العنوان:	Optimum crop combination of field crops, that maximize farmer's income, in Abuzabad locality west Kordofan state
المصدر:	مجلة جامعة السلام
الناشر:	جامعة السلام
المؤلف الرئيسي:	Bakri, Elnour Ibrahim
مؤلفين آخرين:	-Breima, Elkhalil E، Maruodl, Maruod Elno، Hassan, Ashraf A . Ahmed(Co Auth)
المجلد/العدد:	ع7
محكمة:	نعم
التاريخ الميلادي:	2018
الشهر:	ديسيمبر
الصفحات:	25 - 36
رقم MD:	996701
نوع المحتوى:	بحوث ومقالات
اللغة:	English
قواعد المعلومات:	EduSearch, IslamicInfo, HumanIndex
مواضيع:	ولاية كردفان، مواسم الزراعة، النشاط الاقتصادى
رابط:	http://search.mandumah.com/Record/996701

Optimum crop combination of field crops, that maximize farmer's income, in Abuzabad locality west Kordofan state

Elnour, Ibrahim Bakri[1], Elkhalil Elnour Breima[2], Ogal Sabil Ali Maalla[1], Ashraf A . Ahmed Hassan[1] and Maruod E. Maruod[1]

Department of Agricultural Economics and Rural Development, Faculty of Natural Resources and Environmental Studies, University of Kordofan,Sudan.[2]Department of Agricultural Economics, Agricultural Research Corporation, Zalingei research Station, Zalingei- Sudan

ABSTRACT: The current study was conducted in Abuzabad locality of west Kordofan state during 2016/2017 cropping season. The objective of the study was to know the optimum crop combination of field crops that maximize farmer's income. The study depended mainly on primary data which was collected via structured questionnaire distributed randomly to 40 farmers. Clustered random sampling technique was used. The data were analyzed via descriptive statistics, gross margin analysis, Linear programming model (L.P), partial crop budget, dominance analysis and marginal analysis. Descriptive analysis results revealed that 70% of the households in the study area were educated while 30% were illiterate. Descriptive analysis also showed that 75%of the respondents were working in agricultural farming activities, 2.5% herders, 20% farmer/herder and 2.5% farmer/trader respectively. Linear programming results showed that the optimum solution was to cultivate 1.2, 2.5, 0.85, 0.5, 1.2, 1.07 and 0.7 feddans of Sorghum, Millet, Groundnuts, Sesame, Roselle, Watermelon and Cow pea respectively, to get total gross margin of SDG 6594.725. Partial crop budget results indicated that all crops financially gave positive net returns. Dominance analysis results showed that T_2 (okra) and T_8 (millet) were dominated and they are economically inefficient due to their higher costs and lower net benefits. Marginal analysis results revealed that sesame is more stable and gave highest Marginal Rate of Return (MRR) SDG 1345, followed by groundnut MRR 142 and cowpea MRR 90.1. The study recommended more research studies pertaining crop optimization should be taken in the study area.

Key ward: descriptive statistics, gross margin analysis, linear programming model (L.P), partial crop budget, dominance analysis and marginal analysis.

المستخلص

أجريت الدراسة بإدارية أبوزبد بولاية غرب كردفان خلال الموسم الزراعي 2017/2016م.وهدفت الدراسة إلى معرفة التركيبة المحصولية المثلى التى تعظِّم دخل المزارع،.اعتمدت الدراسة على المعلومات الأولية التى جمعت عن طريق إستبانة صممت خصيصاً لهذا الغرض ووزعت إلى 40 مستهدف عن طريق العينة العشوائية. تم تحليل البيانات عن طريق الإحصاء الوصفي، البرمجة الخطية، تحليل السيادة، الموازنة الجزئية والتحليل الحدي.أظهرت نتائج الإحصاء الوصفي أن 70% من المستهدفين كانوا متعلمين و 30% غير متعلمين، وأظهر أيضاً أن 75% من المستهدفين يمارسون الزراعة و 2.5% رعاة و20%كانوا يمارسون الزراعة والرعي و2.5% يمارسون الزراعة والتجارة معاً.أظهرت نتائج البرمجة الخطية أن التركيبة المحصولية المثلى التى تعظم الهامش الإجمالي هى زراعة 1.2 ، 2.5 ، 0.85 ، 0.5 ، 1.2 ، 1.07 و 0.7 فدان من كل من الذرة ، الدخن، الفول السوداني، السمسم، الكركدى، حب البطيخ واللوبيا لكل على التوالى للحصول على هامش إجمالي قدره 6594.725 جنيه سوداني.الموازنة الجزئية أكدت أن كل المحاصيل الحقلية أعطت هامش إجمالي موجب.تحليل السيادة أكد أن البامية والدخن أكثر المحاصيل سيادةً إلا أنها غير كفؤة اقتصاديا نتيجة لتكلفتها العالية وعائدها المنخفض.نتائج التحليل الحدي أكدت أن السمسم أعطى أعلى معدل عائد حدي وقدره 1345 جنيه يليه الفول السوداني 142 ثم اللوبيا 90.1 جنيه سوداني. أوصت الدراسة بمزيد من الدراسات فى هذا المجال فى منطقة الدراسة.

