseph Matere of ILRI for facilitating the first stakeholder meeting with livestock feed producers, and the participants themselves.

Correct citation

Pasiecznik NM, Choge SK, Muthike GM, Chesang S, Fehr C, Bakewell-Stone P, Wright J, Harris PJC. 2006. Putting Knowledge on *Prosopis* into Use in Kenya. Pioneering Advances in 2006. KEFRI, Nairobi, Kenya and HDRA, Coventry, UK. 13pp.

Cover photographs

Top left: Presenting and tasting a range of foods containing *Prosopis* pod flour, Kampi ya Samaki
Top right: Preparing foods with *Prosopis* pod flour (with *Prosopis* trees in the background), Garissa
Bottom left: Chainsaw milling a short *Prosopis* log into boards with an 'Alaskan' frame mill, Bura
Bottom right: Carpenters working *Prosopis* wood for the first time, chainsaw milled that morning, Marigat
All photographs: NM Pasiecznik (November, 2006)

Authors' contact details

Nick Pasiecznik
Agroforestry Enterprises
Villebeuf
71550 Cussy-en-Morvan
France
npasiecznik@wanadoo.fr

Simon Choge
KEFRI
Maguga
Nairobi 20412-00200
Kenya
skchoge2002@yahoo.com

George Muthike
KEFRI
Karura
Nairobi 30241-00100
Kenya
muthikegm@yahoo.com

Salina Chesang
KEFRI
Marigat
PO Box 50, Marigat
Kenya

Clemens Fehr
Consultant
PO Box 10347
Kampala
Uganda
clemens.fehr@unique-forst.de

Petra Bakewell-Stone
PO Box 297
Bagamoyo
Tanzania
dadapatra@hotmail.com

Julia Wright
HDRA
Ryton Organic Gardens
Coventry CV8 3LG
UK
jwright@hdra.org.uk

Phil Harris
Coventry University
Priory Street
Coventry CV1 5FB
UK
pjc.harris@btopenworld.com

Contents

Summary

A quiet revolution has occurred in parts of Kenya in 2006 - a revolution that will ultimately improve the well being of millions of some of the poorest, most vulnerable and most marginalised people in the country's drylands. An exotic tree, *Prosopis juliflora,* was introduced 25 years ago to provide fuel and fodder, but has since become an invasive weed, threatening, rather than improving local livelihoods. It is now being turned into a valuable resource, and is starting to provide the rural poor with a ready cash income and numerous indirect benefits. One year ago, expensive eradication and biological control of *Prosopis* was considered the best option. However, five years ago, a DFID project (R7295) was the first to collate the global knowledge on *Prosopis*, concluding that eradication was not only impossible but also unnecessary when improved management, utilisation and marketing could provide incalculable benefits to rural communities if the knowledge contained therein was applied effectively, while also effectively controlling further spread.

In 2005, the DFID project co-ordinator and KEFRI, Kenya, teamed up to prepare a policy brief to see how the generic knowledge on *Prosopis* from R7295 could be best applied to the problem in Kenya, published in January 2006. This fortuitously coincided with a UK development fund (Kennington Overseas Aid) agreeing to support work in two villages of Baringo District to develop the management and commercialisation of *Prosopis*. This ran alongside and complemented a small FAO-funded pilot project running in five villages. Although only on a modest scale (with funding of only £18,500), the final outputs of DFID project R7295 were thus applied for the first time. The 'Baringo Project' was managed and operated throughout 2006 by Mr Simon Choge of KEFRI, with the DFID project coordinator making two visits, and the results have been outstanding. By December 2006, over 100 farmers and pastoralists had participated in demonstrations and training in *Prosopis* management and utilisation. Some are now managing trees on community land and others have begun to do the same on their own private land. Logs have been milled into boards using an innovative and appropriate technology in chainsaw milling. Pods have been milled and the flour consumed for the first time in Kenya. In addition, this knowledge has been transferred to other areas, with trainees from Baringo disseminating through peer-training to receptive audiences in communities in Garissa and Bura.

Notwithstanding the potential of *Prosopis* in providing much needed food and fodder in drylands, perhaps the most exciting development has been the forging of links with the private sector. Promoting the use of *Prosopis* pods has progressed so rapidly that an export order to South Africa (as a dietary supplement) has already been dispatched and a second for livestock feed to Nairobi is due for delivery before Christmas 2006. These two orders total 23 tonnes, and have injected over £1000 directly to local community households which collect the pods, at very favourable daily rates. Participating households include the landless and extremely poor. Environmentally, the removal and milling of each tonne of pods destroys around two million seeds, with a corresponding effect on controlling the spread of *Prosopis* as a weed, this year seeing almost 50 million seeds destroyed. For 2007, there is already a further order for 40 tonnes, and two other companies are very interested, one for 100-200 tonnes per year, and another for at least 200 tonnes per month. No biological, chemical or mechanical control programme could consider the destruction of seeds at such a rate, and this innovative approach is not only cost-free once established, it actually puts money into the community, and it is not just environmentally benign, with good training it improves stand management, maintenance of tree cover and improvement of understory growth, soil fertility and biodiversity.

There is a cost to developing such an initiative of course, such as for capacity building, training, workshops, demonstrations, experimentation, extension materials, and small enterprise support grants, but relatively small costs in comparison to mechanical, chemical or biological control. It is also clearly sustainable, driven by market forces, with multiple indirect benefits such as reducing imports of wood/flour. Impacts from using this approach can be clearly monitored in terms of income generated by local communities and effects on reducing invasion, e.g. tonnes of pods collected and traded, and by whom. In communities where training has been held, perceptions on the value of *Prosopis* have changed immediately, and where income has been generated, the whole 'problem' of *Prosopis* has been turned into a solution. For example, people in parts of Baringo now demarcate private land where *Prosopis* is present, when previously it was considered valueless.

The 'Baringo Project' has indicated what can be achieved through the wider application of DFID project R7295 outputs. With more resources, the rate of uptake across the country and the region could be dramatically speeded up, leading to the evidently clear and significant double-benefits of improved rural livelihoods and an improved environment, which could be achievable in years rather than decades.

