The Role of Indigenous Fruits Trees on Rural Households Income and livelihoods in *Elsanut* locality of South Kordofan State, Sudan

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Abstract - The current study was conducted in Elsanut locality - South Kordofan State during 2013/2014 season. The study aimed to test and identify the advantages of wild fruits collection activity, fruit gross margin (GM) and optimum trees combination that maximize the small producer's gross margin (GM) in the locality. Fifty household were selected randomly through field survey in the season. Data were analyzed using descriptive statistics, GM analysis and linear programming. The optimum tree combination that maximized the small producers GM was to cultivate 1.3, 2 and 0.5 feddan of desert date (Balanites aegyptiaca), baobab (Adansonia digitata), and tamarind (Tamarindus indica) respectively to get GM equals SDG 12346.44, 2927.16 and 972, respectively and the total GM was found to be SDG 16245.54 .The selected farmers obtained annual cash income SDG 8650 from agricultural production. The total annual income was found to be SDG 24896 which would cover all household expenses with net income equals SDG 8150. The optimum under reallocation of resources indicated that, an improvement in GM and total cash income per feddan by 10%. Partial budgeting indicated that, all fruits quantities gave positive returns. The collection days provide employment between production seasons. Household economy analysis showed that, contribution of wild fruits to household income and expenditure was found to be 65% and 97%, respectively. Fruits collection is most important source for cash income and employment. The study recommended that fruits trees adoption and domestication increase their returns and provide employment for people in the study area.

Keywords: Gross margin, Linear programming, Optimality, South Kordofan .

I.   INTRODUCTION

Elsanut locality population around 105,405 inhabitants, they mainly cultivate cash and food crops and animal raisings beside wild fruits collection. The study found that, the wild fruits which collected are tamarind, *desert date, Christ*'s thorn and baobab. These trees are predominated in semi-arid in tropical zone; their fruits are underutilized as wild edible plants in some parts of Africa (11). Non-timber forest products (NTFPs) are plants or plant parts that have economic or consumption value which collected and removed from the forest (16), (2). It also referred to resources or products that may extracted from forest, which are utilized within the use of household, marketing value or have social, cultural and significance impact (15). He added that forest goods are either timber or non-timber. NTFPs are collected for both subsistence and commercial use and livelihood for millions rural people (6). Majority of rural and urban households in Nigeria depend on forest products to meet their households' nutritional needs and incomes generation (13). Transporting of NTFPs to the markets is expensive, because of the transportation and marketing competition (3). Christ's thorn tree grows in bush land as well as riverbeds, edges of cultivations and gardens (12). Its fruit is edible for human food and animal fodders (11), (8). Desert date tree is available in semi-arid areas of some parts of Africa (12). It's a major producer of fruits, locally the fruits are known as *laloub* that traded in large quantities in local markets in Kordofan, Darfur and Southern Sudan (1). Baobab tree spreads in most African countries zones with 100 – 1000 mm annual rainfall and rocky hills (19). It forms belts in central Sudan, Kordofan, Darfur, Blue Nile, Upper Nile, and Bahar Elghzal (7). The tree is used primarily for its fruits that eaten fresh or processed for non-food uses. The mature plant produces more than 250 capsules (30 kg) of fruits (7). Tamarind is a multipurpose tropical fruit tree. It is used primarily for its fruit, which are eaten fresh or processed as a seasoning spice. The tree is grown as a subsistence crop for meeting local demands and commercial purposes (17). It performs well in both semi-arid and humid climates, the tree produces up to 50 kg fruit in west Africa, where rainfall less

than 500 mm annually while domesticated tree in those areas yields of 800 and 500 kg, respectively (5). Reference (9) reported that tamarind tree can produce an annual fruit yield in the range of 150- 500 kg/tree. White crossberry (*Grewia tenax*) fruits are an important economical commodity, locally and internationally, moreover is used as food, medicine and exported for food and pharmaceutical industries (4). Reference (5) stated that, in Shiekan rural areas of North Kordofan State Christ's thorn, derert date, baobab, tamarind and white cross berry fruits were most important as they gathered and used by different communities. Reference (10) found that, NTFPs are considered important for rural livelihoods which diversify people activities and alleviating rural poverty. Reference (10) found that, NTFPs are considered important for rural livelihoods which diversify people activities and alleviating rural poverty.

II.   MATERIALS AND METHODS

The area selected for this study was *Elsanut* locality in western localities of South Kordofan State, where NTFPs activity providing employment for people in study area. Fifty respondents of fruits collectors were selected randomly from 5 villages. Ten collectors were selected randomly from each village. The main job for area people is agriculture (crops and livestock production) and local trading beside fruits collection. NTFPs are source of cash income during the dry seasons.

