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ANALYSIS OF ECONOMIC VIABILITY OF GUM ARABIC (*Senegalia senegal*) PLANTATIONS INVOLVED IN DESERTIFICATION CONTROL AND REVENUE GENERATION PROJECTS IN YOBE STATE, NIGERIA

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ABSTRACT

This study analysed the economic viability of gum Arabic (*Senegalia senegal*) plantations for desertification control and revenue generation projects in Yobe state, Nigeria. Specifically, it assessed the socioeconomic characteristics of gum Arabic marketers, economic viabilities of gum Arabic plantations, the profitability of gum Arabic marketing as well as establishment and management costs of gum its plantations in the state. Three plantation areas of Afunori, Nangere and Damaturu, established in 1999, were purposively selected for this study. A total of 125 gum Arabic marketers were randomly selected based on Yero Yemeni`s sample size model. Two structured questionnaires were developed. One was exclusively directed to the marketing respondents, while the other was restricted to the plantation managers. The variables on which data were collected included marketing costs and revenues as well as establishment and management costs. Data were also collected on socioeconomic variables of respondents. Results showed that gum Arabic plantations in the state were economically viable with BC-R values greater than 1 and with positive NPV and LEV values. Similarly, Gross Margin and profitability analyses for gum Arabic marketing showed significant profit margin with up to ₦2, 403.09 net profit per ton per marketer generated from 685.41tons of gum Arabic marketed within 5 years. However, establishment cost per hectare of ₦337, 515.63 was comparatively greater than the management costs of ₦57, 583.33per hectare. Conversion of gum Arabic substation of Rubber Research Institute of Nigeria at Jawa into a full fledge gum Arabic Research Institute was the major policy recommendation made.

Keywords: Economic viability; *Senegalia senegal;* desertification control; revenue generation

INTRODUCTION

Yobe state grapples with severe environmental degradation (UNDP, 2005) due to the consequences of climate change (NIMET, 2014). This culminates into cyclical drought with resultant catastrophic development of arid and semi-arid conditions (Iloeje, 1992). Apart from climatic variability; deforestation has taken its toll in recent times. Consequently, desert encroachment is eating up the marginal lands at the rate of 0.6 km/annum (FAO, 2009). This

is apparent in Kaska, Tulotulo, Kumaganam and Gumsi communities encroached by large masses of sand dunes besides farmlands and infrastructure overtaken by the desert (Muhammad, 2016). Thus, the environment is highly degraded and this requires aggressive and sustainable environmental management programs (YBSES, 2008). Resuscitating and maintaining degraded environment gulps huge sums of money that cannot be afforded by the state. This is due to its total dependence on inadequate fund allocation from the Federal Government occasioned by dwindling oil revenues (CBN, 2006). The need to diversify the state's economy therefore becomes apparent (Ogbebahu, 2009). It is for this reason that the federal government directed all states to look inwards for alternative sources of revenues for all forms of development in their respective domains. To achieve this, the Raw material Research and Development Council (RMRDC) and the National Economic Empowerment and Development Strategy (NEEDS) have been mandated to identify important renewable and non-renewable resources available in each state for subsequent investment into the sector (YBSES, 2008). Accordingly, Yobe state endowed with favourable agro-ecology for gum Arabic resources is considering large-scale investment in plantation forestry for desertification control and revenue generation. The use of gum Arabic to achieve both objectives could be a right strategy. However, there is a need for critical analysis of its economic viability with respect to the attainment of the set objectives (Wilkinson and Elevitch, 2012). A prior research work is therefore necessary. The choice of this species from tens of other species is based on the findings of the Yobe State Afforestation Project (YBSAP) and the Food and Agriculture Organization (2008) that gum Arabic is highly adapted to the Sudano-Sahelian agro ecology and that it produces gum nodules that are highly valued in the global market.

This work was set to analyse the economic viability of *Senegalia senegal* plantations involved in environmental management and revenue generation projects in Yobe state, Nigeria. Specifically, it assessed the socioeconomic characteristics of gum Arabic marketers, economic viability of its plantations, the profitability of its marketing as well as establishment and management costs of its plantations in the State.