1. Overview – piloting the application of knowledge on *Prosopis* in Kenya

By December 2005, the '*Prosopis* debate' in Kenya and elsewhere in East Africa had reached grave proportions. The tree was to be subject to wholesale eradication, and the people who depended on the firewood, poles, pods and other products, would have to look elsewhere for resources to sustain or improve their livelihoods.

The Ilchamus community (akin to the Maasai linguistic group), with the support of Community Museums of Kenya, a local NGO, began legal action in 2004 against the FAO and the Government of Kenya for introducing *Prosopis* to Baringo District. Their claim was that *Prosopis juliflora*, known in Kenya as 'mathenge', or even as the 'devil tree', was introduced by recipients of the writ without an adequate assessment of potential future risks. Planted to control erosion and provide fuel and fodder, it rapidly escaped from cultivation and spread widely, creating thorny and impenetrable thickets with reduced grazing and access to water, and livestock feeding on the pods suffered health problems or even death. The Ilchamus claimed their very livelihoods were threatened and demanded compensation and total eradication of the tree. Owing to FAO's immunity status as a UN organisation where Kenya is a member, the court case continued against the government, and in 2006 a toothless goat was even brought to a Nairobi court house as evidence of the negative impact of *Prosopis*. Newspaper articles continue to appear regularly, and communities in other areas where *Prosopis* has invaded are also increasingly vocal, demanding its eradication. The government is considering whether to declare *Prosopis* a 'National Disaster', and wholesale clearing of stands by bulldozer, introducing biological control agents, and spending millions of Kenyan shillings in attempting to reduce *Prosopis* densities in ASALs (arid and semi-arid lands), where trees are needed most.

In contrast to this story, *Prosopis* species in their native ranges in Central and South America are known to provide valuable products and multiple benefits. It does not become weedy when properly managed, and provides local people in the Americas with essential raw materials for home use and for sale, sustaining and improving their livelihoods, especially during droughts. In the 1990s, researchers with experience in both the native and exotic ranges began to see this gap in knowledge, and from 1998, a group of them worked together on the first ever global collation of information on the species, the *Prosopis* 'Monograph' published in 2001, and related publications, funded by DFID. Selected information from this document was turned into country-specific policy briefs to inform those where it was considered a weed, that efforts were required on all levels to change the perception of this tree, and to take strides to improve its management and utilisation, to improve rural livelihoods *and* control existing invasions. One of these policy briefs was authored by Mr Choge of KEFRI and Mr Pasiecznik of HDRA (also lead author of the Monograph), and it made concrete suggestions as to changes in policy and practice that were required to begin to bring about such a change of perceptions in Kenya. This brief was published in January 2006.

Astounding advances have been made during 2006, even more remarkable considering the limited resources available. One year on, in December 2006, this report summarises what has been achieved in the past 12 months, and describes what further steps are being taken in 2007. In brief, new knowledge made available in the Monograph allowed advances built on two KEFRI managed projects in Baringo, a pilot supported by the FAO from July 2004 to August 2006, and a KOA (UK) funded project from December 2005 to December 2006. The latter clearly demonstrated that people were keen to make use of *Prosopis* products, but that major impacts on rural poverty and control of weedy invasion required the establishment and expansion of large markets for wood and pods amongst a number of other transformations regarding local capacity building, national policy and regional coordination. Work in this area has begun, the first orders have been made, networks are being established, and with more involvement of the private sector, great advances are expected in the coming years, much more so if support from international donors for capacity building and additional resources can be attracted.

In December 2006, people in Kenya are eating *Prosopis* pod flour, logs are being milled for timber, pods are being bought nationally and exported, and local businesses have started to show interest in creating markets. Where knowledge has been introduced and made meaningful, perceptions on *Prosopis* have changed, and the concepts summarised in the policy brief have already moved from being *potential* to being realised.

2. Promoting knowledge into use on *Prosopis* management

Before 2005, there was arguably no conscious management of *Prosopis* in Kenya at all. The first recorded plantation of *Prosopis* in Kenya was established in 1973, of *P. pallida* on the old Bamburi Cements Works near Mombasa. Seed of these trees were taken and seedlings planted at railway stations and other locations in the interior of the country where some can still be found. However, the dominant *Prosopis* in Kenya today is *P. juliflora*, which was planted widely as part of dryland reforestation schemes in the 1980s, supported by the FAO and funded by various aid agencies, such as FINNIDA (Finland) in Tana River and NORAD (Norway) in Turkana. It is *P. juliflora* that then escaped from cultivation and spread widely and rapidly, to become a major weed in seven districts; Baringo, Garissa, Mandera, Tana River, Taita Taveta, Turkana and Wajir. In fact, the local name for *Prosopis* in Turkana is "msumari wa norad", or "NORAD's nails", maybe the only common name of a plant that implicates an aid agency in its introduction.

Observations of *P. pallida* trees in Kenya are that they do not spread, due to very low pod production, although they are known as a high yielding species with very sweet pods in their native range. Further studies on the reason for this lack of fruiting are required. No other *Prosopis* species have been identified to date, even after nationwide collections. In Kenya today, *P. pallida* is estimated to account for less than 2% of the current *Prosopis* biomass, and as such, references to '*Prosopis*' in this report refer only to *P. juliflora* unless otherwise stated. As far as is known, no efforts were made to manage the first plantations. However, some different types of management were attempted, at least by Finnish researchers in Bura, and results were published, with data on growth rates, effects of irrigation, coppicing and regrowth, etc., which give an indication on annual increments. Naturalisation and invasion was observed before 1990 in some districts, and no further plantations were established after that date. No interventions were made, even though professionals from organisations involved in the original introductions must have seen invasions begin, and the actual and potential negative effects of their own research and development work, albeit with the best of intentions at the outset. National institutes were at that time unaware of the risks posed by 'alien invasive species', a subject that has only gained prominence in the last 5-10 years. So in the 1990s, *Prosopis* spread, aided by livestock and ignorance, with farmers and pastoralists standing by as this tree grew and spread, as sparse trees became impenetrable thickets, and as they began to appear in previously unaffected areas. This was a lack of management on an unprecedented scale. It has only very recently become apparent that these failures must be corrected, two decades since plantation establishment was in full swing, and management implemented that convert invasive weedy stands into productive agroforestry systems.

