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TREE SPECIES FOR FOOD SECURITY IN THE SOUTHERN REGION OF MADAGASCAR

Lolona RAMAMONJISOA ⁽¹⁾, Felana RALISON ⁽²⁾, Vero ANDRIAMIARANTSOA⁽²⁾

⁽¹⁾Associate Professor at Forest Department, Graduate Agronomy School, University of Antananarivo, MADAGASCAR, e-mail:Lolona.ramamonjisoa@gmail.com

⁽²⁾Master student at Forest Department, Graduate Agronomy School, University of Antananarivo, MADAGASCAR

ABSTRACT

In tropical countries, the interest of food tree species (FTS) for rural people is widely recognized especially during shortage period.

Our research was based on two socio-cultural groups in the southern region of Madagascar (arid and sub-arid zones) where 6 villages were selected to conduct survey for 180 households and 2 leftover forest for species assessment.

Methodology was based on enquiries on consumed FTS, on way and quantity of consumption. Then, rapid assessment for ecology and biological aspects was conducted to have basic data for conservation and sustainable use of food tree species in the future.

The research focused on two socio-cultural groups (Antandroy and Antanosy) has permitted to identify the most used species in food shortage period. Way of consumption varies from a socio-cultural group to another, it is depending on traditions. Quantity consumed is high during food shortage period (from August to January) for some species such *Adansonia za*, *Maerua filiformis*, *Strychnos spinosa* and *Tamarindus indica*. While fruits of other species are sporadically consumed. Some species used for main meals (mostly dinner) are prepared before consumption but other fruits are directly consumed or eaten as snacks. Some households get fruits of *Flacourtia indica*, *Salvadora angustifolia* and *Tamarindus indica* within a high productivity to be sold in the market and to win punctual incomes. FTS are threatened mainly by the degradation of their habitats due to anthropic and natural disasters. FTS management is based on social convention and cultural rules. Some species are sporadically domesticated in households' farms. FTS are growing on a poor clayey sandy soil, at high mean temperature (> 20°C) and a low rainfall (up to 200 mm/ year). However, some species are widely spread because of their adaptability to hard ecological conditions and their dissemination by animals and human. Some species such *Adansonia za* and *Operculicarya decaryi* are becoming very rare in the forests and presenting a very low natural regeneration. The other species are still abundant but their potential of regeneration is moderated.

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Keywords: Arid zones, food shortage period, genetic resources.

INTRODUCTION

Madagascar is known as one of hot spots of Biodiversity because of its richness of ecosystems and species with a very high rate of endemism (fauna and flora). The floristic biodiversity is offering a high value for in one hand, ecological purpose such as animal nutrition and habitat and different ecosystem services and in other hand, social and economic importance.

Madagascar is also known by the high level of poverty, mainly in rural zones where life depends much on natural resources. Food insecurity is among main aspects of poverty and it is an increasing problem.

In this context, a research on food tree species was done in Madagascar in the framework of Sub-Saharan Forest Genetic Resources Network (SAFORGEN) Programme. The general objective is “to study the sustainable use and the preservation of Forest Genetic Resources with a nutrition value for poor rural people”. For that, main activities were: gathering knowledge on food tree species (FTS) highly consumed in food shortage period and establishing recommendations and measures for conservation and sustain use in order to support livelihood of local population in aspects of their nutrition.

MATERIALS AND METHOD

The study was executed in southern zone of Madagascar characterized by a regular passage of drought season accompanied by cyclic food shortage period (from August to December) in some areas. The climate is sub-arid to arid, the soil is alluvial-sandy, hydromorph clayey calcareous, ferruginous or calcimorph. The ecosystem corresponds to caducifolious forest, spiny xerophytic vegetation and grassy savanna. The population is composed by two socio-cultural groups (Antandroy and Antanosy) whose main activities are based on agriculture, livestock (zebu and cattle) and fishing (Antanosy). During famine period, activities on picking up at the forests for food and market are practiced. This is confirming words of FAO (1989) which said that neglected numerous wild FTS become very important for rural population during famine time.

The study has followed two steps to reach the expected objective. The first step was related to 261 interviews touching 180 households in 6 villages (samples composed by 30 communities and 3 villages per socio-cultural group) spread through 60 communities. Interview method was according to QUIVI and CAMPENHOUDT (1995) guidelines, based on a half-structured questionnaire addressed to different focus groups: farmers, men, women, children, village chiefs and traders in local markets. The second step aimed to do rapid assessment of FTS by transect method with local guides.

For interviews, different topics were covered: period of cyclic food shortage with regards to agricultural calendar; FTS used and appreciated during this period; part of tree used (leaves, fruits, bark...), quantity consumed, price in the market, threats and conservation status.

