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# Effect of technology transfer on farmers' crop productivity and returns in Bargei village of Central Darfur state-Sudan

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**ABSTRACT:**
The process by which new inventions practiced in those agricultural research institutions 'or labs and tested to become a technology. The purpose of this study is to shade light on the effect of new introduced innovations on crop farmer's productivity and returns in Zalingei locality during 2019/2020 cropping season. Demonstration farms conducted in an area of 2 feddan. Improved seeds of Millet, Dura, Groundnut, sesame and cowpea grown versus local in an area of 900 square meters each. Sowing date, sowing methods, Seed priming versus none primed, preparation done land Land with chisel plough against the slope of water run, thinning to 2 plant/hole, weeding practiced 2-3 times, isolation, rouging, harvest and post-harvest technologies learned by farmers. Partial crop budget run for costs benefit analysis. The study used clustered random sampling technique. Partial crop budget results showed that all variables gave positive net returns except sesame promio, seame local, cowpea Elmadih and cowpea local. It was noted that improved sorghum seed priming yield increased over local by 151%, net returns of improved sorghum increased versus local by 43% and straw value of improved sorghum versus local exceed by 18%. Results also indicated that seed priming of improved millet ashana yield exceed local by 54%, ashana net returns increased local by 210% and improved straw exceed local straw by 28%. Results also revealed that primed yields, net returns and straw return of improved groundnut exceed local by 25%, 13% and 14%, respectively. Dominance analysis results showed that sorghum local, millet local and millet ashana were dominated and eliminated due to higher costs and lower net returns. Marginal analysis indicated that sorghum tabat and groundnut gibaish had marginal rate of return of 872% and 31%, respectively. This result entails that for every 1 Sudanese pound invested in improved seeds cultivation farmer can returns the 1 SDG and obtain additional SDG 8.72 and 0.31, respectively. Sensitivity analysis for cost overrun by 10% showed that groundnut Gibaish was not sensitive to risk and uncertainty with MRR 26%, while analysis of benefit shortfall by 10% explored that groundnut Gibaish also had MRR of 26%. We recommended more developing and dissemination of improved technologies to enhance crop yield and farmers income.

**KEYWORDS:** Dominance analysis, marginal analysis, Partial crop budget, technology, yield

## Introduction

According to Osman *et al*, 2012 traditional dry-land farming is the major production system in western Sudan and it is the main source of livelihood for more than 75% of the population. The main crops grown by farmers are millet, sorghum, groundnut and sesame. It was noticed that the yields of these crops are very low. Poor crop establishment and declined soil fertility are some of the main causes for this low productivity.

Breima *et al*, 2015 Central Darfur state (CDS) is located on the eastern border of Sudan, lying between latitudes $23.48^0$ N and longitude $12.90^0$ E. The total land area is 6425000 thousand square kilometer of which 4,659,000 feddan rain fed area, 12000 feddan irrigated while the cultivated land 1310887.6 feddan. The area displays different climatic zones: Mediterranean in Jabalmarra, rich savanna in southern part and poor savanna in the central areas. Land degradation is particularly acute in sub-Saharan African regions where long-term overuse of soil and low, unpredictable rainfall are prime reasons for poor food production. Agriculture plays an important role in the central Darfur economy and is a major source of income for most people including the rural poor. The availability of quality seed is the foundation for food production and productivity. Efforts raised by governments to improve the performance of agricultural sector should include seed production and seed delivery. Improved seeds can achieve its purpose only if it is transferred to and adopted by farmers. Agricultural technology can affect smallholder income, labor opportunities for the poor, food prices, environmental sustainability, and linkages with the rest of the rural economy (Wadsworth *et al*, cited 2020). Effective technology of improved seeds can result in higher agricultural production and increased incomes of farming families, which may unequivocally have a positive impact on rural poverty levels.. Soils are depleted and yields and crop quality decline, leading to widespread hunger and under nutrition. In the long run, the adoption of improved seed technology by farmers can make agro-industries more competitive in the international markets. The failure to replenish the soil fuels an unrelenting, vicious cycle. Unless nutrients are replaced, to address the problem of soil fertility, which is a greater constraint to food production than drought across much of sub-Saharan Africa, scientists at International Crop Research for Semi Arid Tropics (ICRISAT) have developed a precision-farming technique called 'Micro dosing'. Micro dosing involves the application of small, affordable quantities of fertilizer with the seed at planting time or as top dressing 3 to 4 weeks after emergence. This enhances fertilizer use efficiency instead of spreading fertilizer over the field, and improves productivity. Rather than asking how a farmer can maximize her/his yields or profits, micro dosing argues how a farmer can maximize the returns to a small initial investment -that might grow over time, turning deficits into surpluses (fertilizer micro dosing ICRISAT, 2009).

