



Searching for socio-ecological approaches to increase *Balanites* trees through local small-scale conservation in the conservancies adjoining the Maasai Mara, Kenya

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Abstract

On the edges of the Maasai Mara in western Kenya there are 15 conservancies, where herds of wildlife, cattle, sheep, goats, and predators are found with *Balanites aegyptiaca*, an iconic and much-photographed tree known by many names, such as desert date, or more simply, Balanites. Most individuals are 80–90 years old, yet the tree has a life-expectancy of about 120 years. Lack of young trees is due to grazing and browsing impacts from sheep and goat herding that began about eighty years ago. Protecting young naturally regenerated trees is difficult as they are also grazed by large herbivores such as elephants and giraffe. In this perspective essay we describe botanical and social approaches to enable small-scale conservation in a remote area where no work on Balanites revegetation has been done previously. There are two core approaches. First, collecting seed from both superior mother trees and more widely to achieve a source of genetic diversity and second, to work with landowners and other locals on methods to protect new saplings from sheep and goats. These avenues of action in this poor rural area will set the stage for further practical research and assessment of methods to improve the regional survival of *Balanites*.

Keywords *Balanites* · Desert date · Maasai Mara · Small-scale conservation · Socio-ecological practice · Grazing and browsing impacts

1 Background

The Greater Mara Ecosystem, in south-western Kenya, and its neighbour in Tanzania, the Serengeti Plains, together make up one of the most famous centres for large animal migration and grazing in the world. Though only one degree south of the Equator, the region is at an elevation of between 1500 and 2000 m and has a sub-tropical temperate climate, with two rainy seasons, one in November to December and a longer rainy season from March to May. Fauna include elephant, wildebeest, buffalo, giraffe, zebra, and hippopotamus, with predators of lion, leopard, and cheetah. The Maasai Mara National Reserve (MMNR) is a gazetted region for

animal conservation. The Greater Mara Ecosystem is made up of the MMNR and a growing number of conservancies that adjoin it (Fig. 1). The current fifteen conservancies are Enonkishu, Lemek, Mara Naboisho, Mara North, Nashulai, Olare Motorogi, Olarro North and Olarro South, Olchorro Oirowua, Ol Kinyei, Oloisukut, Pardamat, and Siana (Maasai Mara Wildlife Conservancies Association 2023).

Conservancies were commenced in 1992 in response to concerns about the pressures on the Mara from competing interests that include massive tourism and traditional grazing; conservancies sponsor low-impact tourism with fewer camps, fewer vehicles, fewer tourists, and there is no displacement of villagers or their livestock. Good links are required across both reserved land such as the Maasai Mara and private lands such as the conservancies for migration routes and sustenance of populations of herbivores and others (Gigliotti et al. 2022). The ambition in the conservancies of combining good tourist management with a continuation of the life of Maasai herding has been described as “difficult conservation” (Pye 2015), with complex economic and ecological problems (Bodasing 2021).

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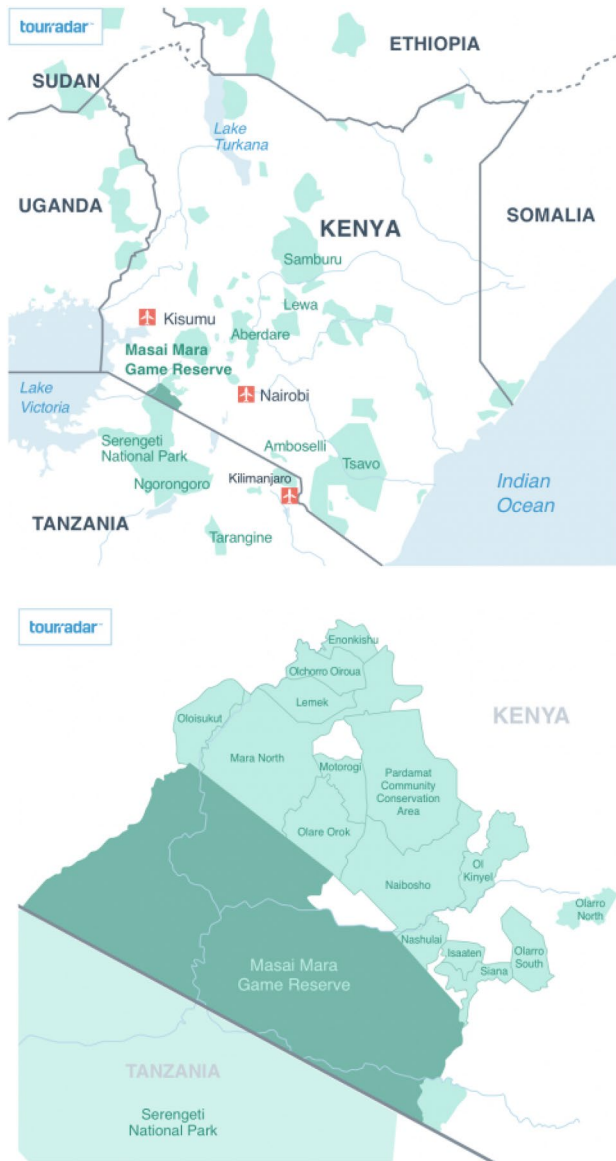


