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Research paper

Economic Evaluation of Broad Bean Production in Traditional Farms and Research Experiments at Aliab District in the River Nile State

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ABSTRACT

The main objective of these surveys was to estimate the broad bean yield variation between research and traditional farm in the River Nile State (RNS). The specific objectives were: to calculate and compare the coefficient index of the profitability between traditional farms and research experiments; to compare the economic efficiency of cultural practices in the sites; to suggest some plans and policies for improving the situation in the traditional farms; and to evaluate the financial challenges facing farmers. Data was collected using structured survey questionnaires with specific sample size put into consideration all variations among the traditional farmers. The paper used descriptive farm budget and cost benefit analysis. In addition to t-test analysis. The conclusion was that yield gap between research and the traditional farms reached to about 50% on favor of the research sites. However; local farmers still economically efficient in producing broad been. The study has recommended that: the government of the RNS has to establish savings programs by encouraging farmers to participate with part of the expenses and to encouraging research and extension services; the cropping patterns has to be diversified with focusing on broad bean; and the yield variation could be bridged by applying appropriate Recommended Technical Package.

Keywords: Discrepancies, traditional, productivities, technical packages, broad bean

فروقات انتاجية الفول المصري ما بين المزارع التقليدية وتجارب البحوث بولاية نهر النيل

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الهدف الرئيس من هذه المسوحات هو تقدير الفروقات في انتاجية الفول المصري بين الابحاث والزراعة التقليدية بولاية نهر النيل. الاهداف الخاصة هي: قياس ومقارنة معامل الربحية بين المزارع التقليدية والابحاث ومقارنة الكفاءة الاقتصادية للعمليات الفلاحية في الموقعين وتقيم التحديات التمويلية التي تواجه المزارعين التقليدين واقتراح بعض الخطط والسياسات التي تحسن من الوضع الاقتصادي بالنسبة للمزارع التقليدية. جمعت المعلومات عن المزارعين التقليدين عن طريق استبيانات مصممة للمسوحات الزراعية مع حجم عينة خاصة محددة مع اخذ جميع الفروقات وسط المزارعين. استخدمت الورقة ميزانية المزرعة وتحليل التكاليف بالنسبة للفائدة بالإضافة الي تحليل التوزيع الطبيعي. خلصت نتائج التحليل الي وجود فجوة انتاجية بين البحوث والمزارع التقليدية وصلت لما يقارب 50% لصالح البحوث. بالرغم من ذلك يظل المزارع التقليدي للفول المصري يحقق فوائد اقتصادية. أوصت الدراسة بالآتي: على حكومة ولاية نهر النيل أنشاء برامج ادخار وذلك بتشجيع المزارعين على الانفاق الجزئي على مصروفاتهم الزراعية وتشجيع الخدمات البحثية والارشادية، يجب تنويع المحاصيل الزراعية وذلك بالتركيز على محصول الفول المصري ويمكن ردم الفجوة الانتاجية بين البحوث والزراعة التقليدية بتطبيق الحزم التقنية الموصي بها من قبل البحوث الزراعية.

كلمات مفتاحية: فروقات، تقليدي، انتاجيات، الحزم التقنية، الفول المصري.

Introduction

Recently after the separation of South Sudan and loss of great part of oil, 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 Sudan. Broad bean is considered as one of the most important cool-season food legumes produced in the River Nile State (RNS) in Sudan. The major production of broad bean is consumed domestically and also small quantities were imported from Ethiopia in the recent years (Ministry of Agriculture, Irrigation and Forestry in River Nile State (MAIFRNS, 2013).