This has begun on a limited scale but to great success. Around Marigat and Salabani locations in Baringo District, KEFRI have managed a two year pilot project funded by the FAO on improved *Prosopis* management and utilisation, from 2004. Practically, there was one year of effective work on the ground which ended with a final field day and workshop in Marigat in August attended by senior government officials and representatives from UN agencies such as UNEP, FAO and others. Following the advice from the world-renowned *Prosopis* expert Dr Peter Felker, included in the DFID-funded monograph which he co-authored, strips in invaded stands were cleared completely leaving rows of trees that were high-pruned. Tree stumps were removed, or killed by burning. These cleared strips were then either sown with forage grasses such as *Cenchrus ciliaris*, or cultivated with rainfed crops. These permanent systems were experimented with by Farmer Field Schools comprising local people and a coordinator, and these provided a focal point where opinions could be exchanged and the system adapted. This system of extension appeared to be a successful mechanism for encouraging local communities to experiment with *Prosopis*.

In February 2006, HDRA/KEFRI training in the region provided a demonstration of *Prosopis* management on a single tree basis. This included: selecting trees to keep and those to remove, singling or high-pruning multi-stemmed shrubs and trees, removing seedlings, killing cut stumps, tools for pruning and clearing, and environmental benefits from thinning and pruning. These techniques are now being applied by trainees to trees around their own homes and fields. A follow-up visit to Salabani in November 2006 showed that these concepts have been taken up by the local community. Around many farmsteads, thinning and pruning is being carried out by individuals on their own land, leaving single-stemmed trees at wide spacing as had been recommended. The grounds of the local school have also been managed accordingly, showing that the knowledge had been successfully adapted and adopted. The same techniques were also demonstrated in two outreach demonstration courses in Garissa and Bura, also to much interest. It is recommended that such demonstrations now be taken nationwide, and to more remote villages in each district.

3. Promoting knowledge into use on *Prosopis* utilisation

3.1. Timber

Training and awareness-raising on timber processing used the simplest mechanical means available: the chainsaw. Activities were undertaken in Baringo in February and November, and Garissa and Bura in November, 2006. The use of simple guides or attachments fixed to the chainsaw bar differentiates chainsaw milling from the more widespread but more dangerous method of 'freehand' milling. The first training course formed part of the DFID-FRP project R8510, 'the potential of chainsaw milling for improving rural livelihoods', using *Prosopis juliflora* in Marigat, with another course undertaken in Meru using *Grevillea robusta.* Detailed reports of both courses and all project outputs are available on the project website (http://chainsaw.gwork.org). A full economic study was also undertaken comparing the economics of chainsaw milling over the nearest alternative systems using (circular) bench saws, and a draft report and spreadsheet allowing users to enter their own data are also both available on the website (see also the bibliography). This spreadsheet is currently being adapted using additional data collected by Mr Muthike of KEFRI, in order to calculate more accurate data for break-even values for local and export markets.

The training and demonstration courses were very well-received, with the most common question being 'where can I buy one' (referring to the milling attachments). Prior to this, there had been only one attempt to mill *Prosopis*, with a local landowner purchasing logs at Ksh 300 each and taking them 100 km to Nakuru to the nearest sawmill where he could produce outdoor decking for his house. However, the sawmills were not accustomed to the hardness of the timber, and cost of transport was prohibitively high. In contrast, this new approach, with low capital investment, low operational costs, and 'turning trees to timber' on the spot where they fall, allowed a completely novel concept of timber processing.

DFID supplied a large Stihl MS660 chainsaw, Blount and Windsor kindly donated safety clothing, maintenance tools and a range of spare parts, and KOA supplied four chainsaw mills, a Beam Machine, and Granberg's Mark III, Small Log Attachment and MiniMill II. These were left with the coordinating KEFRI field station in Marigat, and have been well used during the year. Mr Muthike of KEFRI has been to Marigat several times to continue training, and the mills were used at a KEFRI open day in Nairobi in March and for the August field day in Salabani. Mr Wilson Sauroki, a chainsaw operator from Salabani, also demonstrated the chainsaw mills in Garissa and Bura in November, as well as showing his freehand skills. In the latter demonstration, local carpenters' jaws were seen to drop as they saw the potential of this. Mr Johnson Mburu of Bura currently buys his timber from Garissa, 100 km away, and this cost is a significant part of his running costs. He estimated, for example, that the nine 3 ft lengths of 2x2 in (90 cm by 5x5 cm) that Mr Sauroki produced from a short *Prosopis* log in 15 minutes had a market value of Ksh 1000 (US$15), and he stated that he would now find a chainsaw operator to start converting *Prosopis* trees and use this local timber for making furniture.

A further strand to developing the use of *Prosopis* timber was added in November 2006, following numerous requests from Baringo in February for training in turning the sawn boards into finished products. Mr Pasiecznik brought his 'workshop in a suitcase', comprising the tools he commonly uses to produce finished products. These were four hand-held power tools; a planer, belt sander, jigsaw and drill, a hand saw and selection of spare blades, drill bits, sandpaper, etc. These were demonstrated in Garissa and Bura to amazement, as with the exception of the drill, the power tools had never been seen by the participants before. Here, people were exposed to 'turning trees to timber' and 'turning timber to traded products', the transformation of a *Prosopis* log into finished parquet tiles and craft items in the same afternoon. This was taken one stage further at a carpenter's workshop in Marigat, with a continuous production line set up, where logs were milled and the boards processed into finished items, producing a wide range of products, from chapatti boards and stools, to parquet flooring tiles and shaped craft items for the tourist market, such as wooden Africa and Kenya shaped wall hangings, animal shaped chopping boards, etc.