Fig. 1 Map of Kenya (above) and its wider region in east Africa, with the Maasai Mara National Reserve in dark green in south-western Kenya, and (below) detail of the Mara and adjoining conservancies. Images: <https://www.tourradar.com/sg/masai-mara-map>

The region, Narok County, is several hours from Nairobi and the Mara is at the end of dirt roads; many tourists fly in to see the wildlife. The population is 91% rural or semi-rural (Kenya Narok Data 2019), with 46% literacy for men and 34% literacy for women (Kenya Bureau of Statistics 2007). That a well-educated headmaster earns about \$US150 per month and a herder far less shows the low finances available for local endeavours and the pressure to make money from herding in this region, which can produce conflict with conservation efforts. Nearly 50% of the population are under the age of fifteen. Currently,



Fig. 2 *Balanites aegyptiaca* in Enonkishu Conservancy, south-western Kenya. No juvenile trees are to be found. Image: M. Grose 2018

only 0.4% attain a university education and less than 10% a secondary education (Shikuku and Hassan 2021).

With the vulnerability of the large animals of the Mara, it might be thought that pressures upon them and concerns about their populations would be of sole concern to local Maasai. However, a great concern for local people, currently unreported, is the population structure of *Balanites*, an iconic tree of the region (Fig. 2). *Balanites aegyptiaca* (L.) Delile is a tall, broadleaved, evergreen tree found across southern Africa, from immediately south of the Sahara to Zimbabwe (Hall 1992), and across parts of the Middle East to India. This thorny species has many common names across its range, such as desert date for English-speakers, Heglieg tree in Saudi Arabia, or more simply as Balanites. It is noted for its deep shade, 8 cm thorns, superb drought resistance (Booth and Wickens 1988), use in medicines (against jaundice, intestinal worm infections, wounds, malaria, syphilis, epilepsy, dysentery, constipation, diarrhoea, stomach aches, asthma, and fever) (Chothani and Vaghasiya 2011), food for human consumption, and oils for cooking (Mariod et al. 2017), and is widely regarded as one of the most important trees in Africa (Hall 1992). Beyond those practical points, it is seen as a rich symbol of the savannah by Maasai.

Leopards (*Panthera pardus*), which are on the International Union for Conservation of Nature's Red List of Threatened Species as Vulnerable (a high risk of extinction in the wild in the immediate future) (Stein et al. 2020), use *Balanites* as a key site of refuge to secure their prey above the reach of other predators such as lions, suggesting a major role of this tree in the ecology of one of the world's declining carnivores.

Despite its extensive range, *Balanites* is under intense pressure from overgrazing and livestock browsing in various

regions, including the Maasai Mara. The Maasai are pastoralists, known as herders of cattle. Løvschal et al. (2019) refer to cattle in Maasai culture as “dispositives”—the basic blueprint of a culture but note that in the last eighty years the Maasai have increasingly turned to goats and sheep (“shoats”) for income, while maintaining the primacy of cattle. With this change in land management, shoats are now a force in the Maasai economy; many use the sale of sheep to fund school fees for their children, in lieu of parting with cattle. Browsing and grazing by shoats on young trees on the grasslands since their introduction has led to a desert date population dominated by trees greater than eighty years old. Because *Balanites* usually live to only about 120 years this current old population structure suggests the need for urgent action in this generation as it now that there is a window of opportunity to prevent the loss of *Balanites* in the Mara landscape.