1. INTRODUCTION:

Sudan is a least developed country in Africa—one of the most vulnerable continents to food insecurity and climate variability. This situation is aggravated by the interaction of multiple stresses occurring at various levels, such as endemic poverty; institutional weaknesses; limited access to capital, including markets, infrastructure and technology; ecosystem degradation; complex disasters and conflicts. These in turn have weakened People's adaptive capacity, increasing their vulnerability to projected food. Sudan is one of the driest but also the most variable countries in Africa in terms of rainfall. Extreme years (either good or bad) are more common than average years. Rainfall, on which the overwhelming majority of the country's agricultural activity depends, is erratic and varies significantly from the north to the south of the country. The unreliable nature of the rainfall, together with its concentration into short growing seasons, heightens the vulnerability of Sudan's rain fed agricultural systems. Mean annual temperatures vary between 26^{o}C and 32^{o}C across the country. The most extreme temperatures are found in the far north, where summer temperatures can often exceed 43^{o}C and sandstorms blow across the Sahara from April to September. These regions typically experience virtually no rainfall, while in the southern regions; climatic conditions are more equatorial with average annual rainfall over 1,000 mm/year (Zakieldeen, 2009). Kordofan region is situated in the central part of Sudan up to the southern borders with the Republic of South Sudan, from 9.50 to 16.40^{o}N latitudes and from 27.30 to 32.25^{o}E longitudes. The region covers an area of approximately 380,000 km2, representing over 20.0% of the total area of the country. The federal system divides the region into three federal States, North, West and South Kordofan States. Each State is divided into Localities and each locality into Administrative Units. The total population is about 3.25 million people comprising about 10.0% of Sudan. Urban population constitutes 15%, nomads 20% and the sedentary rural population constitutes 65% of the total population. Abdelrahim*et al*, (2014).The study was conducted in one localities of western Kordofan state; namely Abuzabad which lie between longitudes 10° 14' N and latitudes 28° 30^{0} E. The average monthly temperature was 34.6°C. The mean temperatures in coldest months are December 14.1°C and January 13.5°C. However; the hottest months (April, May and June) with an average mean temperature exceeding 30°C. According to estimated population rate since last census in 2008. The total population of the study area was

75163. The area is characterized by the two types of soil loamy, sandy soil (Goz) and clay soil to south .The Goz soil is easily cultivated by hand and hence, is considered as more attractive to small farmers (Breima, 2016). The farming system in the study area is based on traditional systems of cropping and animal husbandry. The major crops grown are millet and sorghum (food crops), and groundnut and sesame (cash crops). Gum Arabic production and forestry products contribute significantly to the household income to a large portion of the population. Other crops grown are watermelon, Roselle (*Karkadhe*), cowpea, maize, cotton, and okra. Animals raised are mainly sheep, goats and camels in the north and cattle and goats in the south. Three main production systems can be defined in the region based on the type of crop (field crops, livestock, horticultural crops and forestry) and the degree of settlement at households. These systems are well inter-related.