In November, a telephone survey of Nairobi-based timber companies indicated that the prices for finished hardwood tongue-and-grooved hardwood parquet flooring at Ksh 600-1200 (US$9-18) per square metre, made potential supplies from *Prosopis* very attractive. More work is required to produce quality finished samples and begin a serious campaign to attract the interest of these and similar companies in Kenya. A UK marketing survey by Ms Bakewell-Stone (see bibliography) also identified a number of potential importers

of *Prosopis* timber products which can be taken forward when a consistent supply is forthcoming. KEFRI are to further test local markets by preparing samples, calculating returns, and arranging the first *Prosopis* timber stakeholder meeting in early 2007.

The original *Prosopis* plantations established in Kenya are now 16-20 years old, and these are now ready for exploitation as a timber. In Bura, a local forester, Mr Alfred Ngonyo, who worked with FINNIDA in establishing 1500 ha of *Prosopis* in the late 1980s, now says that most of these trees have trunks with diameters over 40 cm, thus giving mean annual diameter increments in excess of 2 cm/yr. At 2 x 4 m spacing, and with a utilisable bole of 40 cm over bark diameter and 1.5 m in length, there would be an estimated standing timber volume of 250 m^3/ha. Taking a very low conversion rate of only 20% recovery, guaranteeing that all sapwood would be removed, this gives a potential 50 m^3/ha of sawn timber, or 75,000 m^3 in just this one single plantation.

Although accurate data for the area of plantations established in the 1980s is not available for the country as a whole, a conservative estimate of 15 times that for the Bura plantation would give a total area of mature stands of 22,500 ha, which could yield over one million cubic metres of sawn timber. This would make a significant impact on Kenya's timber balance, and this does not take into account timber from naturalised stands which are also known to contain very large standing volumes with diameters in excess of 40 cm. Growth rates are also high. This indicates to potential buyers of *Prosopis* timber for parquet flooring or other uses that adequate supplies exist and are inexhaustible at least in the near future.

Although such exploitation would begin with low levels, as experience, technologies and markets would need to develop, it is clear that the supply of *Prosopis* timber is not in doubt, and improved management leading to the production of longer and straighter stems, thus improving recovery, can only benefit the situation. The appropriate technology of chainsaw milling for converting *Prosopis* logs to sawn timber in remote areas has been tested in 2006, and the economics have been assessed and compared with tractor bench saws, and comparisons with other mobile sawmills is in progress. In areas such as drylands that have no history of timber exploitation, there is a distinct lack of appropriate processing skills, and any training and development must appreciate this if it is to succeed. Risks in drylands are often so high and returns so low as to severely limit investment, and high value timber has been identified as the one product that has the potential to realise significant profits and livelihood improvements.

3.2. Posts and poles

Prosopis continues to meet an import need for local rural construction through the provision of poles for rustic rural structures, although the sapwood is easily and quickly attacked by insects. A recent development has been the contracting of the Forestry Department to provide long, thin, flexible sticks of *Prosopis* for making the framework of simple structures for Somali refugees in Garissa District.

For use as fence posts, some anecdotal reports note that they are resistant to decay for at least for two years, whilst others note infestation with wood borers. A study was completed this year (Chepkwony JC. 2006, BSc thesis, Moi University, Nairobi, Kenya) which found that *Prosopis* heartwood was unsuitable for pressure treatment with a timber treatment agent, with only minimal uptake in the wood. Further studies are being considered by KEFRI, using water soaking or heat-treatments to reduce immediate attack. Amerindians used to reduce insect attack by only harvesting on a waning moon, which may reduce sugar content in the sapwood, and this technique could also be tested in any future trials.

3.3. Firewood and charcoal

Prosopis has been seen as a saviour for many dryland households. Views commonly held by many people in Marigat or Bura are that before the 1980s, the land was bare, dust storms were commonplace, and women had to walk long distances in search of firewood. With the spread of *Prosopis*, firewood is now easily accessible and in plentiful supply, and the dust storms have ceased completely. The government is starting to realise the exploitation of invasive stands as a means to control weedy invasions while also providing much needed firewood for Somali refugees, while also reducing conflict with local people over collection of firewood. There are an estimated 140,000 refugees in camps around Garissa town, and the UNHCR has very recently contracted the Forestry Department to supply them with 500 tonnes of firewood. Similar schemes

could provide valuable sources of firewood to Sudanese and Somali refugees in camps in northern and north-eastern Kenya, while also providing much needed local employment, revenue for the state and help to control the spread of *Prosopis* on government land.

Prosopis charcoal is widely acknowledged to be of high quality, and is more popular than that from other trees according to a recent KEFRI survey. However, Kenyan government policy is that the production and transport of charcoal is illegal unless a license has been applied for and approved. This law was introduced in an attempt to stop the cutting of natural forests for charcoal, seen in earlier decades as one of the main causes of deforestation. However, changing this law alone is identified as the one single most important means of promoting *Prosopis* exploitation, as charcoal is widely and commonly used in rural and even in urban areas. This was clearly stated in the policy brief and may have already led to some change in the perception of the issue, supported by continuous lobbying from KEFRI and other groups. The Ministry of Environment and Natural Resources has now submitted a Cabinet Memorandum for discussion by parliament, with a request for an immediate but restricted lifting of the ban, to allow the production and sale of charcoal from *Prosopis* areas, i.e. where *Prosopis* is causing problems through its invasiveness.

In two cases, this ban was lifted on a special trial basis. Around Garissa, 240 ha of government land infested with *Prosopis* was leased via the Forestry Department with permission to exploit and sell charcoal. Mr Abdi Zeila of ICRAF managed this two year project, due to end at the beginning of 2007. The use of improved 'Casamance kilns' was promising, with up to 49% recovery in three days. Land was cleared but stumps were left, and were only removed when incentives were provided, such as the provision of seedlings of improved mango varieties. The biggest success of the project was in starting-up trade, but the project failed to establish and develop a solid market for charcoal in the district. The price for charcoal is Ksh 120-140 (c. US$2) per 25 kg bag.

