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Discrepancies in Broad Bean Productivities between Traditional Farms and Research Experiments

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Abstract

The main objective of this survey was to estimate the yield variation between research experiments and traditional farm of broad bean production in the River Nile State (RNS). The specific objectives were: to investigate the production capability of the traditional farmers in this area; to make comparison of productivities between research and traditional farmer; to investigate the potentiality of crop production in the River Nile State; and to evaluate the financial challenges facing the traditional farmers. Data was collected from the traditional farmers using structured survey questionnaires with specific sample size put into considered all variations among the traditional farmers. The analysis was based on a descriptive analysis, farm partial budget and benefit-cost ratio analysis. The analysis has concluded into significant yield gap between research experiments and the traditional farmers reached up to about 50% extra for the research sites. However; the traditional farmers were still economically efficient to some extent in producing broad been in the area. The study has recommended that: the government of the RNS has been advised to establish savings programs by encouraging farmers to participate with part of the expenses; also an advisement to encourage research and extension services in supporting farmers; the cropping patterns has to be diversified with focusing on broad bean cultivation; and the yield variation could be bridged by applying appropriate Recommended Technical Package (RTP)).

Keywords: *Discrepancies, Traditional, Productivities, RTP, farm-level, Broad Bean, BCR.*

تباينات إنتاجية الفول بين المزارع التقليدية والتجارب البحثية

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المستخلص

الهدف الرئيسي من هذه الدراسة هو تقدير التباين في إنتاج الفول بين التجارب البحثية والمزارع التقليدية في ولاية نهر النيل. وتضمنت الأهداف الفرعية ما يلي: دراسة القدرة الإنتاجية للمزارعين التقليديين في هذه المنطقة؛ ومقارنة الإنتاجية بين التجارب البحثية والمزارعين التقليديين؛ ودراسة إمكانات إنتاج المحاصيل في ولاية نهر النيل؛ وتقييم التحديات المالية التي يواجهها المزارعون التقليديون. جُمعت البيانات من المزارعين التقليديين باستخدام استبيانات منظمة، مع تحديد حجم عينة مناسب لمراعاة جميع الاختلافات بينهم. واستند التحليل إلى تحليل وصفي، وميزانية جزئية للمزارع، وتحليل نسبة الفائدة إلى التكلفة. وخلص التحليل إلى وجود فجوة كبيرة في الإنتاجية بين التجارب البحثية والمزارعين التقليديين، حيث بلغت الزيادة حوالي 50% في مواقع التجارب البحثية. ومع ذلك، لا يزال المزارعون التقليديون يتمتعون بكفاءة اقتصادية إلى حد ما في إنتاج الفول في المنطقة. وأوصت الدراسة حكومة ولاية نهر النيل بإنشاء برامج ادخار من خلال تشجيع المزارعين على المشاركة بجزء من النفقات. كما يُنصح بتشجيع البحوث وخدمات الإرشاد الزراعي لدعم المزارعين؛ وضرورة تنويع أنماط الزراعة مع التركيز على زراعة الفول؛ ويمكن معالجة تباين المحاصيل بتطبيق حزمة التقانات الموصى بها.

الكلمات المفتاحية: *التباينات، الزراعة التقليدية، الإنتاجية، حزمة التقانات الموصى بها، مستوى المزرعة، الفول، نسبة العائد إلى الإنتاج.*

Introduction

After loss of oil export resources, considerable attention has been put into agriculture in Sudan. Special attention was paid to legume crops as important sources of protein to numerous people of the country. Broad bean is considered as one of the most important cool-season food legumes produced in the River Nile State (RNS). The major production of it is consumed domestically and also small quantities were imported from Ethiopia in the recent years according to the reports of the Ministry of Agriculture, Irrigation and Forestry in River Nile State (MAIFRNS).

The research on food legumes has been ongoing at Hudeiba Research Station since the early sixties. The main objective of that research is for improving both the productivity and quality of the legume crops through crop husbandry programs. On-farm research on legumes and grain in Sudan was initiated since 1979 as the Nile Valley Project (NVP) as formulated by the Agricultural Research Corporation (ARC) in collaboration with the International Center for Agricultural Research in the Dry Areas (ICARDA) through financial support from the International Fund for

Agricultural Development (IFAD) (Salih, *et al.*, 1995).