2.1 Partial budget method

Partial budget is used to estimate fruits quantities, quantities costs and fruits collection days as well as fruits returns.

2.3 Linear programming method

Table (5) showed that 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 at the household level. Reference (18) Stated that, linear programming requires information of the NTFPs options with their resources and constraints on their production. The fixed requirements and constraints that limit family production were cash costs, 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, that maximizing small producer's GM. 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):

Ziziphus spina-christi (Christ's thorn) = X_1

Tamarindus indica (tamarind) = $X2$

Grewia tenax (white crossberry)= $X3$

Balanities aegyptiaca (desert date)= $X4$

Adansonia digitata (baobab) =X5

-Labor (man-days)

$\sum Mdij \leq D$

$X1i + X2i + X3i + X4i + X5i \leq D$ (3.1)

$X1j + X2j + X3j + X4j + X5J \leq D$

Where:

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

Mdij = is the amount of required man-days for wild fruits collection activities

Working capital = SDG

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

$X1ki + X2ki + X3ki + X4ki + X5ki \leq wk$ (3.2)

$X1kj + X2kj + X3kj + X4kj + X5kj \leq wk$

Where:

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

Kij = 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 for 18), (14). (fruits collection)

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

$\sum aijpD \geq PD$

Where:

aijpD= 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 $= \sum cjxj + \sum cj* xj*$ objective function (3.3)

$X1j + X2j + X3j + X4j + X5ij$

Subject to constraints

$\sum aijxj \leq bi$ constrain equation

Xj and $xj \geq 0$

Where:

Z= gross margin. Cj = price of collected fruit Cj*= price off-farm production

xi= unit price of fruit collected Xj= level at collection activity

Aij= resources required Bi=resources available

Number of resources (activities)

Constraints:

Man-day ≥ 0

Tree number ≥ 0

2.4 Household economy analysis

Household economy analysis was used to calculate household annual income, expenditure and its contribution for them.

III. RESULTS AND DISCUSSION

3.1 Partial budget.

Elsanut Locality is abundant of fruit trees. The study found that, the collected quantity of desert date fruits was 346.1 kg, while the quantities of Christ's thorn, baobab, tamarind and white crossberry were 269.376, 120.12, 264.83 and 34.1 kg, respectively (Table 1). This was an indication that, fruits were available for generating high income for fruit collectors. Days for desert date collection were 27.5, whereas, Christ's thorn, tamarind, Baobab and White gross berry collection days were 24.6, 23, 18.7 and 14.6, respectively. Baobab fruits gained high return while desert date, tamarind, Christ's thorn and White gross berry gained less income, because their lower prices affected their quantities returns. The collection days fill the gap between production seasons. Fruits gross margin for abovementioned trees were SDG 508.78, 317.86, 1274.47, 525.82 and 353.28, respectively which equal to total of SDG 2980.21. Cost of the collected quantities was SDG107.1, 89.2, 104, 92.9 and 89.8, respectively which was equal to SDG 483. The net returns were SDG400.68, 228.66, 1170.47, 432.92 and 263.48, respectively which equal to SDG 2508.1. It indicates that household expenditure depends on its annual

income and consumption costs, this comparable with reference (10) that, NTFPs are considered important for rural livelihoods which diversify people activities and alleviating rural poverty.

Table (1): Fruits average returns in *Elsanut* Locality

Fruits	Desert date	Christ 's thorn	Baobab	Tamarind	White gross berry	Total
Collected quantity kg	346.1	269.376	120.12	164.833	34.1	
Collection days	27.5	24.6	18.6	23	14.6	108
Productivity Kg/ tree	177.9	89.14	75.1	74.143	3.74	
Fruit price SDG/ kg	1.47	1.18	10.61	3.19	10.36	
Fruit gross output SDG	508.78	317.86	1274.47	525.82	353.28	2980.21
T.V. costs of collected qu/kg	107.1	89.2	104	92.9	89.80	483
Fruit gross margin /SDG	401.68	228.66	1170.47	432.92	263.48	2497.21

Source: Study field survey, 2014.

3.3 Linear programming:

Linear programming results showed that fruits collectors gross margin was found to be SDG 9497.26, 1589.02, 1463.58, 1943.95 and 231.17 for desrt date, Christ's thorn, baobab, tamarind and white crossberry, respectively. The total gross margin was found to be SDG 14724.98 (Table 2).