The research on food legumes has been ongoing at Hudieba 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) 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, mainly heat stress were the main research objectives (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 (Hedhly, 2011; Luo, 2011), permitting extreme weather events to be incorporated into crop-climate models (Deryng *et al*., 2014). Nevertheless, the response of broad bean to heat stress during floral development and anthesis has not been previously investigated. 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 noticeable. Faba beans are poor competitors to weeds, particularly in the seedling stage (Ali *et al*., 2000). This makes integrated weed control important for successful crop production. Select fields with light weed pressure, do the primary tillage several weeks before planting and killing emerged weeds with shallow tillage just ahead of planting. One of the abiotic stresses is heat stress during floral development causing reductions in key yield parameters of faba bean. There are many demonstration studies in negative effects of drought stress but only one previous work on heat stress that focused on 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. 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 broad bean harvest (Porter *et al*., 2014).

The major insect pest which reduce the quantity and quality of broad bean production in Sudan was reported by Siddig (1980). 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 paper was to estimate the broad bean yield variation between research and traditional farm in Aliab area in the River Nile State (RNS). Specific objectives were:

a. To calculate and compare the coefficient index of the profitability between traditional farms and research experiments.
b. To compare the economic efficiency of cultural practices in the traditional farms and research experiments.
c. To suggest some plans and policies for improving the situation in the traditional farms.

Materials and methods

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, and cost benefit 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 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. T-test was conducted to determine the significance of differences between the traditional and research farms. Furthermore, a special additional cost of fair practices was analyzed to estimate feasibility of broad bean cultivation in the study area. Finally, a cost benefit analysis was done to determine how well, or how poorly, a planned action will turnout.

Results and discussion

Yield variations between research and traditional farming

Table (1) shows both averages of production of broad bean for research sites and traditional farming in the River Nile state. Maximum outputs of the crop were 2.20 metric ton (MT) per hectare and 1.30 MT for the research sites and traditional farming respectively. The minimum yield of broad bean in research sites was amounted to be 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 mean yield of the research sites was 0.82 MT/ feddan while the mean yield of traditional farms was 0.41 MT/ feddan, so the result will be:

$$\text{Yield variation} = \frac{0.82 - 0.41}{0.82} \times 100 = 50\%$$

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

Table (1): The maximum, minimum and average broad bean yields of research and traditional farms (monitored farmers' plots in Aliab Scheme during 2012/13 season).

Farming sites	Yield MT/ feddan		
	Maximum	**Minimum**	**Mean**
Research	0.95	0.70	0.82
Traditional	0.60	0.30	0.41
Total	1.55	1.00	1.23

Field survey, 2013/14

Table (2) shows the significant differences on broad bean production and its gross return between traditional farms and experiment sites. However, the differences were highly significant (Sig. 2-tailed= .000) between the two sites on the favor of the research sites.

Table (2): The independent sample tests on broad bean yields and gross returns of the research and traditional farms (monitored farmers' plots in Aliab Scheme during 2012/13 crop season).

Items (Equal variances assumed[1] and not assumed[2])	t-test for Equality of Means						
	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
kg/fed.Assu[1]	-11.4	28	.000	-407.5	35.6	-480.4	-334.6
kg/fed.NotAssu[2]	-11.3	17.5	.000	-407.5	36.1	-483.5	-331.5
SDG/fed.Assu[1]	-10.5	28	.000	-8400	801.4		-6758.3
SDG/fed.NotAss[2]	-11.0	20.4	.000	-8400	766.6		-6802.8

Assu[1]= Equal variances assumed, Assu[2]= Equal variances not assumed, fed.= feddan

Cost benefit analysis

Cost-Benefit Analysis (CBA) estimates and sums up the equal money value of the benefits and costs to community of projects to establish whether they are valuable (San Jose State University, 2011). A cost benefit analysis is done to determine how well, or how poorly, a planned action will turn out. Although a cost benefit analysis can be used for almost anything, it is most commonly done on financial questions. Since the cost benefit 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 3).

Table (3): Broad bean cost items (Source: Field Survey 2013/ 14).