In Baringo, a similar scheme was established as part of the FAO pilot project. However, there was little uptake of charcoal making in the area, generally believed to be because the local people are pastoralists and would not change the activities of their ancestry. Thus, although some entrepreneurs have began to produce and sell charcoal and have witnessed an improvement in their livelihood, this is making an insignificant impact on *Prosopis* invasions. There may be scope for leasing government land in the region to people from outside the area in an attempt to reduce tree density. As in India, however, removal of the roots *must* be a stipulation of any leasing agreement with charcoal makers, or otherwise resprouting will lead to tree densities equal or worse than before, within only a year after cutting.

3.4. Pods as a human food

For local consumption and markets

By the end of January 2006, no Kenyan had *ever* produced and consumed food using milled *Prosopis* pod flour. The only way pods had been consumed was by being occasionally sucked and chewed by children. This has changed in 2006 in areas where the project has worked, though further training, demonstration and extension is still needed, also developing and adapting methods for reducing risks of negative health effects.

During the training course run in Marigat, Baringo in February 2006, a strong demand was shown by local beneficiaries for experience in food uses. Mr Pasiecznik began by asking what foods were most commonly made using flour, from whatever grain. Maize and wheat flour were most commonly used, occasionally millet flour. Wheat flour was used for chapatis, pancakes, mandazi and cakes, and maize flour for the traditional ugali and uji. For mandazi, participants noted, a proportion of the wheat flour could be substituted with maize flour, being cheaper, to reduce the cost with no real effect on taste. This was used as an example of how *Prosopis* flour could and should be used, as a low cost and nutritious substitute for up to one fifth of the flour in any of the previous described foods. A large sack of flour had already been prepared using a tractor powered hammer mill given as part of the FAO project. The participants, however, felt this flour was too coarse, and it was then sent to a 'Posho mill', a type of mill found in every village, privately-owned for hire, to mill locally purchased grains. That pods need to be milled not just to release the protein in the seed, but also to prevent further spread of the seeds as a weed, was very much a new concept to the participants, and this knowledge may have large impacts as the tree and pods are adaptively managed in the future.

The participants were very nervous in the beginning, though Mr Pasiecznik noted confidently that it was used widely at up to 20%, one part *Prosopis* to four parts any other flour. The participants, who were mainly women, then tried a chapati mix with wheat flour, but found that it did not bind well, blaming this on the coarseness of the flour. The *Prosopis* pod flour was then passed through a fine sieve, and this was found to be acceptable. Chapati dough was made, rolled out and fried, and tasted tentatively by all present. "It's nice" was the general if somewhat surprised response. The group then went into production with minimal trainer input, making chapatis at different mix ratios, pancakes, mandazi, ugali, uji and cake, and they were entirely proactive in the new recipes.

Many other parallel activities took place that afternoon. One participant experimented with ways of destroying the seed by hand using a heavy flat-ended stick against the floor, another roasted some of the flour to make a form of coffee substitute, and one gave milled flour to passing goats and cattle unsure at first whether they would eat it. A pestle and mortar was used to grind some dry pods by hand, and sieved to make 'home-made' flour without the need for a tractor powered hammer mill. However, the seeds and their capsules had to be separated and discarded so the flour was derived only from the mesocarp, and was rather bitter and disliked by the participants, all preferring the flour from the whole milled pods.

A *Prosopis* cake was 'officially' cut and shared at the end of the day. Participants discussed the results of what they had made, confirming that the best ratio was 20% *Prosopis* flour. They then discussed how to best take this knowledge forward, by making *Prosopis* foods for weddings, church gatherings and women's group meetings, holding special women's workshops, and producing pamphlets and having a project open day. Some flour was also taken to the local Soi Safari Hotel; the head chef did not believe it was edible but made breakfast pancakes for all the guests the following morning, which were very well received.

Trained women then practiced further, and made a range of foods similar to those made in the Baringo training, but for the KEFRI open day in March, which were very well received. This was repeated during the field day in Salabani in August, where even the Permanent Secretary of the Ministry of the Environment and Natural Resources and other governments officials tasted and appreciated the *Prosopis* food. Two women from Marigat and Salabani also came to the first outreach training days in November, making *Prosopis* chapatis, mandazis and cakes for the participants in Garissa and Bura, to total amazement. One participant, a pastor, said this was like "manna from heaven", that "people wander hungry in the desert but the Lord has given them food to eat, just that until today they and I did not know we could eat it. I will spread the word." The 'recipe book' produced after the Baringo training (see bibliography) was in great demand and more copies are to be made and distributed. More outreach and training is needed, but a huge watershed has been safely crossed this year. Taking this to the more drought-hit districts of Turkana, Mandera and Wajir is clearly now a very high priority, and this is to start during government-funded work by KEFRI in early 2007.

For export

For the first time ever, 2006 saw the export of *Prosopis* products from Kenya. Through KEFRI, a deal was brokered with a South African company, Dune Foods, which manufactures dietary products. The company was aware of the value of *Prosopis* pods as a component of dietary food products. However, pods from invasive *Prosopis* in South Africa were unsuitable for their needs, because seed-feeding beetles which were introduced as biological control agents in the late 1980s, although not having had a significant affect on spread, still infest a large number of pods thus rendering them unsuitable for use as a human food. This also suggests that promotion of biological control may actually be detrimental to the use of *Prosopis* as an income generator by beneficiaries, which should be considered before release. The first order of 15 tonnes was placed in July and shipped in a container in August, as whole sun-dried pods in sacks. A second order of 40 tonnes was placed in November, though for this, it was requested that pods are to be broken or undergo primary course milling in order to reduce the volume, thus allowing a container to carry 40 t, and not 15 t for whole pods. It was also requested that the pods are sealed in plastic bags to prevent the dried pods from rehydrating in transit as they are very hygroscopic.

