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**Economic Contribution of African Locust Bean
Seeds Processing in Saki Area of
Oyo State, Nigeria**

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ECONOMIC CONTRIBUTION OF AFRICAN LOCUST BEAN SEEDS PROCESSING IN SAKI AREA OF OYO STATE, NIGERIA

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ABSTRACT: We examined the processing of African Locust Bean or *Parkia biglobosa* seeds with a view to understanding the economic contribution and resource sustainability in Saki area of Oyo state, Nigeria. Data were obtained from one hundred and twenty (120) major processors of *P. biglobosa* by means of questionnaire survey. Data analysis included using descriptive statistics such as frequencies and percentages to describe the source of *Parkia* seeds and the processing method(s) adopted as well as the strategies put in place for sustainable use of *P. biglobosa* in the study area. In addition, Gross Margin analysis and Rate of Return on Investment (RORI) were used to evaluate the profits accrued to the processors in the area. Results from the analysis revealed that women (91%) were actively involved in the business. In addition, majority (85%) of the processors were in the active age range of 21-40 years. Most (86%) of the processors had *Parkia* stands on their farmland which served as a major source of the pods and seeds from which 'Iru' was processed while others without tree stands collected the fruits from nearby forest lands. The RORI for the processing business in the study area was 91% indicating that for every ₦1 incurred, a profit of ₦0.90 kobo was obtained. Furthermore, to promote sustainability of the resource the people have adopted local means of sustaining production by preventing indiscriminate livestock grazing and bush burning. Therefore, it is imperative that policies should incorporate sustainability measures for the resource and the processing enterprise in the study area.

Keywords: African Locust Bean, Income, Production, Sustainable Development, Women

1. INTRODUCTION

From time immemorial, forests have continued to play a vital role in sustaining the lives of many people, especially poor communities. Sustainable livelihood is defined as the ability to cope with and recover from stress and shock while maintaining the natural resource base for present and future generations (DFID, 2008). Hence, forest ecosystems have served as buffer for people by providing multiple benefits at local, regional and international levels. People depend upon forest resources for, for instance, provisioning, cultural and socio benefits (Arabomen *et al.*, 2009). However, the type of resources and utilization patterns, may vary across ecological zones and socio-cultural areas. For instance, rural people extract and produce a variety of non-timber forest products (NTFPs) including *Parkia biglobosa* (African Locust Bean) either for consumption or income generation. In the south-north western provinces of Cameroon, *P. biglobosa* production and marketing amounted to over USD19 million in 2009, thus contributing 3% to the national GDP. Although, in Nigeria, the contribution to the forestry sector in particular and rural dwellers generally have been undervalued in the past (FAO, 2018). Notably, *P. biglobosa* contribute to rural and urban households, through processing and trade in local, national, and global markets. It is an important source of income,

particularly for women and families that do not have direct access to agricultural trade. *P. biglobosa* processing could serve as a vital source and alternative for agricultural crops in the event of failure and/or scarcity (Western *et al.*, 2014).

The Locust Bean tree, a native to tropical Africa is distributed across a wide range of open savannah forestlands from Senegal in the Atlantic coast to southern Sudan and Uganda in the North (Heuze *et al.*, 2019). *P. biglobosa* belongs to the Fabaceae family in the genus *Parkia*. It is a deciduous legume tree with umbrella shaped crown that often reaches a height of about 7 and 30 meters (Heuze *et al.*, 2019). The indehiscent fruit pods of the tree, commonly referred to as locust beans, are pink at the early growth stages and turn dark brown at maturity. There are about 2700-6800 hard coated seeds/kg that can remain viable up to 8 years. In the northern belt of Nigeria, around 200 000 tons of the seeds are processed annually (Karou, 2015). Although, the products are not common documented in global trade, they are an integral part of local and national trade in West Africa (Abioye *et al.*, 2017). Propagation is mainly done by seeds, however, vegetative propagation by grafting of 11-25-year-old trees have yielded good results in Burkina Faso and Nigeria (Traoré *et al.*, 2013). African locust bean can thrive in areas with 400-700 mm rainfall (Orwa *et al.*, 2009). It can grow on well-drained and fertile

soils as well as shallow lateritic soils. (FAO, 2018). The helophytic and deep tap roots enable them withstand fire and drought conditions (FAO, 2018). African locust bean is valued for both its health and nutritional potential. *P. biglobosa* stands serve as agroforestry species and helps to erosion control, nutrient recycling, provides litter for maintaining soil organic matter, acting as wind break, provides shade for human and livestock amongst others.