MATERIALS AND METHODS

The Study Area

Yobe State is located between latitudes 10° 27′ and 13° 23′ North and longitudes 9° 40′ and 12° 30′ East of the Green Which Meridian (Figure 1). It occupies the North Eastern part of the country and is bordered on the North by the Niger republic, on the East by Borno State, Bauchi on the Southwest and Jigawa state on the Northwest (Encyclopaedia Britannica, 2006). It covers a total land area of 45,502 km^2. Available data indicate remarkable variations in the amount of rainfall and length of the rainy season between the Northern and Southern parts of the State. In the North, annual rainfall ranges from 300mm to 500mm and the rainy season lasts for only 90 days. In the Southern part, the range per annum falls between 500mm and 1000mm within a maximum of 140 days (YBSG, 2004). Besides the shortage of the growing season, the pattern of the rainfall is very unpredictable leading to drought. Temperatures are particularly very high throughout the year ranging from 39^0 C to 42^0 C (YBSG, 2004). The temperature and rainfall data give a vivid picture of the type and distribution of vegetation in the State: Sahel in the North and Sudan Savannah in the South. Both vegetation types are under severe and continuous threats of desert encroachment (Iloeje,

1992). The dominant ethnic groups are Manga, Fulani, Ngzim, Bade, Bolewa, Karei-Karei. Their major occupations are farming and marketing. Among the popular cash crops grown in the State are gum Arabic, groundnut, onion, cotton, and tomatoes. Other crops commonly grown in the State include millet, guinea corn, maize, rice, beans and sesame.

The State was divided into three plantation areas established in 1999 National Tree Planting Campaign, comprising Afunori Plantation Area (APA), Nangere Plantation Area (NPA) and Damaturu Plantation Area (DPA) with each covering 6, 4 and 7 Local Government Areas respectively (Figure1). This is based on the existing zoning arrangement of the Yobe State Afforestation Project (YSAP). APA covered a total land area of 16,059.52 km^2, whereas NPA and DPA had 10,706.35 and 18, 736.12 km^2 respectively (YBSES, 2008).

Data Collection

Two sets of structured questionnaires were used in the collection of primary data for the study. One set was administered on 125 out of 182 total number of gum Arabic marketers. The 125 randomly selected respondents comprised 44, 29 and 52 gum Arabic marketers from APA, NPA and DPA respectively, based on Yemeni's (1967) model of sample size determination (equation I). The other questionnaire was administered on 3 plantation managers. Thus**,** a total of 150 questionnaires were produced for data collection out of which 125 copies were correctly filled, returned and used in data analysis.

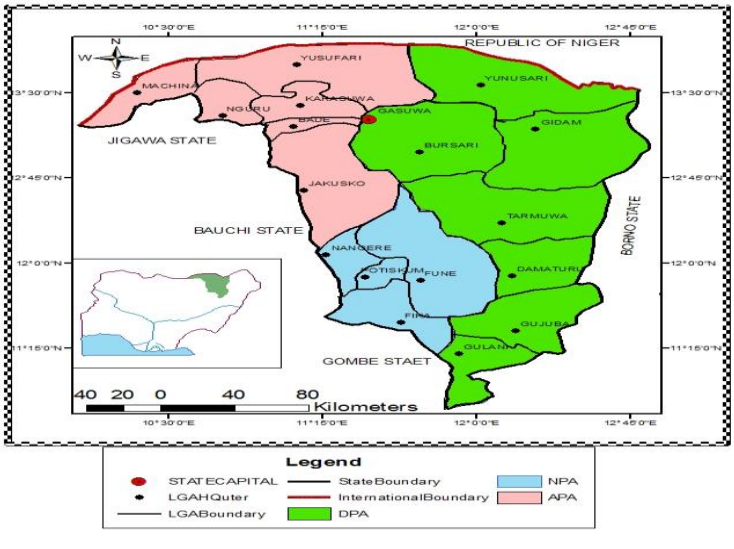

Figure 1: Map Yobe State Showing the Study Area

Produce @ GIS Laboratory, Geography Department MAUTECH Yola 2016

Model specifications

The outline of Yemeni's formula as used in Buba (2012) is given below:

$$n = \frac{N}{(1+Ne^2)} \quad \text{..... (I)}$$

Where:
n = Sample size
N = Population size
e = Sampling error (0.05)