Table (2): Number of fruit trees/ *feddan* and their GM in ElSanut Locality

Fruits trees	Desert date	Christ's thorn	Baobab	Tamarind	White crossberry	Total
Trees number	46	21	2	10	8	
Productivity Kg/ tree	177.9	89.14	75.1	74.143	3.74	
Fruits production/kg	8183.4	1871.94	150.2	740.143	29.92	
Fruit price SDG/ kg	1.47	1.18	10.61	3.19	10.36	
Collection days						
Fruit gross output SDG	12029.6	2208.89	1593.62	2361.1	309.97	18503.18
Variable costs of collected qu/kg	2532.34	619.87	130.04	417.15	78.80	3778.82
Fruit GM /SDG	9497.26	1589.02	1463.58	1943.95	231.17	14724.98

Source: Study field survey, 2014.

The optimum tree combination that maximized the small producers GM in this area was to cultivate 1.3, 2 and 0.5 *feddan* of desrt date, baobab and Tamarind, respectively to get GM equal to SDG 12346.44, 2927.16 and 972 and the total GM was found to be SDG 16245.54 (Table 3). It agrees with reference (7) which stated that baobab forms belts in central Sudan, Kordofan, Darfur, Blue Nile, Upper Nile and Bahar-Elgazal and most parts of Africa. This optimum GM makes an increment in the previous GM by 10% which will contribute much in the household expenditure in the food items in the locality. Such results were supported by previous studied such as those of reference (6) and (3) who reported that, 80% of the people in the developing countries use wild plants to meet their medicine and nutritional needs and provide a source for

income for women and men in the rural area. Whereas reference (12) stated that desrt date tree is available in semi- arid areas of Africa.

Table (3): Optimal solution of trees harvested in *Elsanout* locality in W.K.S

Tree	Area/*feddan*	Gross margin/*feddan*	Value/SDG
X1 (Desrt date)	1.3	9497.26	12346.44
X2 (Christ's thorn)	0	0	0
X3 (Baobab)	2	1463.58	2927.16
X4 (Tamarind)	0.5	1943.95	972
X5 (White crossberry)	0	0	0
Total			16245.54

Source: Study field survey, 2014

Study found that the constraints of wild fruits collection were fires, over-grazing and cutting of the trees for crops production or fire wood and charcoal as well as fruits quantities transportation. The farmers' incomes in *Elsanout* locality are generated by; agriculture production (crops production and livestock) and NTFPs collection. Household total annual average income was found to be SDG 25,221 (Table 4). The results go in line with reference (2), (16) which denoted that NTFPs products are plants or plant parts which have economic or consumption value. While less than what reported by reference (9) which stated that tamarind tree can produce an annual fruit yield in the range of 150- 500 kg/tree. The fruits income was high contributor to households' annual income when compared with agriculture as the main income in the study area. While reference (4) stated that white cross berry fruits are used as food, medicine, and exported for food and pharmaceutical industries (Table 4). Agriculture income contribution was small to the total household income when compared with the contribution of the fruits income (Table 4). Contribution of wild fruits to household income and expenditure was found to be 189% and 108%, respectively. (Table 5). These findings agree with studies conducted in Shiekan rural areas of North kordofan State by (5), in Nigeria by (13), in Ethiopia and other parts of Africa by (11), (6) and in both semi-arid and humid climates by (5) who stated that *Christ's thorn, desrt date, baobab, tamarind and white cross berry* fruits were most important as they gathered and used by different communities. The same study conducted by reference (1) in Raahad locality; wild fruits were traded in large quantities in Kordofan, Darfur and Southern Sudan. While reference (8) explained that tamarind tree can produce an annual fruit yield in the range of 150- 500kg/tree. Hence reference (17) stated that tamarind is grown as subsistence crop for meeting local demand and commercial purposes. Whereas reference (15) explained that NTFPs are products that extracted from forest, which utilized within the household and marketing value.

Table 4. Household net income and the contribution of NTFPs to household expenditure and income in Elsanut locality

Average income	Variable attributed
8650	Agricultural Production income
16246	Non- timber (NTFPs) income
24223	Total annual income
15745	Expenditure
8150	Net H-H income
97%	Contribution Of NTFPs to H-H Expenditure
65%	Contribution Of NTFPs to H-H income

Source: Study Field survey, 2014.

IV.   CONCLUSIONS

The optimal model for trees with relevant unit area *feddan* of linear programming indicated that, three trees (desrt date, baobab and tamarind) were optimized. *Desrt date* was the most profitable fruits tree. 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. However, collection days provide employment in the dry seasons. According to the annual income and expenditures, the net household income found to be positive.

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