Rapid assessment in Sahanakamba forest (Androy region) and Ifotaka forest (Anosy region) of species was focused on their main ecological and biological characteristics to get basic knowledge for further domestication actions. Method adopted was based on inventory (abundance evaluation and natural regeneration counting according to ROTHE's method, 1964) and observation following transects in forest habitat of FTS in the two regions of study.

RESULTS AND DISCUSSION

Consumed food tree species

18 species were listed by the two socio-cultural groups (Antandroy and Antanosy). 8 species are common for the 2 groups but the Antanosy listed more species because their region is including some zones which are less arid because of influence of humidity from the south eastern coastal area. Species are spread in 17 genus and 13 families.

For all species, fruits are the part consumed. The same observation was done in 1996 with the study made by STYGER who inventoried 150 of wild fruit tree species in the humid eastern forest at medium altitude in Madagascar.

Table 1: list of consumed food tree species

Scientific name	Family name	Local name	Common name	Type
<i>Adansonia za</i>	MALVACEAE	Za	Baobab	Tree
<i>Araliorhamnus vaginata</i>	RHAMNACEAE	Borodoke	nd	Shrub/Tree
<i>Azima tetracantha</i>	SALVADORACEAE	Filofilo	Needle bush	Shrub
<i>Capparis chrysomeia</i>	CAPPARACEAE	Rohavitse	nd	Shrub
<i>Dombeya ctenostegia</i> (syn. <i>Helmiopsiella ctenostegia</i>)	MALVACEAE	Tabarika	nd	Shrub/Tree
<i>Eugenia emirnensis</i>	MYRTACEAE	Rotra	nd	Shrub/Tree
<i>Ficus grevei</i>	MORACEAE	Fihamy	nd	Tree
<i>Flacourtia indica</i>	SALICACEAE	Lamonty	Madagascar plum	Tree
<i>Grewia androyensis</i>	TILIACEAE	Taolankafotsy	nd	Tree
<i>Maerua filiformis</i>	CAPPARACEAE	Somangilety/Solety	nd	Shrub
<i>Opuntia dillenii</i>	CACTACEAE	Raketa	nd	Shrub
<i>Operculycaria decaryi</i>	ANACARDIACEAE	Jabia	Fake japanese pepper tree	Shrub/Tree
<i>Phyllanthus decipiens</i>	PHYLLANTHACEAE	Sanira	nd	Shrub
<i>Poupartia caffra</i> Syn. <i>Sclerocarya birrea</i>	ANACARDIACEAE	Sakoa	Plum of Africa	Tree
<i>Salvadora angustifolia</i>	SALVADORACEAE	Sasavy	nd	Tree
<i>Strychnos spinosa</i>	APOCYNACEAE	Dagoa	nd	Shrub/Tree
<i>Tamarindus indica</i>	FABACEAE	Kily	Tamarin	Tree
<i>Terminalia monoceros</i>	COMBRETACEAE	Kobay	nd	Tree

Consumption of food tree species

Period of consumption

Annual food shortage is happening in the southern arid and sub-arid region of Madagascar, from August to January. Farmers are preparing soil in September – October in order to grow crops (rice, maize, cassava...) in November – December. Then, collecting would be about February or March. Because of lack of rainfall, poor fertility of the soil and traditional technique applied for cultivation, crops' yield is low and quantity collected is not sufficient to cover all needs of food for population. In parallel, many households are getting a part of their production to the markets to win money that they need to buy essential products (e.g. sugar, candles ...), to insure schooling of their children and their health care.

Flacourtia indica and *Salvadora angustifolia* are the most preferred species consumed during food shortage period because they can replace lunch, give energy and have sweet taste. *Tamarindus indica* fruits are also very consumed during food shortage period but its very acid taste and need specific preparation.

Tamarindus indica and *Poupartia caffra* are consumed both during food shortage and collecting crops periods. The difference is only about quantity (less consumed in collecting period).

Way of consumption

Way of consuming fruits from FTS is varying between the two regions: directly eaten for population in Anosy region and within culinary preparation for Androy's habitants, only sweet or sweet-tart fruits are directly consumed for these last.

Pulps of *Adansonia za* and *Tamarindus indica* are mixed overnight with fermented milk (locally called 'Abobo') or with water and sugar to get juice. Pulps of *Tamarindus indica* are soaked in the same volume of water for one hour and the very dilute solution is mixed with fermented milk or wood ashes to reduce acidity during about one hour before consumption. This preparation, locally called 'Bonta', is very familiar in Antandroy socio-cultural group. Women helped by their daughters are ensuring the preparation of these dishes.