Gross Margin (GM) and profitability analysis model was used in determining the profitability of gum Arabic marketed from 2009 to 2013 in the three plantation areas. This work adopts Umar et al. (2014) method of GM calculation as follows:

GM = TR – TVC ..... (II)
NP = TR – TC ..... (III)
Where: GM = Gross Margin for gum Arabic Marketing (₦)
TR = Total Revenue realized from the sales of gum Arabic produce (₦)
TVC = Total Variable Cost incurred in marketing gum Arabic produce (₦)
NP = Net Profit realized from the marketing of gum Arabic produce (₦)
TC = Total Cost incurred in the marketing of gum Arabic produce (₦).

Benefit Cost Ratio **(**BCR) was used in order to compare the flows of benefits and costs involved in the establishment and management of *Senegalia senegal* plantations *in* the three plantation areas studied. For any project to be economically viable, the benefit cost ratio (BCR) must be greater than or equal to 1 (i.e., *BC-R≥1);* and when deciding between alternative projects, the one with the highest BCR should be selected**.** This work adopts Sinden and Thampapillai (1995) method for calculating BCR as follows:

$$B/C = \frac{\sum_{t=0}^{t=n} \frac{Bt}{(1+r)^t}}{\sum_{t=0}^{t=n} \frac{Ct}{(1+r)^t}} \text{.....Eqn.2}$$

Where:
BCR = Benefit Cost Ratio of gum Arabic plantation
B_t = Total Value of Benefit derived from the sales of gum Arabic produce in the 15thyear of the project (₦)
C_t = Total Value of costs incurred in the Establishment and Management of Gum Arabic plantation in the $1^{st} – 10^{th}$ year of the project (₦)
t = Time (15 years)
r = Interest rate (24% based on cost of borrowing capital in the study area)
∑ = Summation sign

The Net Present Value (NPV) was applied in this work to assess the economic viability of gum Arabic plantation projects in the state. To determine NPV, all cash flows were discounted since it stands for the sum of all discounted costs and benefits. This sum reflects how much the project would earn. A project with negative NPV is not viable because the costs associated with it outweigh the benefits. This work adopts Sinden and Thampapillai (1995) method of NPV computation as follows:

$$NPV = \frac{\sum B_t(1+r)^t - \sum C(1+r)^t}{(1+i)^t} \quad \text{..... (V)}$$

Where:
NPV = Net Present Value of gum Arabic plantations
B_t = Total Value of Benefit derived from the sales of gum Arabic produced during period of the Project (₦)
C_t = Total Value of costs incurred in the Establishment and Management of Gum Arabic plantation in the 15 year of the project (₦)
t = Time (5 years)
r = Interest rate (24% based on cost of borrowing capital in the study area)
$\sum$ = Summation sign

Land Expectation Value (LEV) is the net present value of income from an infinite sequence of harvests and it represents the value of bare land used to grow trees. LEV was considered relevant in this work because it assesses financial returns from the management of even-aged plantations of *Senegalia senegal* as well as its suitability in valuation of forest land that can be used for growing timber. Since this work involved even-aged plantations, it adopts Thomas and Steven (1991) method of LEV calculation as follows:

$$LEV = \frac{\sum B_t(1+r)^t - \sum C(1+r)^t}{(1+i)^t - 1} \quad \text{.....(VI)}$$