According to Osman *et al* 2012 Dry Land Coordination Group (DCG), based on its experience in the Sahelian zone, has recommended seed priming and micro fertilizing as simple technologies that can be used by resource-poor farmers to improve crop establishment, soil fertility and yield and hence improve their food security. These technologies were tested to verify their suitability to the traditional small scale farmers of Kordofan and Darfur States in Sudan. Both on-station and on-farm trials were conducted. Trial sites in North and South Kordofan are shown in figure 1.a and figure 1.b. The objectives of Ecofarm

Research Project (2007-2010) were to increase agricultural production, improve the environmental conditions and improve human nutrition and food security.

## 2.0 Research Objectives

- To know the effect of agricultural technologies on farmers crop productivity and income
- To enhance farmers adoption on agricultural technologies
- To increase/improve farmer skills and capacities

## 3.0 Study area

This study was conducted in Zalingei, locality of Central Darfur State. Zalingei lies to the west side in the poor savanna area; it was bordering north Darfur state from north, west Darfur state (Ginaina) from west, south Darfur from the eastern side and Chad from south. The main ethnic group in the area is the "Fur" tribe, after which the State is named. The average annual rainfall ranges between 450 and 600 mm, with the. The area has until 2017, been the scene of frequent armed clashes between government forces and armed rebel groups.

## 3.1 Research methodology

The study used clustered random sampling technique. Partial crop budget run for costs benefit analysis. On-farm demonstration plots were conducted in an area of 2 feddan. Improved seeds of millet, sorghum, Groundnut, sesame and cowpea grown versus local. 25 farmers randomly selected and trained in farming technical packages. Improved seed, sowing time, sowing methods, seed dressing (seed soaked in water for 8 hours and spread to air to dry for 20 minutes then treated and sown), Seed priming versus none primed, water harvesting by using terracing and chisel plough against the slope of water run, thinning to 2 plant/hole), weeding practiced 2-3 times, harvest and post harvest technologies learned by farmers.

## 3.2 Analytical tools

### 3.2.1 Partial crop budget:

Partial budgeting is a tool used to assess the costs and benefits associated with a specific change in an individual enterprise within the business operation (Soha, 2014)

### 3.2.2 Dominance analysis

Scott 2002 dominance and marginal analysis compares the variable costs with the gross margin, showing the increase in costs required to gain a given increase in gross margin. Treatments were first listed in order of increasing variable costs. Any treatment that had a total gross margin less than (or equal to) those of a treatment with lower total variable costs is dominated. Therefore, dominated treatments have a lower extra gross margin per unit of extra costs than other treatments (Evans, 2005).

### 3.2.3 Marginal analysis

Marginal analysis as used within this context is a procedure for calculating marginal rates of return between technologies, proceeding in a stepwise manner from a lower-cost technology to the next higher-

cost technology, and comparing marginal rates of return to acceptable minimum rates of return (Evans, 2005). According to Ahmed, et al 2013 marginal rate of returns can be expressed as:-

$$\textit{Marginal rate of returns (MRR)} = \frac{\text{Incremental net benefits}}{\text{Incremental net costs}} \times 100\%$$

$$\textit{Maximizing TPP: when} \frac{\partial TPP}{\partial x} = MPP = 0$$

*Where:*

TPP = Total physical productivity (output price per unit)

MPP = Marginal physical productivity

x = Input used (cost price per unit)

### 4.2.4 Sensitivity analysis

According to He, *et al*, 2016 Sensitivity analyses were applied to different cropping systems and climate conditions to evaluate the importance of inputs to outputs using crop, soil and hydraulic models.

## Results and discussions

Table 1, 2, 3, 4, 5 shows to what extent the use of seed priming can increase productivity and net returns of sorghum, millet, and groundnut. Results showed that all treatments gave positive net returns except sesame promio, seame local, cowpea Elmadih and cowpea local. The highest yield among sorghum was obtained by sorghum tabat (650 kg/ha), millet represented by ashana (105 kg/ha) and groundnut gibaish 113 kg/ha.It was observed also the highest net returns were showed by sorghum tabat (47969 Sudanese pound) and the lowest returns by sorghum butana (43128 Sudanese pound). Accordingly highest net returns obtained by millet ashana (29920 Sudanese pound), while millet local gave 9638 Sudanese pound. Results also indicated that groundnut gibaish gained higher net returns (124078 Sudanese pound) while local groundnut 53861 Sudanese pound. It was noted that sorghum primed yield and net returns increased over local by 151% and 43%, respectively. Analysis also shows that straw value of primed sorghum exceed local by 18%. Results explored that millet ashana primed yield exceed local by 54%, as well as millet ashana net returns and straw increased local by 210% and 28%, respectively. Results also revealed that primed yields, primed net returns and primed straw value of improved groundnut exceed local by 25%, 13% and 14%, respectively.