2. MATERIALS AND METHODS:

The micro-level study was conducted in Abuzabad locality in western Kordofan State. Data was collected during 2016/2017 cropping season. The required primary data regarding crop (varieties) was randomly collected to represent the households' heads in the target area. In addition, secondary information was also collected from relevant institutions. The study used a form of clustered random sampling procedures which covered all the study area. The sample size was taken to represent a population of 75163. Due to higher homogeneity in the study area 40 households were randomly selected to represent the entire area. The study used a form of clustered random sampling procedures which covered all the study area. The sample size was taken to represent a population of 75163. Due to higher homogeneity in the study area 40 households were randomly selected to represent the entire area. Questionnaire (pre-coded open close ended one) was applied to drive percentage, means and standard deviation. Linear programming (LP) model specified in terms of its objective function, activities and constraints to determine the optimum combination of crop activities for farmers profit maximization. Partial crop budget based on costs benefits of various alternative treatments used.

4. Linear programming model

One of the core tools of farm management analysis is the linear programming model. Linear programming (LP) is a method of determining a profit maximizing combination of farm enterprises that is feasible with respect to a set of fixed farm constraints (Breima, 2016).

Maximize Z= ∑_(j=1) 〖C_jX_j〗
CjXj……..... (1)
Subject to:
aijxj ≤ bi (standard factors of production)…….....(2)

∑AijXij≤ bj (Resource constraint)……...(3)
djxj>□ (Climate Variables)……..(4)
∑ QjkXjk ≥ dkj (Food consumption constraint)……(5)
Xj ≥ 0 all j = 1 to m non-negativity constraint activities
Where:
Z = Gross margin
Cj = Price of production activities
Xj = level of jth production activity
aij = the ith resource required for a unit of jth activity
bi = the resource available with the sample farmers
j = refers to number of activities from 1 to n
i = refers to number of resources from 1 to m
Under constraints of land/ha, labor/MH, working capital SDG/ha, temperature, rain fall, and humidity.

5. Partial crop budget models

Partial budgeting is a method of organizing experimental data and information about the cost and benefits of the various alternative treatments

The key requirement for using the partial budgets method is to identify all the changes (positive and negative) produced by shifting from a standard input to a proposed alternative.

6. Dominance analysis:

Dominance analysis is carried out in order to rank the treatments in order of increasing costs that vary (Cash costs and opportunity costs). Any treatment has net benefits that are less than or equal to those of treatment with lower cost that vary is dominant (marked with D).

7. Marginal analysis

Marginal analysis is conducted to know returns to investment and thus the less benefited treatments were eliminated by making the use of dominance analysis. Marginal rate of return indicate what farmers can expect to gain, on average, in return for their investment when they decide to change from one practice to another. Marginal values were calculated as:

Marginal rate of returns (MRR)

$$= \frac{\text{Incremental net benefits} \times 100}{\text{Incremental net costs}}$$

Maximizing TPP when

$$\frac{dTPP}{dx} = MPP = 0$$

Where: TPP = total physical productivity (output price per unit)

Mpp = marginal physical productivity

x = input used (cost price per unit)

RESULTS AND DISCUSSIONS:

Descriptive analysis:

Socio-economic characteristics of farmers:

Distribution of respondents by education:

According to Breima (2006), education increases people's receptiveness to new ideas, makes it easier for them to understand extension messages and increases their ambition and, therefore, their willingness to embark on new income-generating activities. Percentage of household's distribution according to education in Table (1) showed that 70% of the households in the study area engaged in education while 30% were illiterate. **Frequency distribution of farmers by occupation:**

Table (2) showed that 75%of the respondents work in agriculture farming activities, 2.5% herders, 20% farmer/herder and 2.5% farmer/trader respectively.

Source: Author 2017

Linear programming

Gross margin analysis

Gross margins are calculated using the average of 2016/2017 cropping season prices and average production per hectare. Gross margin is the average production multiplied by average price minus variable production costs, Table (3)

Solving linear programming problems

Based model is solved using a linear programming model. To formulate the problem mathematically the study introduced as following:-

By letting X_1= Dura, X_2 =millet, X_3 = ground nut, X_4 = sesame, X_5 = Roselle, X6=watermelon, X7=cowpea, X8=okra

Maximize $Z = 1265x_1 + 565x_2 + 2220x_3 + 1505x_4 + 1277x_5 + 201x_6 + 1433x_7 + 136x_8$

Subject to:

