

Wild fruits impact on household's income and livelihoods in Abyii locality in western sector localities of South Kordofan State, Sudan.

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ABSTRACT: The current study was conducted in Abyii locality to identify wild fruits contribution on Household income and livelihoods, fruits return, collection days and fruits trees optimum combination that maximize the small producer's gross margin (GM). 100 fruits collectors were selected purposively through field survey in 2013/2014 season. Fruits collectors obtained SDG 17,596.34 of fruits annual cash income followed by agriculture SDG 7,700. The total annual income was found to be SDG 25,296.34 as GM to cover household expenditure. Study found that household net income was SDG 9,191. Regression analysis results showed that, the estimated R^2 was 0.83 which explained that 83% of fruits return variation was determined by fruits prices, distance and collection cost. However F-value was 8.63 while F-tabulated was 2.54, indicates that the model is highly ($p < 0.001$) significant in explaining the fruits return variation for fruits. The previous GM was SDG 17,596.34 Linear programming result showed that, a total GM was found to be SDG 19,285.61. Five trees were tested in the area where optimum tree combination that maximized the small producers gross margin was to cultivate 1.23 and 4.13 feddan of *Balanites* and *G.tenax* to get GM equal SDG 15440 and 3845.61 respectively and total GM was found to be SDG 19,285.61. The optimum GM makes an increment in the previous GM by 8.75%. The optimum under reallocation of resources indicated that, an improvement in GM and cash income per feddan (4200 M²) by 4%. Partial budgeting indicated that, all fruits quantities gave positive returns. The collection days fill the gap between the production seasons. The results showed that *Grewia tenax* fruits GM was found to be SDG 806.58 (4). Household economy analysis showed that, wild fruits contribute to household income and expenditure by 70.5% and 109%, respectively. Fruits collection is most important source of cash income and employment. The study recommended that fruits trees should be adopted and domesticated through, extension services. Because NTFPs collection and marketing improving household income and participate on food item expenditure.

Keywords: Non-timber Forest Products (NTFPs), Livelihood, Food Security fans.

INTRODUCTION

Abyii locality is one of western sector localities of South Kordofan state. Most of area people are farmers. Predominant important fruits trees are *Z. spina-christi*, *B. aegyptiaca* and *G.tenax*. Reference (7) stated that forest goods are either timber or non-timber. Non timber forest products (NTFPs) are harvested for both subsistence and commercial use and play a role in the livelihood of millions rural people (7). Majority of rural and urban households in Nigeria depend on forest products to meet their households' nutritional needs and incomes generation (16). While reference (3) stated that the bringing of NTFPs to the markets is expensive. *Zizyphus* tree grows in bush land as well

as riverbeds and edges of cultivations (8), (15). Its fruit is edible for human food and animal fodders (14), (11). Desert date (*Balanites*) tree is available in areas of Ethiopia and some parts of Africa (8)(15). It's a major producer of fruits, locally they were traded in large quantities in local markets in Kordofan, Darfur and Southern Sudan (2). Tamarind (*Tamarindusindica*) is grown as a subsistence crop for meeting local demands and commercial purposes (17). Reference (12) reported that tamarind tree can produce an annual fruit yield in the range of 150- 500kg/tree. Reference (6) stated that, in Shiekan rural areas of North kordofan state *Z. spina Christi*, *B. aegyptiaca*, *A. digitata*, *T. indica* and *G. Tenax* fruits were most important as they gathered and used by different communities. While reference (1) reported that, fruit sales are important in lowering the unemployment during the dry season. Reference (13) reported that, NTFPs are an important source of income in rural area and employment.

MATERIALS AND METHODS

Non timber forest products (NTFPs) provide employment through fruits collection and marketing. 20 of fruits collectors were selected purposely from 2 villages. Ten collectors selected purposely from each village. Secondary source of data were also used. Regression analysis, partial budget, linear program and household economy were used to identify wild fruits contribution on household income and livelihood.