Where:
LEV = Land Expectation Value of gum Arabic plantations
B_t = Total Value of Benefit derived from the sales of gum Arabic produce in the 11^{th} – 15thyear of the project (₦)
C_t = Total Value of costs incurred in the Establishment and Management of Gum Arabic plantation in the 1^{st} – 10^{th} year of the project (₦)
t = Time (5years)
r = Interest rate (24% based on cost of borrowing capital in the study area)
$\sum$ = Summation sign

RESULTS AND DISCUSSION

Socioeconomic Characteristics of Gum Arabic Marketers

The male gender dominated the marketing scenario of gum Arabic produce. It constituted 80% of the total respondents engaged in gum Arabic marketing (Table 1). The balance of 20% represented female participation. The low participation of the female gender might not be unconnected with the hectic marketing activities including movement from one plantation to another or from one village market to another, grading, parking and standardization. However, the attractive market prices are commensurable with these marketing activities. Therefore, enlightenment campaign needs to be incorporated in the women empowerment program severally reiterated in the stipulations of the Millennium Development Goals (MDGs) (UNDP, 2008).

Results in Table 1 showed that the sampled gum Arabic marketers were mainly youths whose mean age was 30.6 years (Table 1). Therefore, as youth, they vigorously handled and endured all hectic marketing activities involved in the business. This agrees with UNDP (2008) stipulations of direct involvement of able-bodied individuals in economic activities. The result further indicates the willingness of both youth and matured persons to accept and manage risk as established by Giroh, Umar and Yakubu (2010).

Table 1: Personal characteristic of Gum Arabic marketers

S/n	Socioeconomic Variable	Frequency (f)	Percentage (%)
1	Gender		
	Male	100	80
	Female	25	20
	Total	125	100
2	Age Class		
	20 – 30	40	32
	31 – 41	75	60
	42 – 52	05	04
	53 – 63	05	04
	Total	125	100
3	Marital Status		
	Married	100	80
	Single	10	08
	Widow	10	08
	Divorcee	05	04
	Total	125	100
4.	Educational Qualification		
	No Formal Education	50	40
	Primary	20	16
	Secondary	55	44
	Total	125	100
5	Main Occupation		
	Farming	50	40
	Trading	10	08
	Civil Servant	65	52
	Total	125	100
6	Marketing experience		
	05 – 08	100	80
	09 – 12	15	12
	13 – 16	10	08
	Total	125	100

Source: Field Survey, 2014.

The married sub variable constituted 80% of the total marketing respondents. Singles, widows and divorcees collectively formed the balance of 20% (Table 1). In other words, gum Arabic marketing engaged persons with many and varied marital statuses. However, the extent was greater among married respondents compared to other sub-variables in the same category. Again, this contradicts MDGs regulations of equal job opportunities for all including women and youth (UNDP, 2008). The high participation of married respondents in gum Arabic business was explained by the need for additional incomes for livelihood improvement (UNDP, 2001).

Respondents with secondary and primary education collectively formed 60% in the respective order of 44% and 16% (Table 1). Individuals with non-formal education constituted the balance of 40%. This could be part of the reason for the high net

profit/tone/marketers realized by the respondents. This agrees with Eboh (2006) who asserted that education is a crucial factor to higher performance in any business activity.

Public service was the major occupation (52%) of the sampled gum Arabic marketers (Table 1). The farming occupation followed closely (40%) but was dominated by individuals in abject poverty and high illiteracy level against the stipulations of the Millennium Development Goals (UNDP, 2008). Thus, the probability of generating high profit margin was high since the marketing scenario was overtaken by public servants with high level awareness about the production packages available.

Results indicate low marketing experience among the respondents (Table 1). This means that gum Arabic marketing was a new business in the study area. However, its attractive global market value couple with high literacy level among respondents can predict generation of high profit. Therefore, the high profitability of gum Arabic marketing could partly be attributed to it. This agrees with Woods (2008) assertion that experience and education create behavioural changes and confidence in business.