In December 2006, a meeting was held with the manager of Gourmet Gardens, a Kampala-based company producing, processing and selling organically certified food products, largely fruit and vegetables for the local market, and dried fruit and vanilla for export. The manager had visited Baringo before and appreciated the taste of *Prosopis* flour and its potential for sale in Europe. He noted a demand for novel tastes and

products, with at least one potential buyer identified, and will present samples at the BIOFACH organic trade fair in Nuremberg in February 2007. Mr Choge of KEFRI will supply the samples, and consultant Mr Fehr will report back on the demand for the flour and conditions for placing an initial order. In addition, Ms Bakewell-Stone will attend the East African Organic Standards meeting in Nairobi in December, and will enquire as to the suitability of *Prosopis* communal lands for certification under the Wild Harvesting standard.

Food quality and safety

The following table gives the nutritional analysis of *Prosopis* whole pod flour from Baringo, carried out by Leatherhead Food International, Surrey, UK in June 2006. This generally confirms pod composition as detailed in the many papers sourced during the preparation of the Monograph (Table 26, page 86). It is now clear that the low protein content contents for *P. pallida* samples from Peru listed in the Monograph are due not to species differences, but that only the mesocarp (without seeds) and not the whole pod was tested.

Component	Value 100 g^{-1} dry matter		Component	Value 100 g^{-1} dry matter	
Protein (g)		16.2	Energy value (kJ)		1530
Total sugars (g)		13.0	Dietary fibre (g)		47.8
Sucrose (g)	7.5		Fat (g)		2.12
Fructose (g)	3.2		Monosaturated fatty acids (g)	0.40	
Glucose (g)	0.8		Polyunsaturated fatty acids (g)	1.06	
Galactose (g)	0.8		Saturated fatty acids (g)	0.56	
Lactose (g)	0.7		Sodium (mg)		20
Maltose (g)	0.3		Ash (g)		6.0
Carbohydrates (g)		69.2	Total solids (g)		93.5

Food safety is an important issue, and tests on food quality identified levels of mycotoxins with potential negative effects on human health. The level of ochratoxin A was 38 ppb, total aflotoxins 5.8 ppb and aflatoxin B1 4.7 ppb. The levels of total aflatoxin and aflatoxin B1 exceed the stringent EU maximum levels for cereals of 5 and 3 ppb, respectively, but not the maximum levels adopted in the USA (10 ppb), Brazil (20 ppb) or India (30 ppb). The ochratoxin A level in *Prosopis* flour exceeded the maximum level of 5 ppb that has been proposed as an international standard by CODEX for wheat, barley, rye and derived products, though this standard was opposed by some countries who argued for a maximum level of 20 ppb.

However, only one Kenyan *Prosopis* flour sample has been analysed so far and this had been produced from pods harvested in the wild and stored for several months. Levels of ochratoxin A far higher than the levels found in the Kenyan sample are occasionally found, such as in European grain samples, when harvest, drying and storage conditions favour fungal growth and toxin production. Similarly, significant levels of aflatoxin in common food products have been routinely reported in Africa, and in Uganda 30% of common food samples analysed tested positive for aflatoxin and approximately 12% exceeded 100 ppm total aflatoxin (Choge et al., 2006, see bibliography). Nevertheless, the results are of sufficient concern to warrant further studies on freshly harvested pods from trees and the ground, and after various drying methods and periods of storage, and to develop appropriate harvesting and storage methods and guidelines.

Traditional and improved storage and handling methods used in South America give an indication of appropriate methods. Traditional pod stores in North America consisted of large baskets made from natural fibres with a rain-proof roof which were raised off the ground to prevent predation and to keep pods dry. In Brazil, standard agricultural barns are used for storing or special rooms with wooden floors and walls. In Peru, rustic rooms made from mud bricks were used, now largely replaced with block built buildings, often 5 x 5 m x 4 m high and capable of storing 40 tonnes of pods, and once filled they are sealed with clay and opened only when the whole batch is to be sold or used. A recent literature review also found that soil serves as a reservoir for aflotoxin-producing fungi such as *Aspergillus flavus*, and as all the traditional techniques above avoid contact with soil, so sun-drying on the ground as practiced in Baringo may promote infection. Thus, sun-drying on tin roofs or concrete is now recommended, of pods collected directly from trees or freshly fallen, with all damaged pods discarded.

3.5. Pods as livestock feed

There were limited advances in early 2006 to promote the collection and milling of pods for animal feeds, with a concentration of project activities on human food uses and timber processing. However, the importance of the prevention of livestock health problems and reducing further invasion was clearly explained during the February training. It appears that local collection and milling for zero grazing does not comply well with traditional extensive grazing of livestock by pastoral groups, who are unwilling to collect and mill what they see as a forage and not a fodder.

During 2006, Dr Sere, Director General if ILRI (the International Livestock Research Institute), based in Nairobi, contacted the project coordinator for further information on *Prosopis*. An exchange of information led to the arrangement of an initial meeting on 21 November, also attended by Mr Matere of ILRI and Mr Choge and Mr Muthike of KEFRI. All accepted the importance of managing *Prosopis*, and the innovative approach being developed was applauded, with ILRI agreeing to facilitate the linking of livestock feed companies with the project. Dr Sere requested Mr Matere to organise such a meeting, which was held on 5 December.

In summary, the first trial order 8 t of *Prosopis* pods was made on the spot, to be delivered before Christmas, with Ksh 3/kg paid directly to the collector, or £24/t to the local communities, especially women, for a resource that previously had no financial value whatsoever. Representatives from other companies also expressed a strong interest in this potential new source of protein, sugar and fibres in their feed mixtures. One stated that dependent on final confirmation from their own chemical analyses, they would consider placing an order of at least 200 t per month. They had never previously considered *Prosopis* pods as suitable, in part due to the negative coverage in the press, thinking that they were harmful to livestock health. A further and larger stakeholder meeting is planned for February 2007, and a literature review is being prepared in time for this. Arising out of that meeting, a request has also been made to the project coordinator from a UK-based feed miller interested in the possibility of using *Prosopis* pods. This company requires more information on the amino acid contents, as they specialise in supplying micro-nutrients to the livestock feed industry, and the levels reported from *Prosopis* pod flour appear to merit further attention. Flour samples are being sent for further testing.