Figure 2 shows a scattered population of *Balanites* on an open savannah and this view is now typical of desert date in the Mara conservancies. Scattered trees without younger generations have been referred to as “the living dead” (Manning et al 2006). However, older Maasai note that one hundred years ago this region had a woodland savannah of desert date with a mixed population structure, with many juvenile trees. This woodland savannah, defined as 40% canopy cover, or forest savannah with continuous cover (White 1983, p. 46) has slowly been lost over the last few decades since the introduction of shoats. In the past, local people relied on natural regeneration to keep up the number of mature trees of desert date and little planting occurred (Hall and Walker 1991, p.23). However, with the introduction of sheep and goats, natural recruitment of trees has failed because they are able to graze down and kill any trees younger than about five to seven years. No data exist for this change in the population structure of the desert date. Maasai state that the survival of desert date on the Mara is one of the most important issues facing the region today, and they fear the potential desertification of this area.

In the Maasai Mara, reports of overgrazing due to goats and sheep (Løvschal et al. 2019) point to a complex socio-ecological situation of wildlife grazing, conservation, soil degradation, herder lifestyles, and tourism pressures. The issue is not confined to the Maasai Mara region. In the Dinder Biosphere Reserve in the Sudan, which is the largest biosphere reserve in the country, most damage is being done to *Balanites* by goats, who severely impact natural revegetation and increase sapling mortality, with mortality as high as 60% (Mohammed et al. 2021); this high fail rate is problematic for any regeneration efforts. *Balanites* also have low juvenile recruitment in fallow lands (Hegazy et al. 2018).

The question is how to change this situation and reduce the decline of desert date and ensure its regional survival and suggest methods to approach its decline in other regions. The

cultural and ecological issues that face desert date on the Mara produce a complex socio-ecological system, involving the life cycle of *Balanites* from seed to old age, its use to humans as food and medicine, its predation by shoats, elephants, and giraffe, and its visual attraction for tourists who bring in major local revenue. The mix of issues point to action research in real world practice (Xiang 2021), with problems that “do not come well-formed” and are “messy, indeterminate, problematic” (Schön 1992). The problem of the conservation of desert date can be broken into a series of small inquiries and questions to address the aged population structure by new plantings and to seek out methods of protecting young trees from their predators. This is important as no work has been done on this issue and there are few, if any, parallels that involve tree decline with livestock predation that include the need for protection from large wild herbivores, when standard tree protection methods for restoration or rehabilitation do not work. In short, there are no cases to draw upon and little published work except an excellent extension handbook about *Balanites* (Hall and Walker 1991), which incorporated a great deal of field knowledge from local landowners and households in the Sahel.

2 Finding an approach to research

Many of the approaches needed are small-scale. All small-scale conservation starts with observations in the field, as for crop improvements (*sensu* Passioura 2020). Field observations raise questions that suggest the need for relatively small-scale tests such as seed collection and seed storage methods, as well as decisions on seed annotation of those from ‘best’ trees and what ‘best’ means to local landowners, mapping of best trees, determination of traditional techniques to ward off destructive animals such as elephants



Fig. 3 Elephants have destroyed this mature desert date in the Enonkishu Conservancy. No younger trees are visible. A graze line from giraffe and elephants can be seen in all the trees in the image. October 2022. Image: T. Nampaso

(Fig. 3), and ideas for fencing that might involve both modern and traditional techniques, or modern ‘takes’ on traditional ideas. In Kenya, as in many parts of the developing world, it is also important that any tests are low-cost and not time intense of researchers, assistants, or landowners. Limiting costs and time add to the challenge and require careful thought.

Small-scale experiments such as needed here are increasingly seen as being important, particularly when done in the field in collaboration with local people with local knowledge of a system. Small experiments in rangeland improvement have been occurring for several years in the conservancies of the Mara. Improved pastures for cattle and shoats in the conservancies has had the dual result of better livestock and increased wild herd numbers (e.g. buffalo, zebra, elephant) moving into the conservancies from the adjoining Maasai Mara due to grazing pressure in the MMNR itself. This has, in turn, led to greater pressure on existing *Balanites*, as seen in Fig. 3.

3 Small-scale practical conservation

In an important editorial, Sutherland et al. (2022) drew attention to the scarcity of tests or experiments that are concerned with small-scale questions in conservation practice. They pointed out that small-scale tests are often key to providing answers to conservation questions. This approach contrasts with the “plethora of frameworks and relatively abstract models ... or highly detailed models of individual case studies” (Anderies et al. 2022). Although reporting small test results will give practitioners in the field greater confidence from a strong evidence base, small results are rarely reported. In part this is due to the pressure of the lower impact factor of journals that publish practical field advice than those that publish more elaborate, and expensive, large-scale collaborative work (Neff 2020), which is rarely possible in rural poor areas.