Fruits of *Salvadora angustifolia* and *Flacourtia indica* are pounded in a mortar and sieved. Then, powder is directly cooked or mixed with fermented milk before consumption.

Prepared fruits from FTS are consumed for breakfast and dinner.

Seeds of *Poupartia caffra* are grilled and consumed in a similar manner to peanuts.

Intensity and quantity of consumption

During food shortage period, local population's survival is depending on wild picking. Wild fruits become basic foods and some are massively and daily collected. Fruits of *Adansonia za*, *Maerua filiformis* and *Tamarindus indica* are specifically highly consumed (1 basket of about 10kg per day per family). High consumption of *Tamarindus indica* could contribute to health improvement for populations because it offers calcium, magnesium, phosphorus, and potassium (CEMANSKY, 2015). *Strychnos spinosa* is also very consumed locally, contrary to what was noted in Malinké socio-cultural group in Ivory Coast where the species is moderately known and consumed by local populations (AMBE, 2000).

Wild fruits are collected mainly by women to supply the households' needs during food shortage. Children and men are only collecting for small quantities and for direct consumption when they are passing through forests.

People who are not picking fruits in the forest are buying them at the market (e.g. *Tamarindus indica* and *Flacourtia indica* fruits are sold at USD 0.2 / kg, *Salvadora angustifolia* at USD1 / kg).

On the other hand, some fruits are eaten before or after main meals according to their availability, during visit or passage in the forests or when working at fields. They are collected in small quantity (1 to 2 handles). It is the case of *Dombeya ctenostegia*, *Eugenia emirnensis*, *Ficus grevei*, *Grewia androyensis* and *Phyllanthus decipiens*.

Antandroy people (in the more arid region) consume more than Antanosy ones.

Table 2: Rates of households consuming FTS

Food tree species	Antandroy socio-cultural group		Antanosy socio-cultural group	
	Percentage of households	Number of households	Percentage of households	Number of households
<i>Adansonia za</i>	74	90	25	90
<i>Araliorhamnus vaginata</i>			10	89
<i>Azima tetracantha</i>			60	89
<i>Capparris chrysomeia</i>			15	89
<i>Dombeya clenostegia</i>			32	90
<i>Eugenia emirnensis</i>			16	90
<i>Ficus grevei</i>			29	89
<i>Flacourtia indica</i>	78	90	57	90
<i>Grewia androyensis</i>			19	90
<i>Maerua filiformis</i>			18	89
<i>Operculycaria decaryi</i>	21	90	35	89
<i>Opuntia dillenii</i>	99	90	64	90
<i>Phyllanthus decipiens</i>			19	89
<i>Poupartia caffra</i>			46	90
<i>Salvadora angustifolia</i>	86	90	46	90
<i>Strychnos spinosa</i>	33	88	25	90
<i>Tamarindus indica</i>	100	90	96	90
<i>Terminalia monoceros</i>	23	90	56	89