Improving broad bean-climate models, planning of adaptation measures (such as agronomic changes), and breeding of new genotypes capable of tolerating or avoiding projected stresses, it is vital to carefully quantify the response of the crop to heat stress (Siebert, and Ewert, 2014). In many environment studies the impact of heat stress during floral development and anthesis on crop yield has now been quantified for many species {e.g. (Hedhly, 2011), (Luo, 2011)}, permitting extreme weather events to be incorporated into crop-climate models (Luo, 2011). Nevertheless, the response of broad bean (*Vicia faba* L.) to heat stress during floral development and anthesis has not been previously investigated (Anonymous, 2025). In particular, broad bean has appreciated role in increasing food production and sustainable escalation (Pretty and Bharucha, 2014).

Discrepancies in Broad Bean yield between traditional Farms and research experiments due to both abiotic and biotic stress are related to many factors. Faba beans are poor competitors with weeds, particularly in the seedling stage (Ali *et al.*, 2000). This makes integrated weed control important for successful crop production. Fields with light weed pressure preferable. Tillage several weeks before planting and killing emerged weeds with shallow tillage just ahead of planting is advisable as well as rotary hoeing of fields 7 to 10 days after planting and use a row cultivator if rows are 50 cm or more apart. One of the abiotic stresses is heat stress during floral development causes reductions in key yield parameters of Faba bean. There are many demonstration studies in negative drought stress but only one previous work in heat stress that focused in initial broad bean vegetative growth {Hamada, 2001; Oney and Tabur, 2013)}. Also heat stress during the floral stage caused severe reduction in yield. (Barber *et al.*, 2015) cited that it can be hard to dependably identify key stages of reproductive development. The crop yield was reduced by heat stress within the temperature range known to provoke yield reductions in other crop species. Sometimes yield reductions were due to gametophyte damage and consequent failure of fertilization. However, it is difficult to forecast how the frequency and magnitude of high temperature differences will change and consequently impact on broad bean harvest (Porter, *et al.*, 2014).

The major insect pest which reduce the quantity and quality of broad bean production in Sudan, as reportedly, (Siddig, 1980), they include: Aphis craccivora Koch; *Acyrthosiphonses baniae* Kan. Dav; Aphis gossypii Geov.; Bemisia tabaci Genn; *Empoasca lubica* Deberg; *Erythron euralubiae* China; *Creontiade spallidus* Ramb; *Spodoptera exigua* HB; *Maruca testalis* Gey; *Caliothrips impurus* Pr; *Caliothrips sudanensis* Bagn Cam; *Bruchus elanairensis* Pic; and *Callosobruchus maculatus* F. Nonetheless, *Callosobruchus maculatus* F is considered as the most harmful pulse beetle attacking stored grains.

Always researchers and pioneer farmers refer to seed dressing and prevention spray to reduce pest infestation. Whereas, the traditional farmers don't apply the full technical package in growing broad bean i.e. they don't use important techniques such as improved seeds, seed dressing, prevention spray, regular irrigation and good land preparations. This generally resulted in decreasing the yield of broad bean among the traditional farmer.

The main objective of this study was to quantify the yield variation between research and traditional farming for broad bean in the River Nile State; so, the field surveys were conducted in two locations (Al-Aliab and Gabaty). These field surveys were conducted with specific objectives including the followings: To investigate the production capability of the traditional farmers in this area; to make comparison of productivities between research and traditional farmer; to investigate

the potentiality of crop production in the River Nile State; and to evaluate the financial challenges facing the traditional farmers.

Methodology

Research methodology included the methods of data collection, data sources (primary and secondary), sample size and the analytical techniques used. A structured questionnaire was prepared to obtain the detailed information from the broad bean traditional farmers in River Nile State, in addition to the field observations. Secondary data was obtained from the official records. Descriptive analyses, partial budget and benefit-cost ratio analysis were used to analyze the collected data for achieving the objectives of the study.

Site Selection

The River Nile State had been selected for the purpose of this study for many reasons. Firstly: it represents the second potential area for farming broad bean in Sudan after the Northern State. Secondly: it uses and adopts relatively best farming systems and the availability of information and good infrastructures. The State is composed of seven localities namely: Shendi, El-Matama, Ed-Damer, Atbara, Berber, Abu-Hamad, and El-Buhayra. However, the survey was conducted in Ed-Damer locality and it covered two villages namely: Alaliab and Gabaty.