Land/ha = $1x1+1x2+1x3+1x4+1x5+1x6+1x7+1x8 \leq 8$

Labour/Man days = $10x1+7x2+16x3+12x4+16x5+4x6+4x7+6x8 \leq 75$
Capital/SD=$4x_1+72.5x_2+950.4x_3+21.4x_4+30.6x_5+33x_6+30x_7+51.2x_8 \leq$ 41409.
Average cultivated area = $1.2x_1 +2.5x_2 + 2.6x_3 + 0.5x_4 +1.2x_5 + 1.3x_6 + 0.7x_7 + 0.4x_8 + \leq 403.5$
Where $x_1, x_2, x_3, x_4, x_5, x_6, x7, x_8, \geq$ zero

Table (4) linear programming tableau

Row name	x1	x2	x3	x4	x5	x6	x7	x8	RSH
Obj. function	1265	565	2220	1505	1277	201	1433	136	
Land/ha	1	1	1	1	1	1	1	1	8
Labor/MDAYS	4	7	16	12	16	4	4	6	75
W.capital/SDG	24	72	950	21	30	33	30	51	41409
AV.cult /ha	1.2	2.5	2.6	0.5	1.2	1.3	0.7	0.4	403

Source: Author 2017: Where**: obj**=objective, MDAYS=man days, W= work, AV.cult =average cultivated area, RHS right hand side, SDG =Sudanese pound, ha= hectare .the first row in the tableau, for crops were grown in this study area,
X_1=local sorghum, X_2 = local millet, X_3 = local ground nut, X_4 = local sesame, X_5 = local Roselle, X6=local watermelon, X7=local cowpea, X8=local okra.

Objective function

The objective function is representing SDG gross margin for sorghum (1265), millet (565), groundnut (2220), sesame (1456), Roselle (1277), watermelon (201), cowpea (1433), and okra (SDG 136).

constrains of the model 1 Land

The land variable was total land resources actually cultivated by farmers it was measured in hectare.

Capital:

The capital expenses variable was the cash expenditure reported the farmers for all agricultural operation. In the study area the average cost of the all agricultural operation for the crops per hectare were SDG 24, 72, 950, 21, 30, 33, 30 andSDG 51 for the Dura, millet, groundnut, sesame, Roselle, watermelon, cowpea, and okra respectively.

Labor:-

The labour variable represents the total labour employed by each farm during a season. In the study area the number of labour Man days of one hectare for crops were 4, 7, 16, 12, 16, 4, 4, and 6 for the Sorghum,

millet, groundnut, sesame, Roselle, watermelon, cowpea, and okra, respectively**.**

Average cultivated area:

The average cultivated area hectare of all crops growing in the study area was1.2 hectare 2.5, 2.6, 0.5, 1.2,1.3, 0.7, and 0.4 hectare for the sorghum, millet, groundnut, sesame, Roselle, watermelon, cowpea, and okra, respectively**.**

Base Optimal Model:

The present analysis is based on information gathered from 40 household participant farmers representing Abuzabad locality. Based model is solved using a linear programming model.

Linear programming results showed that all crops reached the optimal solution except okra. Table (5) showed that the highest gross margin was obtained by Roselle with SDG 1532.4, followed by sorghum SDG 1518, millet SDG 1412.5, cowpea SDG 1003.1, groundnut SDG 188.7, sesame SDG 729.5, and watermelon gave 215.07SDG. A total of SDG 6594.725 gross margin was obtained in the entire area.

Partial crop budget results:

Partial crop budget results indicated that all crops were financially gave positive net returns. The highest net returns were obtained by sesame (SDG 916), groundnut (SDG 914), cowpea (SDG 768) and sorghum with SDG 732. While the lowest net returns was given by millet (SDG 52) and okra (SDG 72). This is entailed that farmers can benefit of growing such crops as shown in table (6).

Dominance analysis:

Dominance analysis results showed that T_2 (okra) and T_8 (millet) were dominated and they are economically inefficient due to its higher costs and lower net benefits, Table (7).

Marginal analysis:

Marginal analysis results revealed that sesame is more stable and gave highest MRR 1345, followed by groundnut MRR 142 and cowpea MRR 90.1. These results entailed that for every 1.0 SDG invested in crop production farmer can get the 1.0 SDG and obtained additional SDG 13.45, 1.42 and 0.91of sesame, groundnut and cowpea, respectively, Table(8).