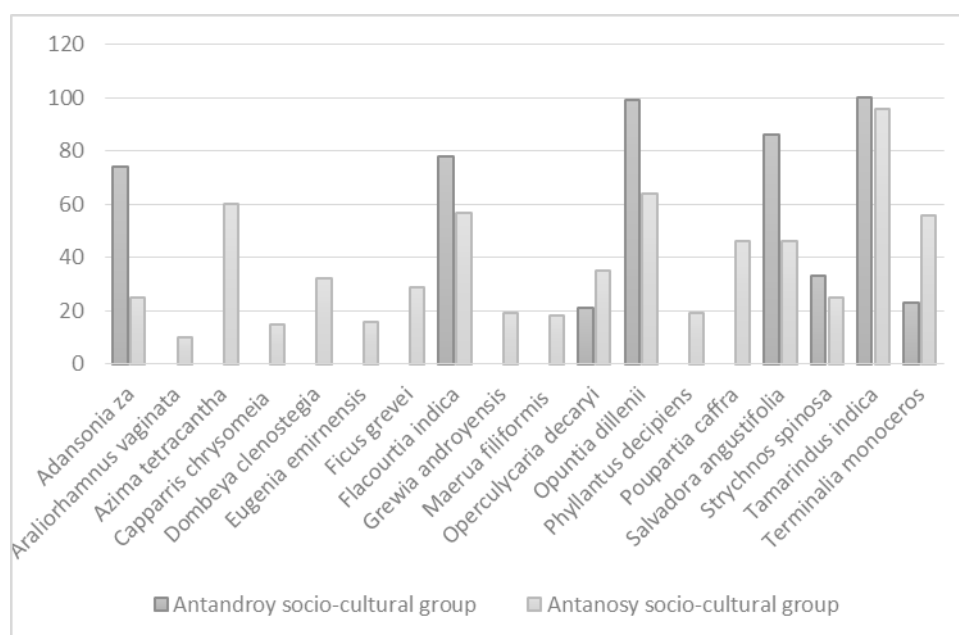


Figure 1: Percentage of interviewed households consuming FTS

Threats

FTS are threatened because of the degradation of their habitats. Traditional practice related to slash and burn cultivation (locally called « hatsake ») for maize and cassava growing is the main cause. Then, there are natural disasters (more and longer drought accentuated by climate change phenomena). Also, cutting of wood for construction and for energy (firewood and charcoal) is continually excessive to satisfy needs of the populations. It was also noted that there is presence of allogeneous and invasive plants such as *Opuntia ficus-indica*. Livestock divagation in the forests is another threat.

Direct threat affecting FTS are the existence of insects which eat seeds generating a lack of natural regeneration (e.g. problem for *Poupartia caffra*, *Strychnos spinosa*, *Terminalia monoceros*) and the massive collect of fruits for food. Otherwise, leaves of some species (*Maerua filiformis*, *Salvadora angustifolia*) are appreciated by animals.

Local FTS management

There is no specific local management of FTS, however, there are rules for forest protection such as placing invigilators committees to check forest products, establishing local convention to regulate entry in the forest and prohibiting old tree harvesting (*Tamarindus indica*). These devices are adopted by local communities who have benefited of a management transfer contract from Forest Administration.

Cultural aspects lead also for forest safeguard. Also, some old trees are considered sacred by the local tradition and to be respected by the populations (interdiction of cutting). Forest area which is including a tomb is integrally protected.

Some FTS are domesticated in farm (*Adansonia za*, *Flacourtia indica* and *Tamarindus indica* in Androy and Anosy, *Poupartia caffra* in Androy).

Ecological and biological characteristics of consumed FTS

Ecology

The general ecosystem of FTS in southern region of Madagascar is formed by a deciduous and spinous dry forest. The vegetation is composed mainly by shrubs but trees could be numerous with specific adaptation: sclerophyllia characterized by hardness and thickness of leaves (*Strychnos madagascariensis*), microphyllia (reduced sizes of leaves for *Tamarindus indica*), aphyllie (leaves are absent and replaced by chlorophyllian rod, case of *Maerua filiformis*) and pachycaulie (sort of water reserve in the main rod, case of *Adansonia za*).

The soil is mostly clayey and sandy. It is presenting a pH slightly acid to neutral (6.69 à 7.18), a poor soil without humus and with coarse particles.

The climate is relatively hot and dry to arid because average of annual temperature is between 20 and 30°C and the annual rainfall (200 – 400 mm in Androy zone and 200 – 1200 in Anosy). Rainy season takes place for 2 to 6 months per year.

Ficus megapoda and *Poupartia caffra* syn. *Sclerocarya birrea* are only growing on well-drained sandy clayey in Anosy region where the soil structure is granular. In opposite, *Adansonia za*, *Maerua filiformis*, *Strychnos spinosa* and *Tamarindus indica* are met on deep sandy red soil, within low content on organic materials and favoring a good infiltration of rainwater that allows the root development of trees. These species are widely spread in sub-arid zones because they have low requirement on soil quality (gravelly or sandy, deep, heavy and permeable) and they are adapted on variable rainfall (from 200 to 1,200 mm). This vast zone of extension is probably also linked to the spread of seeds by animals (monkeys, rats, birds ...) but also by man since the fruits of these species are edible.

In terms of vegetation, in general, the main genus associated are *Alluaudia* (DIDIEREACEAE), *Euphorbia* (EUPHORBIACEAE), *Cassia* or *Senna* (FABACEAE). These genus are characterizing spinous dry deciduous forest in the southern part of Madagascar.

Biology

FTS in the southern area of Madagascar are fructifying during different periods of the year. But some are in their peak of ripening during food shortage period. It is the case for *Adansonia za*, *Azima tetrachantha*, *Flacourtia indica*, *Grewia androyensis*, *Phyllanthus decipiens*, *Salvadora angustifolia*, *Strychnos spinosa*, *Tamarindus indica* and *Terminalia monoceros*. The other species could present fruits during food shortage period but within a low intensity.

Seeds dispersal are mainly by barochory (natural regeneration installed around the mother-trees within 10 to 20 m) or by zoochory (natural regeneration could be spread farer from the mother-trees).