P. biglobosa has been identified as a valuable multipurpose tree of economic significance in many African countries (Dankleman and Davidson, 2015). Hence, the World Wide Fund for Nature (WWF) and the International Union for Conservation of Nature (IUCN) have established conservation programs that could benefit local communities through incentives while at the same time sustaining biodiversity (Brechen *et al.*, 2013). One method been encouraged is through sustainable processing and trade of NTFPs. This conservation based approach is envisaged to provide both economic incentive and sustainability of the resource on which it is based (Kainer *et al.*, 2013). Despite the importance, *P. biglobosa* is being threatened from deforestation and forest degradation due to rising population that has placed extreme pressure on forest ecosystems to meet basic needs. Large forest areas are being converted for other land uses. Also, the increasing rate of fuel wood collection from forest areas. For example, Odihi, (2013) reported increasing land degradation from fuel wood collection across the Sudano-Sahelian region. Moreover, it was estimated that about 70% of the population in Nigeria use at least some wood fuel for their cooking needs and/or food production (Boffa, 2009). In addition, increasing deforestation coupled with intensive agriculture is a threat to the traditional agricultural system across the region (Boffa, 2009). Initially, traditional agricultural system involving a fallow period whereby trees are allowed to grow under “parkland system” was intensively practiced (Boffa, 2009). But nowadays, most of these parkland systems are being thinned out resulting in short fallow periods, thus reducing the number of trees on the forest areas. This is due to increasing demand for agricultural land, as some argue that multi-purpose tree species and the economic viability of tree products should be explored (Boffa, 2009).

The African locust bean retains its leaves during the dry season, thus it is highly valued by farmers who can harvest the branches as supplement for the low quality forage available to their livestock. It is worth mentioning that in the first stages of establishment, the African locust bean is quite sensitive to browsing and needs protection from livestock (Orwa *et al.*, 2009). In Nigeria, Karter *et al.* (2012) revealed that regeneration has become a problem particularly in areas having large livestock population. Livestock and fires have been identified as major barriers to regeneration of the tree. Additionally, despite Oyo state being a major processor of African locust bean a paucity of information exist on the economic contribution of processing Locust bean in Nigeria. Therefore, this study aim was to document baseline information on the effect of

processing *P. biglobosa* seeds with a view to determining its economic contribution in Saki area of Oyo state, Nigeria. It was envisaged that findings from this study could provide up-to-date information to policy makers that could enhance sustainable management in the study area and/or elsewhere.

2. METHODOLOGY

2.1. Brief Description of the Study Area

Saki town is one of the 33 local government areas (LGAs) of Oyo state, Nigeria. The geographical coordinates of the town is located at 8°40'N and 3°23'E along the Guinea Savannah belt of Nigeria. Bounded in the west by the Republic of Benin, in the North by Kwara state, to the east by Orelupe and to the south by Atisbo, Saki town has two major LGAs and 16 districts namely: Saki East (5) and Saki West (11) with about 438 000 inhabitants (National Bureau of Statistics, 2011). The area has two seasons: a rainy period from March to October and a dry harmattan period from November to February. The people are Agrarian in nature involved in processing and trade of many NTFPs. Owing to the well-drained and rich ferruginous tropical soils, the area favours the production of both arable crops and tree crops such as *Vitellaria papradoxa*, *Parkia biglobosa*, *Acacia sp. amongst others*. Also, being a border town, there are lots of commercial activities and foreign goods that are traded.

2.2. Data Collection

Requisite information were obtained from six selected sites within Saki east (3) and Saki west (3) LGAs. The sites were purposively selected due to the prevalence of *Parkia biglobosa* processing activities. In addition, the study employed a socio survey for selection of twenty (20) processors from each district making a total of one hundred and twenty (120) respondents. The processors were interviewed and administered questionnaires to be filled and returned immediately. The questionnaires were designed to elicit information on the socio, economic and/or demographic profile of the processors; the activities in relation to processing *P. biglobosa*; and the strategies adopted for sustaining the resource in the study area. Other data were gathered from personal observation, relevant literature and texts. Overall, 120 valid forms (100% response rate) were coded for the analysis. Data analysis was done on SPSS statistics 23 platform where frequencies and percentages were calculated to describe the profile of the respondents, the source of *P. biglobosa* pods/seeds, the processing method adopted, and the strategies adopted for sustainable management. In addition, Gross Margin analysis and Rate of Return on Investment (RORI) were computed to determine the profits accrued to the processors in the study area.