Small systems are sometimes reported in major journals when part of a wider study or when seen as innovative. For example, Bishop et al (2022), working in marine biology, examined a suite of man-made heterogeneous structures and their use by marine organisms on rocky foreshores. Their focus was on simple tests of patterns, some with cavities and some without; it was practical, simple, and innovative. Part of the work for desert date survival will require small-scale simple experiments in the protection of young trees planted on the savannah.

A key to adding to the knowledge base for *Balanites* is asking questions that are easy to test. Sutherland et al. (2022) suggested four options for identifying suitable questions for small tests; they are statements from guidance, evidence

gaps in solutions to the problem, looking for improved processes, and opportunities for experimentation. We articulated test questions under these four options to assist us to identify useful and informative knowledge about the life of *Balanites* today and strategies and methods that could be implemented and taken to local communities of the Mara conservancies.

3.1 Questions arising from extension manuals

Many of the questions that can be asked for better survival of desert date on the Mara are concerned with seed collection, seed storage, and seed survival. Seeds of *Balanites* are contained within fleshy pods that ripen in the middle to the end of the dry season. In the important monograph for extension workers on the growing of *Balanites* it was noted that the preparation of seeds for sowing should be done by covering with hot water and soaking for twelve to eighteen hours (Hall and Walker 1991, p. 20); other work suggests other methods to improve germination. Seeds collected from dung germinate particularly well (Von Maydell 1986, pp. 179–181). Such notes from agronomic practice answer small but important questions about how desert date grows and what knowledge already exists for plant propagation. Thus an important task is to make such a publication, which was difficult to procure, available to local people on the Mara.

There are two parts to collecting seed of desert date. First is to obtain a wide selection of seeds for storage with good genetic diversity from a range of sites in valley floors, along riverbanks, and in lower hillslopes, where desert date is commonly found on deep soils of sands over clay (Hall and Walker 1991, p. 6), such as the open savannah seen in Figs. 2 and 3, which show *Balanites* on wide valley floors. Some desert date grow on seasonally flooded heavy clay soils, and others on wind-blown sands, and thus it is important to record the source of seeds accurately to ensure provenance for later planting decisions.

In addition, sites from drier areas need to be collected to ensure that populations of seed will be available for planting against erratic or lowered rainfall in the region as predicted by the IPCC for the Mara (Bartzke et al 2018). Desert date is considered resistant to long periods of drought in semi-arid regions across sub-Saharan Africa (Hall 1992), and has good potential to provide shade and livestock food in a drying climate. Bartzke et al (2018) found that rainfall has become not less but more erratic and extreme on the Mara since the 1930s, when records were first available, and this “can be expected to create conditions conducive to ... reduced vegetation quality for herbivores”, suggesting the importance of collecting seed from a wide range of population sources. Montes et al (2012), working in the West African Sahel,

suggested that it would be prudent to increase the drought tolerance of planted populations of *Balanites* by selecting trees from drier zones.

Second, seed needs to be collected from trees that are good seed producers or good growers as determined by local landowners and herders. Some *Balanites* are regarded as a ‘good trees’ (Hall and Walker 1991, pp. 17–18). This is the casual term for a superior mother tree, and describes those trees with superior phenotypical properties, such as fruit production, size of canopy and shade provided, speed of growth when young, apparent health, or age. Accurate maps of the sites of superior mother trees on the Mara will be valuable for seed with high quality germplasm, and to suggest what types of sites are most likely to support new plantings of desert date to commence planting juveniles. Currently, nothing has been formally reported about which trees are “good”, or how local provenances might vary in this regard on the Mara. The coordination of work with landowners and herders who can identify superior mother trees and the favourable environmental conditions that account for good trees is vital. These might be the first sites to re-plant with saplings.

3.2 Questions arising from gaps in the evidence

New questions related to evidence gaps regarding desert date seeds might be: When is the best time to collect seed? How to best store the big seeds of *Balanites*? How long do seeds survive at room temperature? Few of these simple questions are yet answered and will need to be explored by first finding what traditional methods were used to take care of these seeds and if they were stored for long periods due to their use for human consumption and as a back-up during droughts, when they are used as emergency rations, especially for children, as they are high in vitamin C (Hall and Walker 1991, p. 8).