Sample Size

The sample size was determined by the desired level of precision increase. Scientifically, it is known that the degree of precision increases as sample size increases. Also the level of precision can be increased by strata issuing more homogeneous sub-samples (Abdalla, 2008). Therefore due to homogeneity of the socio-economic characteristic of the agricultural community in River Nile State and considering limitation of funds and transportation cost about 100 respondents had been selected to represent the total sample size. This sample has been divided equally between the two villages.

Analysis Techniques

To achieve the targeted objectives of the study various techniques were used. A wide range of tools (frequencies, percentages, and averages) of descriptive analysis were used. The comparison between the production of broad bean at the farm and on-station levels also tested. Furthermore, a partial budget was done as analysis to estimate feasibility of broad bean cultivation in the study area. Finally, a benefit-cost ratio analysis was done to determine how well, or how poorly, a planned action will turnout.

Results and Discussion

These results were based on number of techniques that used for analyzing the data in case to realize the objectives of this study. Nonetheless, the parameters included yield variation formula (research site yield – traditional yield/ research site yield) measurements, partial budget analysis,

and benefit-cost ratio analysis (CBA).

Yield Variations Between Research and Traditional Farming

Table 1 shows both averages broad bean productivity for research sites and traditional farming in the River Nile state. Maximum outputs of the crop were 2.20 and 1.30 metric ton (MT) per hectare for the research sites and traditional farming respectively. The minimum yield of broad bean in research sites was amounted to about 0.84 MT per hectare; whereas the minimum yield of the crop of on traditional farms was equivalent to 0.47 MT/ hectare. Yield variation was calculated by subtracting the averages yield of broad bean of the traditional farms from the yield of research site, then divided by average research yield. The formula was:

$$\text{Yield variation} = \frac{\text{Research yield} - \text{Traditional farms yield}}{\text{Research yield}} \times 100$$

From Table 1 below, the maximum yield of the research sites was 5.2 MT/ha while the maximum yield of traditional farms was 2.9 MT/ ha, so the result will be:

$$\text{Yield variation} = \frac{1.08 - 0.55}{1.08} \times 100 = 49.07\%$$

The drawn conclusion, however, demonstrated that the production of broad bean on research sites was approximately doubled the production of traditional farms.

Table 1.The maximum, minimum and average yields of the research and traditional farms (monitored farmers' plots in Aliab Scheme during 2012/2013 crop season).

Farming sites	Yield MT/ ha.		
	Maximum	Minimum	Mean
Research yield	2.2	0.84	1.08
Traditional yield	1.3	0.47	0.55
Total	3.5	1.31	1.53

Source: Field survey 2013/2014.

Partial Budget

It has been informed that the partial budgeting is an excellent managerial tool to help evaluate the financial considerations caused by changes in a business (http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/beef11843). However, in some cases, partial budget is usually done to examine farmers' financial abilities to grow a certain crop. Regarding the **inflation rates in Sudan**, nowadays, all prices and costs had been adjusted to exchange rates of dollar ($)/ Sudanese pound ($).

Selected Cases of the Study

The following farmers' cases were selected among other cases of this survey to show the finance situations and budgets of broad bean growers in River Nile State season 2013/2014. Two farmers are randomly selected from each village which ended to four farmers.

Farmer No. (F3)/ with 10 Feddans at Al-Aiab Village, in the River Nile State Season 2013/14.

The farmer was 46 years old with total area of about 4.2 hectares and all of the area was utilized. Two of his sons assisted in cultivating broad bean in winter as well as grain sorghum in summer seasons. The farmer hadn't any other income than farming. His total return from both faba bean and sorghum during faming season 2103/2014 was estimated at $2477.14 and the net income was $1134.29 (Table 2).

Table 2 Partial Budgets for Farmer No. (F5)/ 4.62 hectares at Al-Aliab village, in the River Nile State Season 2013/2014 (source: Field survey, 2013).

(1) Beginning cash balance	0
(A) Cash inflow	
(2) Farm product sales	2724.86
(3) Capital sales	0
(4) Other cash income	0
(5) Total cash inflow	2724.86
(B) Cash outflow	0
(6) Farm operation expenses	1194.29
(7) Capital purchases	0
(8) Other expenses	282.86
(9) Total cash outflow	1477.14
(10) Cash balance (5-9)	1247.71
(13) Ending cash balance	1247.71

Source: Field survey 2013/2014.

