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Sustainable harvesting and trading of mopane worms (*Imbrasia belina*) in Northern Namibia: an experience from the Uukwaluudhi area

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The roles of the Uukwaluudhi Traditional Authority (UTA) and government institutions were assessed in the sustainable harvesting of the mopane worm *Imbrasia* (= *Gonimbrasia*) *belina* and in marketing this food item in northern Namibia. There has been a shift from harvesting mopane worms for subsistence to trading them in both rural and urban markets. The increasing importance of the mopane worms in the urban diet has caused overexploitation of the insect. Unless this common property food resource is managed in a sustainable manner, there could be very low populations and market failure for the crop. It is recommended that the government improves the property rights and institutional arrangements that govern the use of mopane worms by supporting communities to establish indigenous natural resource management systems.

Keywords: By-laws; Edible-insect; Overharvesting of mopane worms

Introduction

Mopane caterpillars, also called mopane worms (*Imbrasia* = *Gonimbrasia*) *belina*, Lepidoptera: Saturniidae) and larvae of the emperor moth, are non-timber forest products (NTFP) that feed mostly from leaves of the mopane tree *Colophospermum mopane* [1–4]. Mopane worms cause extensive damage to individual mopane trees [4], and accordingly foresters tend to consider these caterpillars as pests [5,6]. Mopane woodlands cover about 77,000 km² in Namibia, and occur mainly in the northern parts, which are home to at least 60% of the Namibian population [7]. As a result of high human population pressure, the north central areas of Namibia have suffered from deforestation [8]. The larva of the mopane worm in its final stage is an important food for the local people in that region [9,10]. From a cultural standpoint, the mopane worm is one of the most important insects in Africa [11–13] as it is a popular foodstuff in Botswana, Namibia, South Africa, Zambia, Zimbabwe and Angola [2,3,14–19].

In most parts of southern Africa, the mopane worm is bivoltine (producing two generations per rainy season), e.g. in Botswana the harvesting periods are in December/January and April/May [1,20]. In more arid areas such as certain parts of Namibia, it is univoltine [9]. In Namibia, the abundance of mopane caterpillars is considered to be dependent on the annual rainfall [14]. Sufficient rainfall is needed to facilitate egg-laying by the emperor

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moth. Low, erratic and irregular rainfall lowers the population of the mopane worms [21]. Climatic factors are an important determinant of the number of mopane worms that survive from hatching to pupation; the first generation is mostly affected by adverse weather conditions [15]. During years of good rain, the distribution of mopane worms will probably extend in the direction of the prevailing winds (Styles 1994 cited in Greyling et al.) [22].

The various stages of the life cycle of *I. belina* provide food for numerous natural predators (Styles 1996 cited by Greyling and Potgieter) [15], including insects, reptiles, birds, jackals, bats, warthogs, aardvarks, baboons and vervet monkeys [15]. This predation can have a significant impact on caterpillar yield. Various studies give reasons why the *I. belina* population is declining [12]. This is partly because of overexploitation of mopane worms. Deforestation also destroys *I. belina* food plants [9] through clearing the land for crop production, and taking trees for fuel wood, and for fencing and building materials [10]. Other factors such as soil type, rainfall, fire and browse quality may also contribute to the decline in the population of mopane worms. In addition, the increased trade in the mopane worm in Southern Africa has led to overharvesting with collectors now harvesting substantially more than a single person would have needed for a family previously (Rebe 1999 cited in Gondo et al.) [19]. For example in Zimbabwe, this has generated interest in options for small-scale farming of mopane worms [23]. The absence of regulations for the collecting of mopane worms has also increased competition for harvesting between the local people and outsiders and this also affects the worms' life cycle [24]. Nevertheless, traditional regulations may include the monitoring of caterpillar development and abundance [25]. Harvesting takes into account age and size, and mature larvae are preferred to younger ones [17]. Thus, the population of mopane worms that are not harvested in one period determines the abundance in the next period [17].

Mopane worm harvesting is one of the ways through which rural communities boost their household economies and nutrition [2,26,27]. The sustainable exploitation of this product could perhaps yield a larger financial return per hectare, to some of the poorest of rural people, than any other forms of land use [28]. Studies conducted on the nutritional value of mopane worms reveal that they contain high levels of crude protein, many vital minerals and vitamins [15,18,29,30]. The mopane worms have higher protein, fat, carbohydrate and calcium content than beef, biltong and chicken [17]. Thus, these worms are important as a supplement for high cereal diets, especially for vulnerable groups such as children [17]. Increasing poverty in urban areas has created demand for low-cost protein such as mopane worms [3]. Occasionally, mopane worms are used as a protein supplement in poultry and cattle feeds [20,31,32].