Regression analysis

As reference (4) regression analysis was used to identify the relationship between fruits returns as dependent variable and factors affecting fruits returns as independent variables.

Partial budget method.

Partial budget is used to estimate wild fruits quantities, fruits costs and fruits and fruits returns, which calculated by multiplying average fruits quantities by fruits prices (10). Net return equals the different between gross return and fruits total variable costs.

linear programming methods

Linear programming model is a method determining the area to be used for different trees mixture for maximum combination. The model was specified in terms of its objectives function, activities and constraints under normal conditions to determine the optimum resources allocation for specific activities for improving the income level for the household. Linear programming requires for NTFPs information options with their respective resource requirements and any constraints on their production, the fixed requirements and other maximum, minimum constraints that limit family production, cash costs, and returns of each activity and defined objective function. In this context a linear programming model has been developed to determine the area to be used for different trees for maximum combination and for improving farmers' income. The model expressed as follows:

Z= maximization function following constraints;

Labour (man-days)

Capital (SGD) or collected quantities cost

Productivity /kg or tree or (man-day).

Activities (fruits collection of the following trees):

Balanites aegyptiaca (*Desert date*) = x_1

Zizyphus spina christi (*thorn cristi*) = x_2

Tamarindusindica (*Tamarind*) = x_3

x_4 *Adansoniadigitata* (*Baobab*) =

-Labor (man-days)

$\sum M_{dij} \leq D$

$X_{1i} + X_{2i} + X_{3i} + X_{4i} + X_{5i} \leq D$ (3.1)

$X_{1j} + X_{2j} + X_{3j} + X_{4j} + X_{5j} \leq D$

Where:

D = is the available man-days for wild fruits collection (hired) activities

M_{dij} = is the amount of required man-days for wild fruits collection activities.

Working capital = SDG

$\sum K_{ij}x_j \leq WK$

$X_{1ki} + X_{2ki} + X_{3ki} + X_{4ki} + X_{5ki} \leq wk$ (3.2)

$X_{1kj} + X_{2kj} + X_{3kj} + X_{4kj} + X_{5kj} \leq wk$

Where:

W_k = is the amount of available working capital for fruit collection

K_{ij} = is the amount of working capital required for fruit collected quantities kg/tree or (man-day) and non-productive activities.

Working capital is the value of inputs (labor) allocated for fruit collection. The cost of working capital is the benefits that farmer trying to allocate 16). Fruits collection

Fruit collected quantities kg/ man-days or kg/tree:

$$\sum a_{ij}pD \geq PD$$

Where:

$a_{ij}pD$ = is the amount of fruit collected (productivity) available with the sample farmer.

P = is the amount of fruit quantities required for collecting activities.

Maximize objective function:

$$Z = \sum c_j x_j + \sum c_j^* x_j^* \quad \text{objective function} \quad (3.3)$$

$$X_{1j} + X_{2j} + X_{3j} + X_{4j} + X_{5j}$$

Subject to constraints

$$\sum a_{ij}x_j \leq b_i \quad \text{constrain equation}$$

$$X_j \text{ and } x_j \geq 0$$

Where:

Z = gross margin.

C_j = price of collected fruit

C_j^* = price off-farm production

x_i = unit price of fruit collected.

X_j = level at collection activity

A_{ij} = resources required

B_i = resources available

Number of resources(activities).

Constraints:

$$\text{Man-day} \geq 0$$

$$\text{Tree number} \geq 0.$$

Household economy analysis

Household economy analysis was used to calculate and identify household annual income, expenditure and the contribution to household income and expenditure.