It was cleared that, farmers tend to maximize their profits and minimizing costs at the same time. Due to dominance analysis as stated by Cymmyt (1998) was applied to accept the most profitable treatments and eliminate the lowest returns and higher costs treatments. Dominance analysis results showed that sorghum local, millet local and millet ashana were dominated and eliminated. This give evidence that net returns these treatments decreased in the face of increasing costs. Hence the non dominated treatments transferred to further analysis of marginal analysis.

Marginal analysis indicated that sorghum tabat and groundnut gibaish had marginal rate of return of 872% and 31%, respectively. The marginal rate of return obtained by sorghum tabat was above the

minimum acceptable rate of returns. This result entails that for every 1 Sudanese pound invested in seed priming and other technical packages farmer can recover the 1.0 SDG and obtain additional Sudanese pound 8.72 and 0.31, respectively. Thus the use of seed priming is recommended.

Sensitivity analysis for cost overrun by 10% showed that groundnut Gibaish was not sensitive to risk and uncertainty with marginal rate of return 26%, while analysis of benefit shortfall by 10% explored that groundnut Gibaish also had MRR of 26%.

**Table: 1 partial crop budget**

| Crop | Variety | Treatment | Yield kg/ha | Adjusted yield kg/ha | Straw value SDG/ha | G.F.B SDG/ ha | Total G.F.B SDG/ha | Cost variation /ha | Net returns SDG/ha |
|---|---|---|---|---|---|---|---|---|---|
| Sorghum | wad-ahmed | Primed | 325 | 260 | 66667 | 4420 | 71087 | 27350 | 43737 |
| Sorghum | Butana | Primed | 230 | 184 | 66667 | 3128 | 69795 | 26667 | 43128 |
| Sorghum | Tabat | Primed | 650 | 520 | 66351 | 8840 | 75191 | 27222 | 47969 |
| **mean** | | | **402** | **321** | **66562** | **5463** | **72024** | **27080** | **44945** |
| Sorghum | Local | 0 | 160 | 128 | 56240 | 2167 | 58407 | 26889 | 31518 |
| Millet | Ashana | Primed | 105 | 80 | 45556 | 1920 | 57476 | 27556 | 29920 |
| Millet | Local | 0 | 65 | 52 | 35501 | 1248 | 36749 | 27111 | 9638 |
| Sesame | Promio | Primed | 65 | 52 | 0 | 3120 | 3120 | 28333 | (25213) |
| Sesame | Local | 0 | 40 | 32 | 0 | 1920 | 1920 | 28222 | (26302) |
| G/nut | Gibaish | Primed | 113 | 90 | 88889 | 6300 | 95189 | 28889 | 124078 |
| g/nut | Local | 0 | 90 | 72 | 77821 | 5040 | 82861 | 29000 | 53861 |
| cowpea | Elmadih | Primed | 25 | 20 | 0 | 2200 | 2200 | 16667 | (14467) |
| cowpea | Local | 0 | 5 | 4 | 0 | 440 | 440 | 18200 | (17760) |

Source; HH 2019

**Table: 2 dominance analysis**

| **Treatments** | **Cost variation SDG/ha** | **Net returns SDG/ha** |
|---|---|---|
| $T_1$ Sorghum Butana | 26667 | 43128 |
| $T_2$ Sorghum local | 26889 | 31518 D |
| $T_3$ Millet local | 27111 | 9638 D |
| $T_4$ Sorghum tabat | 27222 | 47969 |
| $T_5$ Sorghum Wad-Ahmed | 27350 | 43737 |
| $T_6$ Millet Ashana | 27556 | 29920 D |
| $T_7$ Groundnut Gibaish | 288889 | 124078 |
| $T_8$ Groundnut local | 29000 | 53861 |