When large numbers of mopane worms occur, they are collected by people, cleaned, dried or roasted and either kept for consumption or more commonly nowadays sold or bartered [19]. Mopane worm is a major rural industry [2] and its trade appears to be a profitable source of income for both formal and informal traders [15]. The income is normally used for essential purposes such as purchasing grain, foodstuffs, paying school fees, buying kitchen utensils, paying medical bills and necessary travel; although mopane income on its own is insufficient to cover all these items [3]. Yet, mopane worms provide seasonal employment to many rural people in many parts of southern Africa. The variability in production between years is very high leading to potentially unstable market conditions [28].

Marketing chains of mopane worms extend between countries in southern Africa [3,14]. In Namibia, traditionally the caterpillar was harvested by rural families for their own use [14], but local entrepreneurs have started to harvest mopane caterpillars to sell at urban

markets [15]. There are growing concerns that natural mopane populations will not be able to keep pace with the increasing consumer demand [15]. Detailed information on the regulations affecting the harvesting process in Namibia is limited. The paper aims to strengthen the database.

Methods and procedures

The method employed for the study was focus group discussions. This means, deriving data from a group of respondents, usually 8–10, during a more or less open-ended discussion about a topic [33]. Focus groups are useful to determine the perceptions, feelings and thinking of the people about issues, products, services or opportunities [34]. With the assistance of government Extension Officers in the region, purposeful sampling by convenience was used to select 10 households to attend a half-day focus group meeting in each community. Sometimes, all participants joined in the discussions. A total number of 42 farm households which undertake mopane worm harvesting were interviewed. The study was conducted in the Uukwaluudhi areas in Omusati region, northern Namibia. Three study sites were selected: Omugulugombashe, Onguludhiya and Omankono in Tsandi constituency. The study was undertaken between May and July 2011.

The focus group meetings were conducted by a moderator and an assistant who prepared the list of discussion questions that guided the interviews. As in other studies, notes were taken by the assistant moderator [35]. One challenge with focus groups is to create an environment where participants are willing to share their concerns, anxieties and suggestions [34]. Another concern is about the subjectivity of the technique, and a feeling that any given results might have been different with different respondents, a different moderator or even a different setting [33]. In order to augment the summarised reports from focus group discussions and to obtain a suitably searching analysis of the findings, interviews with key informants such as professional experts in the subject area were also conducted through office visits or over the telephone. Focus group analysis is done concurrently with data collection [34]. Hence, the findings from each subsequent group are analysed and compared to data from earlier groups.

Findings and discussions

Role of government and traditional authority by-laws

Regulations need to be put in place to ensure standards of quality and supply and acceptable, sustainable harvesting levels that will ensure the maintenance of natural mopane populations (Styles, 1996 cited by Greyling and Potgieter) [15]. The harvesting of mopane worms does not appear to be strictly regulated, but is largely based on local knowledge, beliefs and local institutional frameworks of control [36]. Problems are inevitable with increasing trade in this product, unless regulations are enforceable [14,15]. There is a need for policies to be reflected in resource management so that exploitation is sustainable [32].

The Namibian Government is managing forestry resources through various acts and policies administered by the Ministry of Agriculture, Water and Forestry (MAWF). The Forest Act No. 12 of 2001, as amended Forest Act No. 13 of 2005, provides general direction for the management of Namibia's forest resources. This includes protecting and making the forests productive to improve the economic welfare of rural communities. In addition, the Environmental Management Act No. 7 of 2007 promotes the sustainable management of

the environment and the use of natural resources by establishing principles for decision-making on matters affecting the environment. Yet, Laird et al. argue that NTFP have been both overlooked and poorly regulated by governments [37]. The same authors state that regulation of NTFP by the government depends on the way the product is used; accordingly, products which are used mainly for subsistence and for local trade are less regulated compared to those that are commercially traded in the foreign market. This was also observed in the case of mopane worms in the Uukwaluudhi area where government (Ministry of Environment and Tourism (MET) and MAWF, Directorate of Forestry) do not have specific rules and regulations on harvesting of mopane worms, probably because government officials perceive the worms as having a low economic value.