Abundance of FTS in the two forests of inventory is very variable according to region. Observed values are from 58 (*Adansonia za*) to 788 (*Grewia androyensis*) in Androy region and from 14 (*Adansonia za*) to 765 (*Maerua filiformis*) in Anosy. Referring to IUCN (2001), the following species are threatened and could be extincted: *Adansonia za* and *Poupartia caffra* in both regions and *Operculicarya decaryi*, *Tamarindus indica* and *Terminalia monoceros* in Anosy (abundance < 250 individuals / ha).

Estimated values for rate of regeneration depends on species and their habitats ecology. Similarity with study made by AGUNDEZ *and al.* on FTS in Nigeria was observed about lack of natural regeneration: *Adansonia za* with a very low rate (<10%); *Operculycaria decaryi*, *Tamarindus indica* and *Terminalia monoceros* with a difficulty in Anosy region (regeneration rate < 100%). The other species have possibility for population renewing without having a high potential in the two regions.

Abundance and rate of regeneration are highly correlated ($R=0.88$ for Androy region and $R = 0.87$ for Anosy).

Table 3: abundance and rate of regeneration of common FTS for the two regions

FTS	Androy region		Anosy region	
	Nb of individuals / ha	Rate of regeneration %	Nb of individuals / ha	Rate of regeneration %
<i>Adansonia za</i>	58	4	14	6
<i>Grewia androyensis</i>	788	534	346	670
<i>Maerua filiformis</i>	264	342	765	860
<i>Operculycaria decaryi</i>	630	321	82	63
<i>Poupartia caffra</i>	245	189	455	246
<i>Salvadora angustifolia</i>	300	256	652	640
<i>Strychnos spinosa</i>	752	453	256	349
<i>Tamarindus indica</i>	352	287	120	48
<i>Terminalia monoceros</i>	260	265	254	73

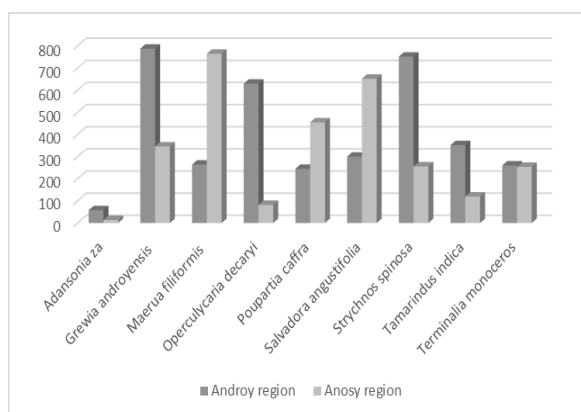


Figure 2: Abundance of species

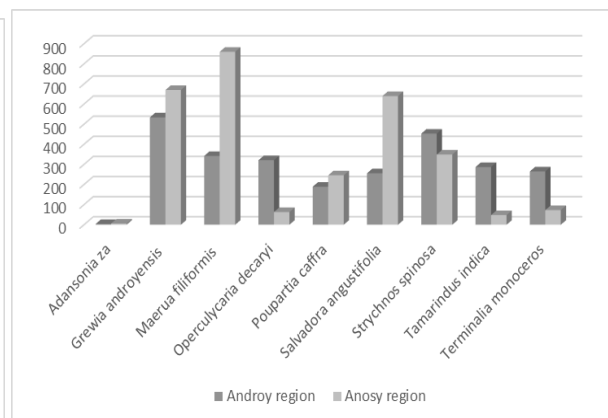


Figure 3: Rate of natural regeneration %

CONCLUSION

This research on food tree species in the southern part of Madagascar allowed to gather basic knowledge on their importance for the diet of rural populations during shortage period. It appears that sustainable management of these resources would contribute to adapted nutrition and food security for the local communities in Androy and Anosy regions where the ecological factors are very adverse to a good and sufficient crops productivity. Gender balance should be a very important issue to be considered about food tree species during food shortage period where women seem to be the main responsible to ensure the procurement and the preparation of meals from the forests. The management of FTS should be based on forest habitat safeguard and restoration to reduce effects of anthropic activities (mainly practice of slash and burn cultivation) and natural disasters (including climate change impacts). In addition, face to diversity of situation through the different edible species, future intervention should be also focused species by species. *Adansonia za*, *Flacourtia indica*, *Operculicarya decaryi*, *Poupartia caffra*, *Tamarindus indica*, and *Terminalia monoceros* should be the prior species which need measures for in situ (assisting natural regeneration) and ex situ conservation (domestication) and sustainable use. These measures will have to be designed and implemented with a full participation of local communities.

ACNWOLEDGMENT

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