RESULTS AND DISCUSSION

Regression analysis

Regression analysis used to measure the relationship between wild fruit return as dependent variable and fruit selling prices, distance and costs as independent variables. According to the study results, the estimated R^2 was 0.81 which indicates that 81% of fruits return variation was determined by estimated model (fruits prices, distance and costs), similar result was reported by reference(4) that regression analysis measures the relationship between dependent variable and one or more than independent variables. However F - value was 8.63 while F - tabulated was 2.54, indicates that model is high ($p < 0.001$) significance in explaining the fruits return variation; hence the variables coefficients of fruits prices were negative. Table1.

The estimated equation is:

$$Y = 277.227 + 270.33x_1 + 204x_2 + 63.66x_3 + 95.27x_4 - 47.23x_5 + 4.94x_6 + 2.675x_7.$$

Whereas;

X_1 = Balanities aegyptiaca fruit price

X_2 = Zizyphus spina –christi fruit price

X_3 = Adansonia digitata fruit price

X_4 = Tamarindus indica fruit price

X_5 = Distance km

X_6 = Fruits costs

Table 1. Coefficients of the costs, fruit distance and fruit prices, Abyii locality

Model	Coefficients	Standard error	Significance
Constant	277.227	2504.694	0.914
Coefficient of Blanites price	270.333	165.616	0.129
Coefficient of Ziziphus price	204.006	225.994	0.384
Coefficient of Adansonia price	63.663	126.294	0.624
Coefficient of Tamarindus price	95.275	190.572	0.626
Coefficient of Grewia price	-47.231	48.647	0.351
Fruit distance	4.943	80.384	0.952
Costs of fruit collecting	2.675	1.184	0.043
R ² square (coefficient of determination)	0.834		
- ² R adjusted	0.738		
F	8.630	560.6017	0.001a

Source: Field survey, 2013. F- Tabulated 2.54

Partial budgeting (Average return of wild fruits in Abyii locality)

Partial budgeting analysis results revealed that, Balanites fruits quantity was 208.5 kg, while Zizyphus, Adansonia and Tamarindus quantities were 229.2, 210 and 154.68 kg, respectively. The same view were reported with reference (16) that Zizyphus tree grows in bush land as well as riverbeds, edges of cultivations and gardens. Its fruit is edible for human food and animal fodders (15), (12). Balanites fruits collection days were 10.6 while other fruits quantities collection days were 45 day. However, wild fruits were collected from area 6.2 Km. Similar results were reported by Reference (6) who stated that, in Shiekan rural areas of North kordofan state Z. spinachristi, B. aegyptiaca, A. digitata, T. indica and G. Tenax fruits were most important as they gathered and used by different communities. While reference (14) reported that, NTFPs are an important source of income in rural area and employment. Similar result with reference (1) who reported that, fruit activity is important in lowering the unemployment during the dry season in which most the agricultural activities were completed. Total gross return was found to be SDG 2040.81. This was comparable to results of reference (7) that NTFPs are harvested for both subsistence and commercial use. Fruits collection distance, unrest security and costs is main factors affecting respondent's movement and fruits activity, which reconcile with reference (2) who stated that the problems of the wild fruits collection are fruits seasonality, transportation, collection costs, pricing and local markets scarcity, which agree with reference (3) that the bringing of NTFPs to the markets is expensive.

Table 4 .10. Fruits average returns in Abyii Locality

Wild fruits	Blanites	Ziziphus	Adansonia	Tamarindus	Grewia	Total
Collected	208.5	229.2	210	154.68	43.45	
Quantity/ kg						
Collection days	10.6	11.5	12	8.6	14	56.7
Productivity kg/ tree	303.75	187.2	133	234.7	4.18	
Fruit price	1.43	1.69	3.22	1.5	22.27	
Fruit gross output	298.16	487.35	676.2	232.02	967.63	2661.36
Total variable cost of collected/ SDG	93	115	167	84.5	161.05	620.55
Fruits GM	205.16	372.35	509.2	147.52	806.58	2040.81

Source: Study field survey, 2013.