In Namibia, much of the mopane belt is located in communal areas where customary laws allow anyone to harvest forest resources. In an effort to ensure sustainable mopane worms harvesting in the Uukwaluudhi area and prevent overexploitation and collecting of immature worms, the Uukwaluudhi traditional authority (UTA) has set up in-house guidelines (by-laws) governing the harvesting in outbreak sites. For example, the commencement (between February and April) of mopane worms harvesting is announced by the UTA via radio and during community meetings. Other regulations governing the harvesting of mopane worms include the control of illegal cutting down of trees such as *Colophospermum mopane* for building and fencing material, and the prohibition of setting fires in the forest and of cutting the fences of local residents.

Moreover, commercial harvesters are accused of destructive practices such as climbing trees, cutting off branches and cutting down whole trees to get at the caterpillar. They also harvest all the caterpillars, which lowers the population level of the next generation to an extent that harvesting is no longer feasible. Although abundant rainfall is good for mopane worm abundance, our research reveals that during seasons with floods or drought there is a significant reduction in the mopane worm population; for example, during heavy rainfall, mopane worms easily fall off from trees and burrow faster, which increases their mortality rate, or drown in the surface water.

The harvesting period for mopane is from February to April; during years with good rains or during years of poor rains. In Namibia, all those who are willing to collect caterpillars during the harvesting period should carry with them a valid harvesting written permit. This permit is obtained from the village headmen and some trusted community members at the UTA's office in Tsandi settlement in the Omusati region. Uukwaluudhi inhabitants pay US\$2.86/permit, and non-residents pay US\$5.71/permit. Payment for a harvesting permit is necessary to cover UTA administrative costs. Moreover, the permit does not stipulate the valid period for harvesters to stay in the forest. Owing to poor monitoring systems, illegal harvesting of mopane worms is widespread, and so it is better to have only small groups of harvesters which would be easy to monitor and control. In addition, there is no punishment for illegal harvesters when found by law enforcement agents (police officers and MAWF, directorate of forestry officials). Thus, anyone found in possession of mopane worms without a valid permit is not fined and the products are not confiscated and auctioned by Forest Management Committee (FMC) of the MAWF. This lack of enforcement of regulations threatens the sustainability of the crop.

Harvesting and processing

Collectors of mopane worms in Uukwaluudhi area include people living in surrounding villages, cattle posts near outbreaks sites and outsiders who travel to harvesting sites. The

largest numbers of harvesters are those who live within the outbreak areas (Omusati region residents including Uukwaluudhi inhabitants). Others travel long distances for about 250 km away from the harvesting area in northern Namibia (from the Oshana, Oshikoto and Ohangwena regions). The long-distance harvesters camp in the outbreak area during the stipulated period for several days.

Mopane worms are an important food item consumed by people from all income groups in Namibia, but are especially attractive as protein rich food to lower and middle-income groups. In Namibia, a number of different caterpillars are collected but it is the *Imbrasia belina* (black) and the *Gynanisa maja* (yellow) (not collected in large numbers) caterpillar that are the most numerous [14]. Harvesting and processing is done following traditional techniques; no improved technological devices were identified during interviews. Thus, management is based on indigenous customary practices.

The bulk of harvesting and processing is done by women and children [3,17]. In addition, unemployed males close to the urban areas are increasingly active in the collection of the caterpillars and in most cases, are under contract to local traders [38]. In this study, which included children, it was established that about 85% of harvesters were women and 15% were men. Thus, these caterpillars play an important role in food security and poverty alleviation for the majority of poor households in Namibia. The most common method of collection is to pick the worms by hand from both the ground and from the mopane trees. Because the harvesting period for mopane coincides with the rain-fed crop-production season, it requires a division of labour in households. Some family members, normally elders, remain at home to take care of planting and weeding while others go to collect mopane worms.

Processing is labour-intensive; removing the undigested material (including faeces) in the gut by squeezing the worm between the thumb and fingers. During collection and degutting, some harvesters wrap their fingers with pieces of cloth or strings or wear gloves to protect their hands from the sharp spines. Some customary degutting techniques include the use of bottles as rollers or crushing the mopane worms with sticks [3]. The mopane worms are then washed if there is water available, boiled in salt water without washing and then sun dried or roasted on charcoal which prolongs their shelf life. The worms are then packed in sacks, baskets or large tins and then taken home for consumption or taken for sale in the local markets. An individual collector can harvest an average mass of 50 kg of fresh mopane worms per day. Therefore, the development activities most likely to succeed for the poorest collectors are those that encourage a harvester's collaboration to benefit from economies of scale in marketing and value-added processing [39].