Table (1) distribution of respondents by education

Education	Frequency	Valid percentage
Illiterate	12	30
Khalwa	5	12.5
Elementary	13	32.5
Primary	6	15
Secondary	3	7.5
University	1	2.5
Total	40	100

Source: Author 2017

Table (2) distribution of farmers by occupation:

Occupation	Frequency	Valid percentage
Farmer	30	75
Herder	1	2.5
Farmer/herder	8	20
Farmer/trader	1	2.5
Total	40	100

Source: Author 2017

Table (3) Gross margin per hectare for crop production:

Crop variety	**Value of prod/SDG/ha**	**Variable cost /SDG/ha**	**Gross margin SDG/ha**
Dura	1398	133	1265
Millet	1875	1310	565
Groundnut	2442	222	2220
Sesame	1824	319	1505
Roselle	1408	131	1277
Watermelon	332	131	201
Cowpea	1541	108	1433
Okra	445	309	136

Source: Author 2017

Table (5): Optimal solution or farm plan for the base model in SDG/ha by locality:

Crop	area/ha	coefficient	optimal solution
Sorghum	1.2	1265	1518
Millet	2.5	565	1412.5
Groundnut	0.85	2220	188.7
Sesame	0.5	1505	729.5
Roselle	1.2	1277	1532.4
Watermelon	1.07	201	215.07
Cowpea	0.7	1433	1003.1
Okra	0	136	0
Total gross margin			**6594.725**

Source: Author 2017

Table (6) partial crop budget

Crop	Yield/ha	Gross field benefit SDG/ha	Cost variation SDG/ha	Net returns SDG/ha
Sorghum	486	1895	1133	732
Millet	227	1362	1310	52
Groundnut	509	2036	1122	914
Sesame	109	1635	719	916
Roselle	111	1332	831	501
Watermelon	37	333	131	202
Cowpea	123	1476	708	768
Okra	127	381	309	72

Source: Author 2017

Table (7) dominance analysis

Crop	Yield/ha	Gross field benefit SDG/ha	Cost variation SDG/ha	Net returns SDG/ha
T_1Watermelon	37	333	131	202
T_2Okra	127	381	309	72 D
T_3Cowpea	123	1476	708	768
T_4Sesame	109	1635	719	916
T_5Roselle	111	1332	831	501
T_6Groundnut	509	2036	1122	914
T_7Sorghum	486	1895	1133	732
T_8Millet	227	1362	1310	52 D

Source: Author 2017

CONCLUSIONS

- Descriptive analysis of households indicated that 70% of the households in the study area engaged in education while 30% were illiterate.
- Frequency distribution according to occupation reveled that
- 75% of the respondents work in agriculture farming activities, 2.5% herders, 20% farmer/herder and 2.5% farmer/trader respectively.
- Linear programming results showed that most crops were optimized and gross margin was improved.
- Partial crop budget explored that positive gross margins were obtained in all crops

The results of marginal analysis revealed that groundnut and cowpea were more attractive because they gave higher net revenues.

REFERENCES

Abdelrahim, E. F., Obudalla, A.A, and Elhag, F. M.A. (2014).

The presidential initiative of food security for the ARAB countries. Greater Kordofan resource base and food security potential. Pp 4-17.

Breima, E. E. (2006).

Impact of improved seeds on farmers' crop productivity and livelihood inUmrwaba and Bara localities of NorthKordofan-IFAD farms. A thesis submitted to University of Kordofan in partial fulfillment as requirement for master degree of science in Agricultural Economics and Rural development.Department of agricultural economic and rural development, Faculty of natural resources and environmental studies, University of Kordofan, Sudan.

Breima, E. E. (2016).

Impact of climate change on food security: an application to Elnuhood, Abuzabad,Elkhwei and Gebaish localities of Western Kordofan State-Sudan. A thesis submitted to University of Kordofan as requirement for philosophy doctorate inAgricultural Economics and Rural development. Department of agricultural economic and rural development, Faculty of natural resources and environmental studies, University of Kordofan, Sudan.

Zakieldeen, S. A. (2009).

Adaptation to climate change: A vulnerabilityassessment for Sudan. Assistant professor at the institute ofenvironmental studies, Khartoum university, Sudan. P 3.