3.3 Looking for improved processes through local engagement

Engaging local people to collect local provenance seed will be essential. Can we establish a community seed bank? The international group Botanic Gardens Conservation International (BGCI) conduct seed collecting workshops to set standard methods for collection and recently ran a programme in Kenya, with a focus on youth. A major point from their training resources is to not take more than 20% of mature seed available from any one tree (BGCI 2023); such authority will provide good guidance and clarity to everyone concerned.

Would local people be more interested in a seed bank for the desert date if other species were included, such as species of indigenous crops for food or fibre that might be

under threat, as well as standard crops such as beans or millet? A key issue will be to negotiate a storage site or sites, and which nurseries will grow up trees.

3.4 Opportunities for experimentation with methods to protect young *Balanites*

Questions related to protection of seedlings and young saplings once planted in the field or savannah are key to the survival of the desert date. In the Mara it is impossible to simply put in tree tubes with small supporting structures, as in many places globally, because while these might give protection from sheep and goats, they give no protection to large wild herbivores. Deadwood fencing could be tested; this has been done successfully in Scotland against deer in revegetation programmes (e.g. Bradfer-Lawrence and Rao 2012).

On the Mara, traditional protection for cattle against big cat predators during the night has been by bomas—a thick circle of thorny deadwood that act as a corral or stockade. When fortified (closed), thorny bomas act to reduce predation, particularly when made with the thorns pointing out. The Maasai have long experience in constructing thorny bomas, as they live in a lion stronghold with some of the highest cattle densities in Africa (Robinson et al 2014). Small versions of thorny bomas or lattice-work barriers are often used today to protect young trees in farm fields from livestock damage but have not been used in the wider landscape at a larger scale and would not be effective against large wild herbivores.

Bomas today are often made of metal and thick wire; these are readily moved from place to place to aid pasture replenishment through nitrogen inputs from the cattle overnight and are being used as part of regenerative agriculture in cattle production on the Mara. While metal bomas against predators are expensive (approximately US\$250) (Kissui et al. 2019) and thus a financial constraint in their use for protecting young *Balanites*, they point to possible methods to use versions with less height that are only required to keep out shoats to protect young trees, and there is potential to test other versions that are not metal. These enclosures, in the style of work done in the Kenya Long-term Exclosure Experiment (Veblen and Young 2010) at the Mpala Research Centre in Laikipia County, Kenya, could act as metal arbours for group plantings of young trees, not just single trees.

Few structures can keep out elephants, and *Balanites* is one of their preferred foods (Tchamba 1995). Elephants detest bees and leave if they hear them. Beehive fences can deter elephants from entering cropland (King et al 2017). However, it is likely that a high attrition rate to elephants will need to be accepted. Guides, herders, and other landowners might have other excellent ideas to test, or long-term unrecorded field observations.

Other opportunities for experimentation lie in the small-scale disturbances related to predation by shoats, such as the degree of soil compaction around trees and the loss of other flora. Small-scale disturbances add to the ecological picture of decline over the larger-scale (Amami et al. 2009) and aid an understanding of the processes at work that currently prevent natural revegetation of this major tree of the savannah ecosystem.

4 Questions and methods related to social conditions and new ways of promulgating *Balanites*

The serious reduction in the future of a viable population of desert date on the grasslands is not a simple forestry or agronomic problem of seed collection, propagation, and transplantation, or re-forestry. The issue overlaps social and ecological arenas and is an example of the general trend of conservation being more interdisciplinary. Beyond ecology and biology, but linked to them, are social questions to be explored that involve landowners, villagers, the owners of the safari lodges, and various agencies that are keen to protect the ecology of the Greater Mara Ecosystem. It is easy to think of the Mara as a wild place, but in the conservancies there are farms, eucalyptus plantations, villages, roads, safari camps, and all pasture land or land that appears as open or wooded savannah is owned. To plant and then tend or check the growth of new desert date will require permission from landowners to work on their land.

All discussions need to be done in the field and personal interviews, or walking interviews, are the most appropriate manner of contact, given the high levels of illiteracy (Sutton et al 2017), particularly in the older generation. Yet it is in the older generation that many traditional ideas will be found that are likely to assist increasing *Balanites* numbers, and this highlights the need for the co-production of knowledge on the Mara. In addition, the low levels of literacy point to methods needed to promulgate news of what is being done, and the ambitions of a re-greening project such as this one—group meetings, verbal contacts, and one on one discussions.