Farmer No. (F12)/ with 10 feddans at Al-Aliab Village, in the River Nile State season 2013/14.

The farmer was 30 years old. He is very young. The total area of his farm was 4.2 hectares and all of it was utilized. It was cultivated by the assistance of his family members. The farm was cultivated with broad bean, wheat and sorghum in winter and with Forage sorghum (Abu-sabeen) as forage in summer season. The farmer hadn't any income other than crops production. His total return from both winter and summer crops was estimated by $1700. However, his ending cash balance was $661.43 (Table 3).

Table 3 Partial Budgets for Farmer No. (F9)/ 4.62 hectares at Al-Aliab village, in the River Nile State Season 2013/2014 (source: Field survey, 2013).

(1) Beginning cash balance	0
(A) Cash inflow	
(2) Farm product sales	1870
(3) Capital sales	0
(4) Other cash income	0
(5) Total cash inflow	1870
(B) Cash outflow	0
(6) Farm operation expenses	906.71
(7) Capital purchases	0
(8) Other expenses	235.71
(9) Total cash outflow	1142.43
(10) Cash balance (5-9)	727.57
(13) Ending cash balance	727.57

Source: Field survey 2013/2014.

Farmer No. (F28)/ with 1.7 Hectares at Gabaty Village, in the River Nile State Season 2013/14

The farmer was 40 years old. The total area of his farm was 1.7 hectares. It was cultivated by the assistance of one of his family members. The farm was cultivated with only broad bean in winter season and with Forage sorghum (Abu-sabeen) as a forage crop in summer. The farmer hadn't any income other than crops production. His return from his farm product sales was estimated by $828.57. His ending budget was $160.57 (Table 4).

Table 4. Partial Budget for Farmer No. (F22)/ 1.87 hectare at Gabaty village, in the River Nile State Season 2013/2014 (source: Field survey, 2013).

(1) Beginning cash balance	0000
(A) Cash inflow	
(2) Farm product sales	911.43
(3) Capital sales	0
(4) Other cash income	0
(5) Total cash inflow	911.43
(B) Cash outflow	0
(6) Farm operation expenses	624.8
(7) Capital purchases	0
(8) Other expenses	110
(9) Total cash outflow	734.8
(10) Cash balance (5-9)	176.63
(13) Ending cash balance	176.63

Source: Field survey 2013/2014.

Farmer no. (f37)/ with 4.2 Hectares at Gabaty Village, in the River Nile State Season 2013/14

The farmer was 55 years old. He was mid age farmer. He was primary level educated. The total area of his farm was 4.2 hectares. It was cultivated by the assistance of three of his family members. The farm was cultivated with broad bean, wheat and alfalfa hay in winter season and with sorghum in summer. The farmer hasn't any income other than crops production. His total on-farm return was estimated by about $742.86. Nonetheless, he realized some losses that estimated by $-393.86 (Table 5).

Table 5 Partial Budget for Farmer No. (F37)/ 4.2 hectares at Gabaty village, in the River Nile State Season 2013/2014 (source: Field survey, 2013).

(1) Beginning cash balance	0000
(A) Cash inflow	
(2) Farm product sales	817.14
(3) Capital sales	0
(4) Other cash income	0
(5) Total cash inflow	817.14
(B) Cash outflow	0
(6) Farm operation expenses	986.43
(7) Capital purchases	0
(8) Other expenses	264
(9) Total cash outflow	1250.43
(10) Cash balance (5-9)	-433.29
(13) Ending cash balance	-433.29

Source: Field survey 2013/2014.

1.1. Benefit-Cost Ratio (BCR) Analysis

The Benefit-Cost Ratio Analysis (BCR) is an indicator showing the relationship between the relative costs and benefits of a proposed project, expressed in monetary or qualitative terms. If a project has a BCR greater than 1.0, the project is expected to deliver a positive net present value to a firm and its investors

However, the technique estimates and sums up the equal money value of the benefits and costs to community of projects to establish whether they are valuable (Shively,1995).). A Benefit Cost analysis is done to determine how well, or how poorly, a planned action will turn out. Although the analysis can be used for almost anything, it is most commonly done on financial questions. Since the BCR analysis relies on the addition of positive factors and the subtraction of negative ones to determine a net result, it is also known as running the numbers. From this study we itemized the benefits by adding all positive factors then we identified and quantified all negative items, cost. The difference between the two indicates whether the planned action was advisable (Table 5).