Economic Viabilities of Gum Arabic Plantations in the State

Benefit Cost Ratio (BCR): BCR assessed all cost and benefit elements of each of the sampled plantation at the prevailing borrowing rate of 24%. Results showed that APA, NPA and DPA studied had 1.56, 1.40 and 1.10 BCR values respectively (Table 2). Based on the decision rule governing BCR regulations, all the gum Arabic plantations studied were economically viable. This agrees with the stipulations of the Department of Finance and Administration of Australia (2006) which requires acceptance of any policy, project or program with BCR value ≥ 1.

Net Present Value (NPV): Similarly, NPVs for all the three plantations studied were computed by subtracting discounted costs from discounted benefits (Thampapillai, 1995) at 24% interest rate (Table 2). Accordingly, the values of ₦163, 036.60/ha, ₦106, 835.09/ha and ₦57, 101.57/ha were computed at APA, NPA and DPA respectively. Again, gum Arabic plantation projects were economically attractive for yielding positive NPV values. This confirms the global recognition of its economic potentialities widely reported by Acacia Market Report (2006) and the Daily Trust (2006).

Land expectation value (LEV): Land Expectation Value (LEV) otherwise known as Soil Expectation Value (SEV) or Bare Land Value (BLV) was used in the same way as BCR and NPV. LEV computations for gum Arabic projects were based on even-aged situation and at 24% rate of interest. Table 2 revealed LEV values for the three sampled plantations as follows: ₦152, 370.65/ha, ₦99, 845.88 /ha and ₦53, 365.95/ha APA, NPA and DPA respectively. Positive LEV values connote economic viability of investment entities. What was responsible for positive NPV and LEV values in the three plantation areas? The global attractive prices it enjoys led to the establishment of functional markets across the state. This further led to the formation of the National Association of Gum Arabic Producers, Processors and Exporters of Nigeria (NAGAPPEN). Thus, the availability of functional markets and supportive services created fertile ground for gum Arabic business in the state (FAO, 2009). This confirms the interdependence of production and marketing severally reiterated by Abbott &Makeham, (1990); Muhammad (2005) and Adegeye and Dittoh (2005).

Table 2: Summaries of BCR, NPV and LEV values for *Senegalia senegal* plantation projects at APA, NPA and DPA

Economic tool	Plantation area	Computed value	Decision based on rule
BC-R (24%)	APA	1.56	EV
BC-R (24%)	NPA	1.40	EV
BC-R (24%)	DPA	1.10	EV
NPV (24%)	APA	₦163, 036.60	EV
NPV (24%)	NPA	₦106, 835.09	EV
NPV (24%)	DPA	₦57, 101.57	EV
LEV (24%)	APA	₦152, 370.65	EV
LEV (24%)	NPA	₦99, 845.88	EV
LEV (24%)	DPA	₦53, 365.95	EV

Source: Field Survey, 2014. Key: EV = economically viable

Profitability of gum Arabic marketing

Table 3 summarizes gross margin and profitability analyses for gum Arabic marketing in the three-plantation areas.

Table 3: GM and Profitability Analysis for Gum Arabic Marketing at APA, NPA and DPA

Variables (Items/Activities)		Value/tone (₦)
(A)	Depreciated Fixed Cost	
i.	Scales	16, 752.05
ii.	Head pans	6, 240.85
iii.	Measures/Modus	1, 860.35
Total Fixed Cost		24, 853.25
(B)	Variable Cost	
i.	Labor	26, 719.40
ii.	Operating Cost	73, 156.55
iii.	Purchasing Cost	922, 833.95
Total Variable Cost		1, 022,709.90
(C)	Total Cost	1, 047, 563.15
(D)	Total Revenue (TR)	1, 347, 950.45
(E)	Gross Margin (D – B)	325, 240.60
GM/tone/Marketer		2, 601.92
(F)	Net Profit (D – C)	300, 387.30
NP/tone/Marketer		2, 403.09
(G)	Total Number of respondents	125
(H)	Total Quantity Marketed	685.41

Source: Computed from data collected from the field, 2014.