Item	Cost (SDG)/ ha
Land preparation	726
Seed cost	1410
Seed broadcasting (sowing)	28
Fertilizers (chemical + organic)	0
Pest control	220
Supportive hand weeding	275
Fuel	55
No. of applied irrigations	413
Hand-harvest	795
Mechanical harvest	0
Empty sacks/ bags	104
Transportation	67
Taxation	17
Total	4109

Field survey; 2013/1

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 1247 kg/ha. 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 110 SDG/ha. So the 1-15 November planting date costs in total about 4109 SDG/ha. The harvesting price was estimated to be about 275 SDG/ 50 kg of broad bean (MAIFRNS[1]). Consequently, the return was estimated by about 8300 SDG/ha and the cost benefit was:

8300 – 4219 = 4081 SDG/ha.

The late sowing date (16- 1 December) costs about 4109. Thus, the cost benefit was:

6237 – 4109 = 2128 SDG/ha.

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

Seed rate in Kg/ha (additional cost and revenue)

The total cost of cultivating one hectare of broad bean was estimated by 4109 SDG. When three seed rates used: 150 - 170 kg/ha, 180 - 200 kg/ha, and over 200kg/ ha.cost is varying.

The first seed rate costs in average about 2112 SDG/ha (50 kg broad bean price was 660 SDG) (MAIFRNS). If we considered other factors constant this seed rate brings about 1445 kg/ha which estimated by about 7227 SDG (50 kg broad bean price was 275 SDG at harvesting time). Therefore, the cost benefit analysis could be calculated as follows:

$$7227 - (4109 - 1410 + 2112) = 6640 \text{ SDG/ ha.}$$

The second seed rate expenses about 2508 SDG/ha. Which produces about 1278 kg/ha of broad bean this could be sold out in approximately 7029 SDG. Using the previous formula, the cost benefit could be as follows:

$$7029 - (4109 - 1410 + 2508) = 6442 \text{ SDG/ha.}$$

The third seed rate cost was about 2640 SDG/ha. Which produced about 1454 kg/ha broad bean this could be produce cash about 7271 SDG. And by repeating the same approach above the cost benefit would be as follows:

$$7271 - (4109 - 1410 + 2640) = 7212 \text{ SDG/ha.}$$

From the preceding results we did terminate that the seed rate 150- 170 kg/ha was in the same efficiency.

Irrigation regime (additional cost and revenue)

Irrigation regime of broad bean in Aliab Scheme ranks from 5, 6, and 7 to 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 50 SDG/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 (2459 kg/ha). This cost equals to about 440 SDG/ha per season. So the cost benefit for the 8 irrigations was:

$$13522 – (4109 – 50 + 440) = 9023 \text{ SDG/ha.}$$

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

$$13522 – 4109 = 9413 \text{ SDG/ha.}$$

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

Weed control (additional cost and revenue)

At the farm level the highest yield was achieved by applying one spray with herbicide (Stomp) (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 770 SDG/ha (220+550 SDG) (MAIFRNS). The cost benefit for the weed control at station-level was estimated as follows:

13522 – (4109 -770) = 10183 SDG/ha.

While the cost benefit at the farm-level was:

11132 – 4109 = 7023 SDG.

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 reached about 50% in favor of research experiments. However, cost benefit analysis showed that at the farm level the early sowing date (1^{st}-15^{th} November) was economically efficient than the late planting date (16^{th} Nov.– 1^{st} December) and the seed rate 150- 170 kg/ha was sufficient to earn good return. 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 found of more benefit (same number of irrigations as the treated plot, within the same section) compared to those without herbicide application.

Conclusion

The study analysis had indicated that the productivity at research experiments was almost double the traditional levels. The poor performance of traditional farmers could be attributed to many factors; probably the limitation in financial resources could be the paramount reason behind the low productivities, in addition to technical knowhow. The cost benefit analysis had shown that broad bean cultivation in the River Nile State was economically efficient.

Recommendations

The study recommends the followings:

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

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