Table 6. Broad bean Cost items (Source: Field Survey 2013/2014).

Item	Cost $/ ha
Land preparation	103.71
Seed cost	201.43
Seed broadcasting (sowing)	4
Fertilizers (chemical + organic)	0
Pest control	31.43
Supportive hand weeding	39.29
Fuel	7.86
No. of applied irrigations	59
Hand-harvest	113.57
Mechanical harvest	0
Empty sacks/ bags	14.86
Transportation	9.57
Taxation	2.43
Total	587

Source: Field survey 2013/2014.

Table 7. Effects of planting date and seed rate on grain yields of broad bean in Aliab Scheme, during 2013/2014 crop season.

	Mean grain yield (MT/ha)
Planting Date:	
1st -15th November	1.66
16th November – 1st December	1.25
Seed Rate (kg/ha)*a:	
150 – 170	1.45
180 – 200	1.41
>200	1.45

Source: Field survey 2013/2014.

*a = Means over plots irrigated at 6 and 7 days intervals at the farm level.

Table 8. Effects of irrigation regime on mean grain yields of broad bean in Aliab Scheme, 2013/2014 crop season.

No. of applied irrigations	Mean grain yield (MT/ha)
(a) At the Farm-Level:	
5 (Five irrigations)	0.72
6 (six irrigations)	1.54
7(seven irrigations)	1.25
8 (eight irrigations)	2.46
(b) At the Station-Level:	
9 (nine irrigations)	2.86

Source: Field survey 2013/2014.

Table 9 Effects of weed control on mean grain yields of broad bean in Aliab Scheme, 2013/2014 crop season.

Weed control	Mean yield (MT/ha)
(a) At the Farm-Level:	
No weed control (same number of irrigations as the treated plot, within the same section)	1.89
No weed control (same number of irrigations as the treated plot, within all sections)	1.48
One spray with herbicide (Stomp)	2.23
(b) At the Station-Level:	
One spray with herbicide (Stomp + Pursuit)+ 1 supportive hand weeding	2.86

Field survey 2013/2**Planting Date**

At the farm level early (1-15 November) planting gave 1660 kg/ha whereas the late (16 November- 1 December) planting gave about 1.25 MT/ha (Table 7). This result emphasized the importance of early planting for obtaining high yields of broad bean at the farm level. However, the early sowing costs two additional irrigation i.e. additional $15.71/ha (Table 6). So the 1-15 November planting date costs in total about $587/ha (Table 6). The harvesting price was estimated to be about $39.29/50 kg of broad bean (MAIFRNS[1]). Consequently, the return was estimated by about $1185.71/ha and the benefit-cost was:

NB= 1185.71 – 602.71 = $583/ha.

BCR= 583/602.71= 0.96

The late sowing date (16th November to 1 December) costs about $583; so the net benefit was $304 and the BCR was (0.96):

NB= 891 – 587 = $304 /ha.

BCR= 587/304 = 1.93

The aforementioned calculations have indicated that the early sowing date (1st -15th November) has given relatively advanced economic efficiency (1.93) compared to late planting date (16th -1st December).

Seed Rate (Kg/ha)

Table 6 shows the total cost of cultivating one hectare of broad bean was estimated by $587. Whereas, Table 7 had shown the three seed rates exactly: 150 - 170 kg/ha, 180 - 200 kg/ha, and over 200 kg/ ha.

The first seed rate costs in average about $301.71/ha (50 kg broad bean price was $94.29) (MAIFRNS). If we considered other factors constant this seed rate would bring about 1.45 MT/ha which its value was estimated by about $1032.43 (50 kg broad bean price was $39.29 at harvesting time). Therefore the BCR analysis could be calculated as follows:

NB= 1032.43 - (587 – 201.43 + 301.71) = $948.57 / ha.

BCR= 948.57/83.86 = 11.3

The second seed rate expenses about $358.29/ha. Which produces about 1.28 MT/ha of broad bean this could be sold out in approximately $1004.14. Using the previous formula the benefit-cost ratio could be as follows:

NB= 1004.14 - (587 – 201.43 + 358.28) = $920.29/ha.