Gross Margin was calculated using the mathematical expression:

$$GM = TR - TVC \quad (i)$$

Rate of Return on Investment (RORI) is expressed as:

$$RORI = GM/TVC \quad (ii)$$

Where: GM = Gross Margin, TR = Total Revenue, TVC = Total Variable Cost

3. RESULTS AND DISCUSSION

3.1. Socio and Demographic Profile of *P. biglobosa* Processors

In general, women accounted for 91% (n = 120) of the locust bean processors in the study area (Table 1). Most (89%) of them have spent more than 12 years in the processing business. Most (85%) were within the age of 21 to 40 years. There were only few (13%) unmarried people. In this survey, 91% had five or less household members (Table 1). The education level was relatively low with about 74% having an elementary school education level while 25% either had no formal or tertiary education. Most (90%) of the respondents had a primary occupation defined as farming or trading. Additionally, 88% of the processors indicated they earned about ₦200 000 (US\$440) or more on monthly basis.

Table 1: Socio-economic measure of *P. biglobosa* processors

Demographic measure ⁺⁺	Frequency (n = 120)	%
<u>Gender</u>		
Female	109	90.83
Male	11	7.86
<u>Age</u>		
≤ 20	12	10.01
21 – 40	102	85.01
41 – 60	6	5.01
<u>Marital Status</u>		
Married	104	86.67
Single	16	13.33
<u>Highest Educational Level</u>		
None	31	25.83
Elementary school	89	74.17
<u>Household size</u>		
0 – 5	109	90.83
6 – 11	11	9.17
<u>Primary occupation</u>		
Trading	12	10.01
Farming	108	90.01
<u>Year of experience</u>		
≤ 5	2	1.67
6 -11	11	9.17
≥ 12	107	89.17
<u>Monthly income level (‘000)</u>		
≤ ₦150	5	4.17
₦151 - ₦200	9	7.51
> ₦200	106	88.33

⁺⁺ Rounding may result in numbers adding to ≥100%

₦ is the Nigerian Currency *Naira* at USD1 = ₦450

Findings from previous studies (Okafor, 2013) and the results from this study showed that women were more involved in the processing activities in study area. This is probably because women are actively involved in forestry

activities such as the collection of seeds and fruits through nurturing and conservation to processing and marketing of forest products for their food security and family welfare (Arabomen *et al.*, 2009; Aiyeloja and Popoola, 2015). In addition, women are more knowledgeable on types of forest resources that are useful for meeting their family needs, hence they tend to conserve these resources during land clearing activities (Aiyeloja and Popoola, 2015). Also they are very knowledgeable about the use of plants in traditional medicine, hence they could be more concerned about the over exploitation of our forest resources (Ajayi *et al.*, 2007). Hence, woman rather than being marginalized could be included in forestry development programs, since such inclusion could assist in poverty reduction for society at large (Agbogidi *et al.*, 2015; Ozon-Eson, 2012). Moreover, the result of the age distribution showed that the processors were in their active age (21 - 40 years). This is probably because the process is quite tedious and would require younger and active persons in the business. Consistent with previous studies (Adeniyi *et al.*, 2007), and findings from this study, majority of the processors were married people. Adeniyi *et al.* (2007) reported that most married women engage in several non-wood forest product activities which they depend upon for income to cater for their children's education and to meet other household needs. Further, most of the respondents are well experienced in the business owing to their involvement over a long period of time (more than 12 years). Adeokun *et al.*, (2012) affirmed that years of experience could enhance transaction and profit.

3.2. Source and Processing Method of African Locust Bean Seed

Another important aspect of this study was to understand how the fruits and seeds of the African Locust Bean were sourced and method of processing in the study area. Majority (86%) of the processors collected the pods of *P. biglobosa* from farmlands owing to the relative availability of the tree stands on farms (Table 2). Tekleheimanot, (2013) reported that forest species form part of many agro-forestry systems in the regions where they occur.