It is evident that between 2009 and 2013, a total of 685.41 tons of gum Arabic were marketed generating ₦923, 898, 717.34. Total GM realized by gum Arabic marketers was ₦222, 923, 159.65 whereas GM per ton stood at ₦325, 240.60. Similarly, GM value per ton per marketer was ₦2, 601.92. Total net profit realized was ₦300,387.30 whereas the net profit per ton per marketer was only ₦2, 403.09. This clearly indicates that gum Arabic marketing was a lucrative business venture in the study area. In other words, all the

participants receive significant profit margin favourable for both increased future production and marketing. This finding confirms the direct relationship between production and marketing observed earlier by Abbott and Makeham (1990). This means that gum Arabic business could make giant strides in revenue generation drive.

Establishment and Management Costs at APA, NPA and DPA

Senegalia senegal had very high establishment expenditure compared to other Xyrophytes (Table 4). This was attributed to two factors. First, was its high palatability to small ruminants thus necessitating the need for fencing which accounted for more than 59% of the total establishment cost (Muhammad, 2016). Second; its susceptibility to pest damage requiring substantial expenditure on chemical inputs against insect pest damage. This explains why the total establishment cost per hectare was ₦337, 515.63 (Table 4). On the contrary, the management expenditure was grossly lower than the establishment cost per hectare. The management cost covered day-to-day expenditure incurred on services essential for proper maintenance of the plantations. These services included replacement of dead stands, construction of micro-catchment, fire terracing, security patrol, pruning, seed harvesting and parking as well as trimming operations. All these operations cost ₦57, 583.33 per hectare (Table 5). Generally, the establishment and management cost of gum Arabic plantations were affordable only to public agencies, NGOs, private organizations as well as individuals with reasonable control of financial resources.

Table 4: Summaries of establishment expenditure of gum Arabic plantations at APA, NPA and DPA

S/n	Expenditure type	Year Incurred	Mean cost/ha (₦) Gum Arabic
1	Land	1999	12, 666.67
2	Fencing	1999	199, 309.54
3	Land preparation	1999	27, 257.92
4	Seedlings (cost & transport)	1999	5, 833.34
5	Borehole (cost & maintenance)	1999	60, 533.33
6	Inputs (tools equipment & chemicals)	1999	9, 081.50
7	Micro Catchment Construction	1999	1, 833.33
8	Fire terraces	1999	5, 000.00
9	Security patrol	1999	16, 000.00
10	Total	-	337, 515.63

Field Survey, 2014.

Table 5: Summaries of management expenditure of gum Arabic plantations at APA, NPA and DPA

S/n	Expenditure type	Year Incurred	Mean cost/ha (₦) Gum Arabic
1	Replacement of dead stands	2000	1, 916.67
2	Micro catchment construction	2000	3, 833.33
3	Fire terracing	2000	16, 500.00
4	Security patrol	2000	28, 000.00
5	Pruning	2003	2, 833.33
6	Seed harvesting and parking	2006	4, 500.00
7	Trimming operations	2007	0.00
8	Total	-	57, 583.33

Source: Field Survey, 2014.

CONCLUSION

Senegalia plantations involved in desertification control and revenue generation projects in Yobe state were economically viable. Results generated from the three plantation areas clearly confirm this. For instance, BCR values were greater than 1 in all the three areas studied. So also, were the positive NPV and LEV values in all the three sites. This means that its economic potentials were not only understood but also reasonably being exploited. If the production capacity can be expanded while the existing resources can be sustainably managed, then the prospects of the crop changing the economic fortunes of the state are high. This work recommends conversion of gum Arabic substation of the Rubber Research Institute of Nigeria at Jawa into a full fledge gum Arabic Research Institute. Environmental laws that can protect this and other trees species with physical and economic potentials need to be enacted. There is an urgent need for the state to move forward in this direction. This paper provides an opportunity for investment in plantation forestry – one of the reliable economic diversification strategies. The program deserves the attention of the best foresters, social and natural scientist, engineers, management as well as extension specialists which the state can produce.

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