Trading and marketing

Although much of the mopane trade seems to be local, there appears to be substantial cross-border trade from Angola. The caterpillars are transported from outbreak areas to local markets especially to Oshakati (the main town in north-central Namibia) and to Windhoek (the capital city about 700 km from Oshakati) and from Angola to Oshakati [14]. Harvesters collect in large quantities both for household consumption and commercial purposes. Mopane worms are sold in rural and urban informal markets such as at open-markets, road side, local *cuca* shops, etc. In order to reduce transport costs, most of the harvesters cooperate by forming groups and arrange transport together.

The labour and transport costs associated with each stage, especially in conveying stock from rural and urban areas, are the main reason for the increase in price along the marketing chain [19]. The price for selling the worms, however, is determined by the number of

buyers, abundance of the caterpillars and distance from the market [24]. In Namibia, although the demand for mopane worms is high, the distance from the harvesting area to the market areas is affected by the stiff competition among harvesters (sellers). When the competition is high, a seller is forced to find a market by travelling long distances to that specific market. In northern Namibia, the harvesters sell caterpillars raw, cooked or fried to the customers. For example, a tin (500 g) full of raw or dried semi-cooked mopane worms on average is sold at US\$1.43. In addition, a 50 kg bag of raw mopane worms is said to be relatively profitable with an average gross income of US\$ 71.43. In rural areas, some harvesters also exchange mopane worms in kind (bartering) for other food. The money earned by harvesters, who are normally poor rural people, is used for essential purposes, as previously stated. Although there are no formal quality standards for mopane worms, consumers have developed good indigenous knowledge to determine whether the worms are of high quality or not. For example, the presence of fungi visible to the naked eye is a sign of poorly dried products and thus poor quality. The taste of the worms is also used to determine the quality of the product.

Conclusion and recommendations

The objective of this article is to assess the roles of UTA and government institutions in the sustainable harvesting and marketing of mopane worms in northern Namibia. The harvesting is one of the most important livelihood activities for rural people in northern Namibia. Over the years, the harvesting of mopane worms has become more significant to rural people as an income generation activity. There is a threat of mopane worms' overexploitation because of human destruction of the host plant (mopane trees), and because of the harvesting of all caterpillars with none left to breed a new generation; whereas, more restrained harvesting will safeguard the crop for the future. Harvesting mopane worms for subsistence has shifted to harvesting for commercial purposes. Trade and the increase of mopane worms in the urban diet have caused the overharvesting of mopane worms, leading to their erratic abundance. Traditionally, collection of mopane worms was undertaken by women and children, but today unemployed men and youths are significant harvesters. Collectors lack market information, obtain low prices and lack transport.

In order to manage the mopane worms sustainably, the UTA had put in place forest regulations which are in line with the government Forest Acts. The UTA issued permits to the harvesters in order to use the resources in a sustainable way without compromising the ecosystem and disrupting its functionality. The mopane worm sector suffers from information asymmetries and thus high transaction costs from administration, monitoring or control and transport costs which are associated with communicating, meetings, negotiating and enforcing agreements. There has to be cooperation and collective action among harvesters.

A number of recommendations may be useful to the better management of the Namibian mopane worm industry.

- The government should improve the property rights and institutional arrangements that govern the use of common property resources such as mopane worms by introducing specific natural resource management systems.
- UTA should become strict in the issuing of harvesting permits and monitoring of the harvesting of mopane worms by securing the participation of the Namibian police

and government, especially MET and MAWF in its implementation strategy.

- The harvesting permit should stipulate a quota per harvester and the size of worms to be harvested. In addition, the number of days a harvester is allowed to spend collecting mopane worms in the forest should be limited and specified on the harvesting permit. It is also recommended that UTA should produce a range of permits at different costs depending on the quantity an individual is willing to harvest.
- The MAWF should introduce appropriate technology for the processing and storing of mopane worms which meets acceptable food safety standards.
- To benefit economically, mopane worm harvesters should establish a cooperative based on internationally acceptable principles.

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