Would villagers be prepared to grow desert date in their village streets? Would they consider that such a move would bring in wild animals, including elephants, which prefer the fruits of this species and might trample other crops to get to it? Previously, household gardens often supported a desert date tree because they are used for both medicine and food for human consumption. We propose setting up group discussions about the renewed planting of desert date in villages. This ambition raises the issue of who in the local community will be passing on news and information, seed collection methods, and finding issues or problems. Xiang (2021) discussed the importance of knowledge brokers, who

work to liaise between groups. Who will be able to act as knowledge brokers to take information between scientists, herders, and landowners, as well as to local villagers who might not belong to those groups? This last is an important part of knowledge implementation for success in the field. We will seek to involve women, who run households, in separate forums, and school children, particularly as they are 50% of the population and it is for their future that planting needs to be done and the ambition is to increase juveniles of *Balanites*, which will age with this generation of children.

In addition to the idea of knowledge brokers is the concept of boundary spanning (Goodrich et al 2020), where people are identified who are able to work between science (here horticulture and growing trees) and decision-making (here local governance and Maasai traditional cultural values). Local governance is an essential part of the system of desert date, landscape management, tourism, wild herbivores, and livestock grazing on the Mara that is needed if we are to improve survival of the tree and new plantings. Boundary spanning people, acting in many ways like the old extension worker to provide communication and action in the field, will be needed for the implementation of ideas and approaches that are gathered. Ideally, major landowners might step up to take the lead as bellwethers in the planting exercises for desert date and become champions for the species.

5 Conclusions

This perspective essay concerns a very place-specific issue about an important goal in one of the world's most famous wildlife areas. Agriculture is the driving force of landscape scenery in the region, as in many places (Plieninger et al 2006), and ensuring the visual survival of *Balanites* will maintain the link that Maasai have with this stately thorn tree and for the millions of tourists who will visit the Mara in future years. Ensuring that *Balanites* thrives into the future is a complex problem. Outlined here is a suite of approaches or methods to the issue based on working through a series of specific questions or tests that have the ambition to be “small-scale, easily testable, low-cost experiments” (Sutherland et al. 2022) that are in keeping with the current financial position of the region. The approaches are for seed collecting and a seed bank, partnerships with local landowners, and field experiments that are focussed on survival and protection.

Seed collecting has commenced, and a community seedbank proposed, with a view to have locals involved and trained in seed collection, seed sowing, transplanting of young trees, the direction from landowners to superior mother trees, and the involvement of women and schools in

the raising up and planting of saplings in both the savannah and local streets and farm plots.

Any work undertaken as part of the solution to this problem needs to be robust and community centred, with strong partnerships with local landowners. In Australia, Passioura (2020) noted that a great deal of research done in the agricultural sector was worth little because the knowledge held by regional farmers had been ignored. Thus, a key point is that knowledge co-production between local groups (landowners, pastoralists, farmers), will need to be legitimate and salient to all (Cash et al 2003), and grounded in socio-cultural, legal, and place-based relations and obligations of the Mara systems (Latulippe and Klenk 2020). Conservancies in the Mara are beginning to come together with focussed groups to have conversations about their traditional knowledge of how the desert date grows and what steps could be used to improve its survival, and perhaps to return the now open savannah to a more wooded one as in the past. Among many ecological advantages, this will aid the survival of the leopard and many small birds on the Mara.

Local knowledge of the Mara will give insights about the life of *Balanites* from seed to maturity and their predation risks that will lead to small field experiments and translate into increased numbers of juveniles growing successfully on the savannah. This in turn will lead to a more stable adult and mixed population of *Balanites* in the future. The implementation of field experiments will begin with planting saplings near their mother trees, where conditions appear to be prime for the species, the assessment of germination conditions in a nursery, and methods of protection of saplings for their first several years of life.

Frequent and important contact is needed between pastoralists and landowners on the conservancies adjoining the Maasai Mara to illuminate the proposals of seed bank, partnerships, and field experiments to work towards the major ecological goal of conserving the iconic desert date in their region. A good outcome is dependent on long-term social and ecological inquiries in unison, with knowledge transfer between groups, and with up-take in the project by members of the local community, who will lead the project with local knowledge inputs into all approaches. Impacts will only be usable if they are practical in both social and biological dimensions to local Maasai on the Mara.

This is a new line of inquiry in Kenya in an important global wildlife area that will set the stage as a three-pronged method for tree conservation that ranges across ecology and social inquiry, particularly for other rangelands and savannahs where there is low or absent funding and high illiteracy rates.

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manuscript; both authors read, commented and approved final manuscript.

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Declarations

Conflict of interest The authors declare that they have no conflict of interests.

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