Table 2: Source and processing method of *P. biglobosa* pods/seed

Parameter ⁺⁺	Frequency	%
<u>Source</u>		
Forest	15	12.51
Free areas	2	1.67
Farm lands	103	85.83
<u>Collection method</u>		
Harvesting	4	3.33
Purchase	14	11.67
Both	102	85.01
<u>Frequency of collection</u>		
During the on-set of the rains	112	93.33
During the dry period	3	2.51
Available all year round	5	4.17

Table 2: Continued

Processing method		
Traditional systems	113	94.17
Modern techniques	7	5.83
Average number of bags per processing		
≤ 5	4	3.34
6 - 11	11	9.17
≥ 12	105	87.51
Reason for processing		
Sale	123	87.86
Consumption	11	7.86
Both	6	4.29

++ Rounding may result in numbers adding to ≥100%

Additionally, most (85%) of the processors obtained the pods and seeds through individual harvesting and/or purchase from major traders (Table 2). This was because the pods/seeds were required in large quantity which were not abundant on their farmland source. Hence, what is collected is augmented by purchasing from people who were primary collectors or harvesters in neighbouring towns and communities. In addition, most (95%) of the processors employed the traditional method of processing whereby more than 12 bags (a bag = 50 kg) of the produce were obtained per season. This low average production recorded in this study could be because majority of the respondents were unaware of modern machines that could replace the manual ones. Hence, awareness creation on improved technology that could enhance the processing enterprise should be emphasized in the study area.

3.3. Monetary Benefits Accrued to Processors of African Locust Bean

The monetary benefits accrued to processors of African Locust Bean was assessed and reported in this study (Table 3). The average variable costs per annum were incurred for purchasing of the needed materials including fire wood, salt, packaging materials (i.e. leaves and polythene) and the depreciated values of the fixed items which are the sieve, containers (i.e. calabash bowls and drums) as well as costs incurred for labour and transportation. Additionally, in Table 3 the revenue from processing of *P. biglobosa* seeds was estimated as the product of the average selling price per kg (₦1 230) and the average quantity produced (650 kg), which yielded an average gross margin of ₦799 500. This showed a significant positive relationship between costs and returns, owing to the high output and average gross return accrued to the processors.

Table 3: Average cost incurred and profitability margin from processing 'Iru'

Materials (VC)	Cost (₦)/annum
Pods of <i>P. biglobosa</i>	193 660
Fire wood	53 000
Labour	86 420
Transportation	66 820
Packaging materials	8 000
Containers	4 952
Sieve	3 200
Salt	2 480
TVC	418 532
AvQ of 'Iru'	12bags (650kg) (1 bag = 50kg)
AvP	1 230
AGR	799 500
ATVC	418 532
AGM	380 968
RORI	91%

₦ is the Nigerian Currency *Naira* at USD\$1 = ₦450; VC = Variable Cost; TVC = Total Variable Cost; AvQ = Average Quantity; AvP = Average Price; AGR = Average Gross Return; ATVC = Average Total Variable Cost; AGM = Average Gross Margin; RORI = Rate of Return on Investment

Although, the processing activity is usually viewed as laborious and expensive, the Rate of Return on Investment (RORI) for the enterprise was 91% in the study area indicating that for every ₦1 incurred, a profit of ₦0.90 kobo would be obtained. Furthermore, RORI as an indicator of profitability, showed that the business was highly profitable since the higher the RORI, the higher the profitability (Akinyemi, et al., 2009).

3.4. Strategies for Sustainability

Most (96%) of the processors of *P. biglobosa* did not engage in tree planting as a measure for sustainability (Table 4). This is probably because the local people believed that the trees germinate and grow on their own. Eboh, (2007) reported that only a few cases of domestication of non-wood forest products exist especially in developing countries. This is owing to the long gestation period of the trees as well lack of awareness of the implications of failure to plant trees as a result of low level of education. Majority (114) indicated that harvesting of pods and seeds by hand picking from the ground was one of the measure adopted to conserve the trees in the study area (Table 4).