It appears that a certain constraint to development, that of lack of knowledge, has now been overcome, and the very large quantities required by feed millers could make enormous impacts both on rural livelihoods via payments for pod collection, and to the environment, via the millions of seeds removed and destroyed. With a demand for 300 t/month as appears possible from the meeting described above, or 36,000/t/yr, this would put £86,400 into some of the most marginal communities in Kenya every year, and remove at least 70 billion seeds, quite staggering numbers, that would surely have a significant impact on rural livelihoods and on reducing future spread of *Prosopis* as an invasive weed.

3.6. Other products

Honey is made in *Prosopis*-invaded areas, though no figures exist as to levels of production and impacts on livelihoods. A workshop in Uganda reported in a recent issue of the Bees For Development newsletter indicated that local markets are the most important and expanding, but export markets especially in Europe demanded ethical goods, i.e. organic or fairly traded honey. The possibility of producing, marketing and exporting organic *Prosopis* honey could be considered during project developments in Kenya, especially when assessing the potential for organically certifying communal *Prosopis* stands, thus having another organic export product alongside pods, for the European market.

No use of exudate gums, tannins or fibres have been recorded in Kenya. However, it was reported that bark is removed and used for roofing houses, especially where or when grasses and reeds are in short supply. However, the first use of *Prosopis* in ethnomedicine in Kenya was recorded in November. Some people in Baringo had observed the disinfectant effects of leaf extracts, as they do contain significant amounts of antifungal and antibacterial chemicals. They are used by gathering a handful of fresh green leaves, which are then squeezed and rubbed over scratches and other wounds. This was then demonstrated in November in Garissa, Bura, Marigat and Kampi ya Samaki, especially when people repeated the common ‘myth’ that thorns are poisonous (they are not, it is just a case of secondary infection).

4. Promoting knowledge into use on *Prosopis* marketing

4.1. Marketing within Kenya

Prior to 2006, there had been no, or negligible, legal trade in *Prosopis* products, with the exception of the limited sale of charcoal and firewood from specially licensed plots of community land, leased by the government on a trial basis around Garissa and Marigat (see section 3.3, Firewood and charcoal). It is hoped that the restricted lifting of the ban on trade in *Prosopis* charcoal will allow its 'branding', and allow it to pass police checkpoints unhindered, for sale to the large markets in Nairobi and Kisumu for example. Several charcoal dealers had come to Salabani in November, keen to buy such branded charcoal, with the possibility of good profits. However, production from the villages in Baringo is still insufficient to begin such a trade.

The only 'marketing' being carried out was by researchers from KEFRI and HDRA, who were attempting to promote the use of *Prosopis* products as a means to improve rural livelihoods and reduce invasion. In the project workshops in Marigat in February, in Nairobi in March, the field day in Salabani in August, and outreach courses in Garissa, Bura, Marigat and Kampi ya Samaki in November, products were displayed, along with processing techniques and other appropriate technologies. Interest has developed slowly, but in only a year there are already success stories. By November, six timber companies contacted in Nairobi were interested in seeing wood samples. A meeting with representatives from several livestock feed manufacturers saw the first national order, for 8 tonnes of pods to be delivered before Christmas, the 'deal' being brokered by participatory action researchers. Clearly, these researchers are here playing an important but temporary role acting as unpaid brokers or middlemen between the owners, collectors and/or processors of *Prosopis* products, and the buyers. The medium-term aim is for rural communities to form local cooperatives to organise their own collection, processing and marketing, and for companies to strike arrangements with communities for resource access. Relating to this, such cooperatives require training in business management, including the setting of their own terms and conditions to ensure equitable trading relationships, and to protect the most vulnerable from exploitation.

4.2. Marketing internationally

Identifying the product for export purposes requires a brand name for marketing *Prosopis* products. '*Prosopis*' itself is difficult to remember and spell. In Kenya, 'mathenge' is the local name, which would impart an immediate recognition of the tree itself. This name has no negative meaning *per se*, in contrast to common names for *Prosopis* in many other countries where it has been introduced and invaded, such as 'vilayati babul' (foreign thorn) in India, 'dakkar toubab' (white man's thorn) in Senegal, and 'gaudi maaka' (bastard thorn) in Niger. The name mathenge is thought to have originated from Tana River District, being the family name of a man who was one of the first to have planted it around his compound near Bura. The children liked the sweet taste of the pods but he would chase them away, and it was the children who would dare each other to go and steal some, and the name of the man and the name of the tree soon became synonymous. However, as perceptions of the tree are so negative it maybe wise not to choose this name for advertising.

In many English speaking countries, 'mesquite' is a popular common name for several *Prosopis* species. This is the common name in the USA, and derives from the Mexican Indian words 'misquitl' or 'mezquite', meaning 'good wood' or 'bark that tans'. 'Mesquite' is already used widely to market *Prosopis* products in North America, such as flooring, furniture and crafts, barbeque chips and pod flour. Thus, the same name could be used nationally and internationally, avoiding confusion, with the origin added to identify uniqueness, e.g. 'Kenyan mesquite', or more specifically, 'Rift Valley mesquite' or 'Lake Baringo mesquite'. Other suggestions include the 'devil tree', being a local name and which attracts attention, or 'sweet thorn' describing the nature of the tree and denoting the sweetness of the pods, and such names could be also used with similar location-specific descriptors. Even without an agreed 'brand name', marketing internationally has been going on in the same way as has marketing within Kenya, i.e. carried out by the researchers themselves. It was a personal contact between Mr Choge and Mr Coetzee of Dune Foods, South Africa that led directly to the first export of pods, and businesses have also clearly taken up the role, by informing colleagues and associates of this new and potentially profitable raw material.

5. Going forward - intentions and potentials for 2007 and beyond

KEFRI has received funding of Ksh 3,000,000 (£24,000) to continue outreach training and demonstrations until June 2007, and aim to establish Farmer Field Schools in Turkana, Garissa and Tana River districts. The FAO stand management demonstrations and the KOA/HDRA processing and utilisation project and outcomes are to be used as models, and trainees from Baringo will continue their valuable roles as outreach trainers. The Government of Kenya may continue to fund similar work after June 2007, though nothing can be confirmed at present. Nonetheless, this work is providing valuable further experience, and is allowing the pioneering initiatives to be adapted and adopted elsewhere in the country.