Linear programming

Gross margin for trees grown in Abyii Locality was found to be SDG 12552.83, 2446.85, 322.5, 1343.02 and 931.14 for Balanites, Ziziphus, Adansonia, Tamarindus and Grewia respectively and the total gross margin was found to be SDG 17596.34.as shown in Table (4.4).

Table 4.4. number of fruits trees / feddan and their gross margin in Abyii Locality in W.K.S

fruits trees	Balanites	Ziziphus	Adansonia	Tamarindus	Grewia	Total
Trees number	42	11	1	6	12	
Productivity kg/ tree	303.75	187.2	133	234.7	4.18	
Fruit production/ fedden/ kg	12757.5	2059.2	133	1408.2	50.16	
Collecting days	45	35	13	25	20	138
Fruit price	1.43	1.69	3.22	1.5	22.27	
FruitGross Output	18243.23	3480.05	428.26	2112.3	1117.06	25380.90
Variable costs of collected/ SDG	5690.40	1033.20	105.76	769.28	185.92	7784.56
Fruit GM	12552.83	2446.85	322.50	1343.02	931.14	17596.34

Source: Study field survey, 2013.

Five trees were tested in the area where the optimum tree combination that maximized the small producers GM in this area was to cultivate 1.23 and 4.13feddan of Balanites and G.tenax to get GM equal SDG 15440 and 3845.61. The total GM was found to be SDG18285.61. In Table 4.4, optimum gross margin makes an increment in the previous GM by 4% which will contribute in the household expenditure in food items in the locality, Similar result with references (10), (16) that Desert date(Balanites) tree is available in semi-arid areas of Ethiopia and other parts of Africa. It's a major producer of fruits, locally the fruits traded in large quantities in local markets in Kordofan, Darfur and Southern Sudan (2).

Table 4.19. Optimal solution of trees harvested in Abyii locality in

Tree	Area/feddan	Gross margin/feddan	Value/SDG
X1(Balanites)	1.23	12552.83	15440
X2(Ziziphus)	0	0	0
X3(Adansonia)	0	0	0
X4(Tamarindus)	0	0	0
X5(Grewia)	4.13	931.14	3845.61
Total			18285.61

Source: Study field survey, 2013.

Study found that the constraint of wild fruits collection were fires, over-grazing and trees cutting for crops production or fire wood and charcoal as well as fruits quantities transport.

Households income and expenditure in Abyii locality

The main sources of income for household in locality were agricultural production (crop production) and (NTFPs). Household average annual income in the year found to be SDG 25,986. Table 5.

The average total expenditure of the food items for a single household for the whole year found to be SDG 16.795 (Table .5).The contribution of NTFPs to household expenditure and income were found to be 109% and 70.5, respectively. This indicates that fruits play important role in household income generation, which agrees with reference (9) who stated that fruits are source of cash income for people in western and central Sudan as well as Sahara regions.

Table 5. Household net income and the contribution of NTFPs to Household expenditure and income in El-merum locality of the WSSKS

Variable attribute	Average income
Agricultural Production	7,700
Non timber forest products (NTFPs)	18,286
Total annual income	25,986
Household annual Expenditure	16,795
Net household income	9,191
Contribution Of NTFPs to household Expenditure	109%
Contribution Of NTFPs to household income	70.5%

Source: Study Field survey, 2013.

CONCLUSION

Regression result shows that, the estimated R^2 was 0.81 which explained that 81% of fruits return variation was determined by fruits prices, distance and fruits costs. Which Indicated that model is high ($p < 0.001$) significance in explaining fruits return variation; hence variables coefficients of fruits prices were negative. The optimal model for trees with relevant unit area feddan(4200 m²) of linear programming indicated that, *Balanites* and *Grewia* trees were most profitable. The optimal under reallocation of resource showed positive improvement in gross margin and cash income. Partial budgeting revealed that, all fruits trees quantities gave positive returns. Collection days provide employment in the dry seasons. According to the annual income and expenditures, the net household income found to be positive for area locality.

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