The local people adopted this method of harvesting because they consider it as “non-destructive”, thus sustaining the resource. Eboh, (2007) reiterated that harvesting of forest resources that does not necessitate tree felling could have the potential for sustainable conservation such that the regeneration potentials of the resource is enhanced in developing countries. Additionally, majority (93%) of the processors indicated that the trees were owned by the community, hence they would ensure the trees were sustained in their community. The people believed that since the trees are on their farmlands and owned by the community they naturally protect them from over exploitation and other harmful disasters such as excessive grazing by livestock and fire.

Table 4: Local conservation strategies for *P. biglobosa*

Parameter ⁺⁺	Frequency (n = 120)	Percentage (%)
<u>Tree planting</u>		
No	115	95.83
Yes	5	4.17
<u>Harvesting method</u>		
Tree felling	0	0
Hand picking	114	95.01
Climbing	6	5.01
<u>Ownership</u>		
Individual	4	3.33
Community	112	93.33
Government	4	3.33

⁺⁺ Rounding may result in numbers adding to $\geq 100\%$

4. CONCLUSION

The key findings of this study revealed that:

1. married women accounted for a larger proportion of the people involved in the processing activity across Saki area of Oyo state in Nigeria. This was owing to their ability to dominate forest gathering and processing activities both for household products and income in both urban and rural areas.
2. Notably, most of the respondents were experienced in the business which they have been for a long time, as such has enabled them to minimize loss.
3. Policies that could promote sustainability of the resource and the processing enterprise should be implemented in the study area.
4. Finally, the high Rate of Return on Investment (RORI) for the enterprise suggests that the business was highly profitable.

REFERENCES

- Abioye E, Akinyemi D, Aiyetoto O, Adegboye M, Oni M, Okoh A (2013). Preliminary phytochemical screening and antibacteria properties of crude stem bark extracts and fractions of *Parkia biglobosa*. *Molecules*, 2013, 18 (7): 8459-8499.
- Adeniyi EO, Ladun I (2007). Women in national development: place of science, technology and mathematics education. *In: Proceedings of the 11th annual congress, Nigerian Academy of Education*, pp 24-32.
- Adeokun OA, Agbelemoge A, Adedoyin SF (2012). Assessment of exploitation of non-timber forest products in Omo Forest Reserve, Ogun State, Nigeria. *In: proceedings of the 28th annual conference of Forestry Association of Nigeria*, pp 11-21. pp 11-21. Abu JE, Oni PI, Popoola L, eds. 2012, Akure, Ondo State, Nigeria.
- Agbogidi OM, Ureigho NU, Okonta BC (2015). Enhancing women Participation in communal forest management in Nigeria. *In: proceedings of the 30th annual conference of Forestry Association of Nigeria*. pp 356-363. Popoola L, Mfon P, Oni PI, eds. 2015, Kaduna, Nigeria.
- Aiyeloja AA, Popoola L (2015). The role of small scale forest based enterprises in sustainable forest management. *In: proceedings of the 30th annual conference of Forestry Association of Nigeria*. pp 179-185. Popoola L, Mfon P, Oni PI, eds. 2015, Kaduna, Nigeria.
- Ajayi ST, Adebisi LA, Fasola YR (2007). The role of women in Conservation of endangered species. *In: Proceedings of the 15th annual conference of Forestry Association of Nigeria*. pp 138-144. Abu JE, Oni PI, Popoola L, eds. 2007, Ibadan, Nigeria.
- Akinyemi GO, Adio AF, Akinyemi IG, Awosusi BM (2009). Assessment of the economic impact of trade in *Thaumatococcus danielli* and *Megaphrynium macrostachyum* on low income women in Ibadan, Nigeria. *Journal of Sustainable Environmental Management*, 2009, 2 (2): 11-15.
- Arabomen O, Baiyewu RA, Areo OS, Ademola IT, Akerekoro RW (2009). Socio-economic impact of non-timber forest products on rural dwellers of Oluyole Local Government Area. *Proceedings of the 23rd Annual conference of Forestry Association of Nigeria*. pp 384-393. Oni PI, Popoola L, Idumah FO, eds. 2009, Edo state, Nigeria.
- Boffa JM (2009). Agroforestry parkland systems in Sub-Saharan Africa. Food and Agriculture Organization of the United Nations Conservation Guide, Rome. 34p.
- Brechen S, Wilhusen P, Fortwangler C, West P (2013). The road less travelled: toward nature protection with social justice. *In: Contested nature: promoting international biodiversity with social justice in the 21st century*. New York State University Press, Albany, New York. pp 251- 270.
- Dankelman I, Davidson J (2015). Women and environment in the 3rd world: alliance for the future. International Union for the Conservation of Nature, London Earth Scan Publications. 30p.
- Department for International Development DFID (2008). Sustainable rural livelihood. DFID Natural Resources Paper. pp 18-27.
- Dogbevi EK (2019). The Shea tree has economic and environmental values for Ghana. Ghana Business News, available online at <https://www.ghanabusinessnews.com/2019/12/01/the-shea-tree-has-economic-and-environmental-values-for-ghana/> (accessed 20th October 2020).