Source; HH 2019

**Table: 3 Marginal analysis**

| **Treatments** | **Costs variation SDG/ha** | **Marginal costs** | **Net return SDG/ha** | **Marginal net returns SDG/ha** | **MRR = V/III x 100 %** |
|---|---|---|---|---|---|
| **I** | **II** | **III** | **IV** | **V** | |
| $T_1$sorghum Butana | 26667 | - | 43128 | - | |
| $T_4$ sorghum Tabat | 27222 | 555 | 47969 | 4841 | 872 |
| $T_5$sorghum Wad-ahmed | 27350 | 128 | 43737 | -4232 | (3306) |
| $T_7$G/nut gibaish | 288889 | 261539 | 124078 | 80341 | 31 |
| $T_8$G/nut local | 29000 | -259889 | 53861 | -70217 | (27) |

Source: Author 2019

**Table: 4 Sensitivity analysis of cost overrun by 10%**

| | | | | | |
|---|---|---|---|---|---|
| **Crop** | **Cost that vary** | **Marginal cost** | **Net returns** | **Incremental net benefit** | **MRR=V/III*100** |
| I | II | III | IV | V | |
| $T_4$ sorghum Tabat | 29944 | - | 47969 | - | |
| $T_7$G/nut gibaish | 317778 | 287834 | 124078 | 76109 | 26 |

Source: Author 2019

**Table: 5 Sensitivity analysis of benefit shortfall by 10%**

| Crop | Cost that vary | Marginal cost | Net returns | Incremental net benefit | MRR=V/III*100 |
|---|---|---|---|---|---|
| I | II | III | IV | V | |
| $T_4$ sorghum Tabat | 27222 | - | 43172 | - | |
| $T_7$G/nut gibaish | 288889 | 261667 | 111670 | 68498 | 26 |

Source: Author 2019

## CONCLUSIONS

Traditional farming is the main production system and source of livelihood security for more than 75% of the population in Western Sudan. The r food crops grown are millet and sorghum while groundnut cowpea and sesame are the major cash crops. This research was conducted in Zalingei locality of Central Darfur State. The purpose of this study is to know the effect of improved technologies on farmers' crop productivity and income. Results of partial crop budget indicated that crop productivity and net returns increased by seed priming and other technical packages. Marginal rate of returns can be enhanced by investment in adopting seed priming technology and that is clearly shown in investment in production of

sorghum tabal with marginal rate of return 8.72, while groundnut is lesser and not much profitable (0.31). Sensitivity analysis ensured crop stability against phenotypic factors. We recommended more developing, dissemination and investment in improved technologies to enhance crop yield and farmers income.

## REFERENCES

Ahmed, E.E.B., Maruod, M.E., Elkhidir, E.E. and Mahmoud, T.E.(2013). Impact of Improved Seedson Small Farmers' Productivity, Income and Livelihood in Bara Locality of North Kordofan State, Sudan. Agricultural Research Corporation Elobeid research Station-Sudan
press.*American International Journal of Contemporary Research Vol. 3 No. 11*

Breima, E.E. (2015).Impact of climate change on crop production: Case of Nertiti and Garcilla localities, Agricultural economics, Zalingei agricultural research station, Central Darfur State, Sudan, annual report

Cimmyt (1998). An economics training manual. From agronomic data to farmer recommendations. Economics program.

Evans, E.E.(2005). Marginal Analysis: An Economic Procedure for Selecting
AlternativeTechnologies/Practices. IFAS EXTENSION. University of Florida.

He, W. Yang, J., drury, C. and Yang, X. (2016). Sensitivity analysis of crop yields, soil water contents and nitrogen leaching to precipitation, management practices and soil hydraulic properties in semiarid and humid regions.Beijing Academy of Agriculture and Forestry Sciences press. Researchgate

Osman, A.K., Elhaj, F.M., Mekki, M.A., Abdalla, E.A. and Aune, J.B.(2012).EFFECT OF SEED PRIMING AND MICRO FERTILIZING ON SORGHUM, MILLET, GROUNDNUT, SESAME AND COWPEA. Norwegian University of Life Sciences press.Ecofarm Research Project- Kordofan Region- Sudan. DCGn Report No. 71, P1.

Scott, F.(2002). Dominance Analysis of Crop RotationTrials Fiona Scott Tamworth Centre for Crop Improvement, NSW Agriculture, RMB 944, Tamworth, NSW 2340.

Soha, M.El.(2014).The partial budget analysis for sorghum farmin Sinai Peninsula, Egypt. Annals of agricultural science, Faculty of agriculture, Ain Shams University. Agric. Economic Dep.Socioeconomic Studies Division, Desert Research Center, *Egypt.Original article.*

Wadsworth, J. and Carlisle, B. (cited 2020). TECHNOLOGY AND ITS CONTRIBUTION TO PRO-POOR AGRICULTURAL DEVELOPMENT. Central Research Department, DFID, and the UK Food Group for their additional contributions and comments.