BCR= 920.29/83.85 = 10.98

The third seed rate cost was about $377.14 /ha.; that produced about 1.45 MT/ha broad bean this could be generate a cash estimated by about $1038.71. So, by doing the same approach above the benefit-cost ratio would be as follows:

1038.71 - (587 – 201.43 + 377.14) = $1030.29 /ha.

BCR= 1030.29/83.85 = 12.29

From the preceding results we did terminate that the seed rate 150- 170 kg/ha was the most efficient one.

Irrigation Regime

Table 8 shows the effects of irrigation regime on mean grain yield of broad bean in Aliab Scheme that could be counted from 5, 6, 7, and 8 irrigations at farm-level. On the other hand the number of applied irrigation at the station-level was equal to 9 irrigation times per season. However, an irrigation at farm level each costs additional $7.14 /ha (the cost of additional fuel), while there was no additional irrigation cost at station-level (Hudeiba Research Station- ARC). To compare the economic efficiency of irrigation between the farm and on-station production; we had to calculate the fuel cost for the 8 irrigations at farm level which realizes the best output (2.5 MT/ha). This cost equals to about $62.9/ha per season. So the benefit-cost ratio for the 8 irrigations (farm-level) was:

NB= 1931.71 – (587 – 7.14 + 62.9) = 1931.71- 642.76 = $1288.95/ha.

BCR= 1288.95/642.76 = 2.01

The benefit-cost ratio for the 9 irrigations at station-level was:

2244.98 –587 = $1657.98/ha.

BCR= 1657.98/587 = 2.82

Based on the aforementioned calculations we could conclude into results that the irrigation was more economical (35.40%) at station level compared to traditions levels. The eight irrigations were the most efficient one at the on-farm level.

Weed Control

Table 9 shows the effects of weed control on average productivities of broad bean in Aliab Scheme. Nevertheless, at the farm level the highest yield was achieved by applying one spra

with herbicide (Stomp) (yield= 2024kg/ha). One spray with herbicide (Stomp + Pursuit) + one supportive hand weeding gained about 2855 kg/ha at station-level.

The additional cost of Pursuit and hand weeding was estimated at about $110/ha ($31.4+ 78.6) (MAIFRNS).

The BCR for the weed control at station-level was estimated as follows:

NB= 1931.71 – (587 -110) = $1454.71/ha.

BCR= 1454.71/477 = 3.05

While the benefit-cost ratio at the farm-level was:

NB= 1590.29 – 587 = $1003.29.

BCR= 1003.28/587 = 1.71

Despite its additional cost, but the application of pursuit and supportive hand weeding has realized more benefit at the station-level compared to traditional level. Whereas, the one spray with herbicide at on-farm level realizes most benefit (same number of irrigations as the treated plot, within the same section) comparing to those without applying any means of spray (no weed control).

Findings and Discussions

The study has concluded that the yield gap between research and the on-farm productions was reached to about 50% in favor of research experiments. The partial budgeting analysis, to the selected cases, showed that most of farmers had a positive ending cash balances. However, benefit-cost ratio (BCR) analysis showed that at the farm level at the early sowing date (1st -15th November) was economically efficient than the late planting date (16th Nov. – 1st December) and the seed rate 150- 170 kg/ha was the most efficient element. The analysis summarized that the irrigation system on station was more economically efficient than that of on-farm level. However, the eight irrigations application was the most efficient at on-farm level. The one spray with herbicide at on-farm level recognized most benefit (same number of irrigations as the treated plot, within the same section) comparing to those without applying any means of spray

Conclusion

The study analysis had indicated that the productivity at research experiments was almost double the traditional levels. The traditional farmers had demonstrated weak performance. This was attributed to many factors; probably the limitation in financial resources could be the paramount

reason behind the low productivities, this is in addition to technical knowhow. The benefit-cost ratio analysis had shown that broad bean cultivation in the River Nile State was economically efficient.

Recommendations

The study has recommended the followings:

1. Provision of technical packages for bridging the yield gap between research and traditional farming.
2. Encouragement of the producers for the establishment of cooperatives capable for facilitate the financial issues and participate in capital formation. Research on irrigation regime should be revisited in this area.
3. Government of RNS should subsidize Farmers with some production inputs (fertilizers, improved seeds, etc.).

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