- Food and Agriculture Organization (2018). Grassland index. Catalogue of Grass and Forage Legumes. FAO, Rome, Italy, [https://web.archive.org/web/20170120044942/http://www.fao.org/ag/AGP/AGPC/doc/GB/accessed 20th October 2020](https://web.archive.org/web/20170120044942/http://www.fao.org/ag/AGP/AGPC/doc/GB/accessed%2020th%20October%202020)).
- Heuze V, Thiollet H, Tran G, Edouard N, Lebas F (2019). African locust bean (*Parkia biglobosa* and *Parkia filicoidea*). Feedipedia, a programme by INRAE, CIRAD, AFZ and FAO. [https://www.feedipedia.org/node/268/accessed 30/11/2020](https://www.feedipedia.org/node/268/accessed%2030/11/2020).
- Kainer K, Schmin M, Leite A, Fadell M (2013). Experiments in forest based development in Western Amazonia. *Society and Natural Resources*, 2013, 16: 869-886.
- Karou S, Tchacondo T, Tchiboza MD, Abdoul-Rahaman S, Anani K, Koudouvo K (2015). Ethnobotanical study of medicinal plants used in the management of diabetes mellitus and hypertension in the Central Region of Togo. *Pharmacology and Biology*, 2015, 49 (12): 1286-1297. Retrieved 23rd November 2020, from the PubMed database.
- Karter L, Kante S, Budelman A (2012). Karite (*Vitellaria paradoxa*) and Nere (*Parkia biglobosa*) associated with crops in South Mali. *Agroforestry Systems*, 2012, 18: 89-195.
- National Bureau of Statistics (2011). Annual abstract of statistics. Federal Republic of Nigeria. pp 59- 60.
- Odihi J (2013). Deforestation in afforestation priority zone in Sudano-Sahelian Nigeria. *Applied Geography*, 2013, 23: 227-259.
- Okafor JC (2013). Strategies for the development of fruit tree and non-timber forest products in Nigeria. *In: Proceeding of the 23rd annual conference of Forestry Association of Nigeria*. pp 13-18.
- Orwa C, Mutua A, Kindt R, Jamnadass R, Anthony S (2009). Agroforestry Database: A Tree Reference and Selection Guide Version 4.0, World Agroforestry Centre, Kenya, [https://www.feedipedia.org/node/1650/accessed 30/11/2020](https://www.feedipedia.org/node/1650/accessed%2030/11/2020).
- Ozo-Eson PI (2012). Gender issues in forestry development in Nigeria. *In: Proceedings of the 28th annual conference of Forestry Association of Nigeria*. pp 218-231. Oni PI, Popoola L, eds. 2009, Akure, Nigeria.
- Tekleheimanot Z (2013). Strategies for improved management of agroforestry parklands in Africa. *In: Agroforestry International Workshop Proceedings*. pp 15-35. Tekleheimanot Z, Painton M, eds. 2013, Ouagadougou, Burkina Faso.
- Traore M, Balde M, Oulare K, Magassouba F, Diakité I, Diallo A (2013). Ethnobotanical survey on medicinal plants used by Guinean traditional healers in the treatment of malaria. *Journal of Ethno Pharmacology*, pp 378-387. Retrieved 24th November 2020 from the PubMed database.
- Western D, Strum S, Tuzin D, Sayre K, Wright M (2014). A few big challenges: natural connections: perspectives in community based conservation in United States. Washington D.C Island Press. pp 536-547.