Until June 2007, Mr Choge of KEFRI will continue marketing efforts within Kenya, and will arrange the supply of orders already received both from inside and outside the country. A second stakeholder meeting is to be organised for February, where *Prosopis* pods as a livestock feed component will be further promoted, and it is hoped, significant orders will be placed. Mr Pasiecznik is also to work on a support paper detailing global experiences on uses as a livestock feed in time for this meeting. A similar meeting is to be arranged with potential buyers of *Prosopis* timber.

Ms Bakewell-Stone will assess the possibilities for organic group certification of communal *Prosopis* woodlands under the Wild Harvesting standard during the East African Organic Certification Standards meeting in Nairobi in December 2006, and Mr Fehr is to present samples of *Prosopis* pod flour at the BIOFACH trade fair in Nuremberg in February 2007.

This report has also been attached as an annex to the proposal 'proforma' submitted to DFID for consideration under the new Research Into Use Programme (RIUP). It is hoped that DFID will support the scaling up of the approaches used in this work on *Prosopis* for the evident benefit of the rural poor in the drylands of Kenya and East Africa, as well as potential benefits to others elsewhere in dryland Africa and Asia, and pan-tropically wherever *Prosopis* is present.

6. Bibliography - selected publications from 2006

Bakewell-Stone P. 2006. Marketing of *Prosopis* products in the UK. Feasibility report. October 2006. HDRA, Coventry, UK. 36p.

Choge S, Pasiecznik NM. 2006. The challenges of eradicating *Prosopis* in Kenya. Policy brief. HDRA, Coventry, UK. 2pp. http://www.gardenorganic.org.uk/pdfs/international_programme/*Prosopis*KenyaBrief.pdf

Choge SK, Harvey M, Chesang S, Pasiecznik NM. 2006. Cooking with *Prosopis* flour. Recipes tried and tested in Baringo District, Kenya. KEFRI, Nairobi, Kenya and HDRA, Coventry, UK. 6p.

Choge SK, Pasiecznik NM, Harvey M, Wright J, Awan SZ, Harris PJC. 2006. *Prosopis* pods as a human food in Kenya. In: Symposium on Nutritional Value and Water use of Indigenous Crops for Improved Livelihoods, 19-20 September 2006, The Centre for Nutrition, University of Pretoria; Pretoria, South Africa.

Choge SK, Odee D, Okeyo M. 2006, Management and control of *Prosopis* species in Baringo District of Kenya. Pilot project terminal technical report. FAO TCP/KEN/3002. KEFRI, Nairobi, Kenya. 18pp.

Landeras G, Alfonso M, Pasiecznik NM, Harris PJC, Ramírez L. 2006. Identification of *Prosopis juliflora* (Sw.) DC. and *P. pallida* (H. & B. ex. Willd.) H.B.K. using molecular markers. Biodiversity and Conservation, 15: 1829-1844. http://www.unavarra.es/genmic/publicaciones/bc2005.pdf

Pasiecznik NM. 2006. Chainsaw milling – improving timber production and rural livelihoods on farms and in drylands. Policy brief. HDRA, Coventry, UK. 2pp. http://chainsaw.gwork.org/

Pasiecznik NM. 2006. Limits to *Prosopis* biocontrol: utilization and traditional knowledge could fill the gap. Biocontrol News and Information, 27 (1): 5N-6N. www.pestscience.com/PDF/GN2701.pdf

Pasiecznik NM. 2006. Inter-African trade in illegal timber – an overlooked cause of deforestation? Bois et Forêts des Tropiques, 290 (4): 93-95.

Pasiecznik NM. 2006. The potential of chainsaw milling outside forests. The Overstory, 171. Permanent Agricultural Resources, Hawaii, USA. www.agroforestry.net/pubs/Chainsawmilling.pdf

Pasiecznik NM, Choge SK. 2006. Turning trees to timber: a chainsaw demonstration/training course. Baringo, Kenya, February 2006. HDRA and KEFRI, Nairobi, Kenya. 12pp. http://chainsaw.gwork.org/

Pasiecznik NM, Felker P. 2006. Safeguarding valued Old World native *Prosopis* species from biocontrol introductions. Biocontrol News and Information, 27 (1): 3N-4N. www.pestscience.com/PDF/GN2701.pdf

Pasiecznik NM, Harris PJC. 2006. *Prosopis juliflora* and related arboreal species: a monograph, extension manual and database. Final Technical Report – Supplemental, incorporating *Prosopis* policy briefs: series 1 and 2, and the Field Guide. Internal report to DFID-FRP. Project R7295. HDRA, Coventry, UK. 12pp.

Pasiecznik NM, Samuel JH. 2006. The future of powersaw splitting (chainsaw milling) in Kenya. Policy brief. HDRA, Coventry, UK. 2pp. http://chainsaw.gwork.org/

Pasiecznik NM, Fehr C, Samuel JH. 2006. The Potential of Chainsaw Milling Outside Forests. Summary report with economic and policy case studies from East Africa. HDRA, Coventry, UK. 60pp. http://chainsaw.gwork.org/ (draft)

Pasiecznik NM, Brewer MCM, Fehr C, Samuel JH, 2006. Turning Trees to Timber. A Chainsaw Milling Manual. HDRA, Coventry, UK. 40pp. http://chainsaw.gwork.org/

Pasiecznik NM, Harris PJC, Trenchard EJ, Smith SJ. 2006. Implications of uncertain *Prosopis* taxonomy for biocontrol. Biocontrol News and Information, 27 (1): 1N-2N. www.pestscience.com/PDF/GN2701.pdf

Pasiecznik NM, Ould Mohamed Ali A, Nourissier-Mountou S, Danthu P, Murch J, McHugh MJ, Harris PJC. 2006. Discovery of a life history shift: precocious flowering in an introduced population of *Prosopis*. Biological Invasions, 8 (8): 1561-1568.