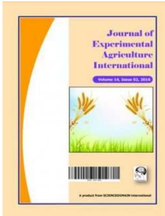

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Paddy (*Oryza sativa* L.) Production Status and use of Agricultural Inputs in Selected Districts of the Eastern and Southern Regions of Tanzania

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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ABSTRACT

Understanding on the status of paddy production and productivity in the 78 BRN irrigation schemes in Tanzania is needed to cope with projected changes with a view to address economic hardships and food security in selected regions of eastern and western Tanzania. The aim of this study was to assess the status of production and productivity of rice grown in the 78 selected BRN irrigation schemes; quantity of agro inputs and their costs and per cent of famers using the inputs during the dry and wet seasons. Three groups of farmers in 4 replicates were interviewed from each of the 78 BRN irrigation schemes. Data on the area under cultivation, quantity and costs of agricultural inputs, cost of production, yields and market price were collected using structured questionnaires. Data analysis was performed using the software of STATISTICA program 2007. Fisher's least significant difference (LSD) was used to compare treatment means at $P \le .05$ (Steel and Torrie, 1980). Descriptive statistics including percentages and means were similarly used for analysis.

The results indicate that during the wet season paddy was grown on a total area of 66,139 ha compared with 2,824 ha grown during the dry season. Results also showed that Mbarali District had 28 per cent of the total area under paddy cultivation during the wet season compared with 23, 17 and 13 per cent of the total area for Kilombero, Mlele and Mpanda Districts respectively. Data

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also indicate that BRN irrigation schemes in Mvomero District cultivated 51 per cent of the total paddy area during the dry season probably due to reliable source and supply of irrigation water. Out of 78 BRN irrigation schemes, 59 with 7,189 farmers from Mbarali, Mlele, Kilombero and Mvomero Districts received 545 tons of different agricultural input subsidies. The data also shows that 4,367,234 kg of Urea was used with overall total cost of TZS 4,532,366,000 during the wet season. Similar trend was observed during the dry season. This quantity and the overall total costs were higher compared with FYM, Minjingu, DAP and CAN. On the average, the main fertilizers were used by between 29 and 46 per cent of the farmers in the irrigation schemes. Compared with other agrichemicals, results showed that 89,907 litres of 2,4-D were used during the wet season by farmers from 39 BRN irrigation schemes. During the dry season, 8,158.3 litres of 2,4-D herbicide corresponding to TZS 177,473,000 was used by more farmers compared with other pesticides.

The overall total mean yield and price of rice in the 78 BRN irrigation schemes during the wet season was recorded as 3.84 t ha^{-1} and 539,343 TZS ton^{-1} respectively. During the dry season, the overall total mean yield of rice was 4.2 t ha^{-1} with corresponding mean price of 557,676 TZS ton^{-1}. The overall total mean variable costs (TVC) during the wet and dry seasons were 1,102,500 and 1,155,000 TZS ha^{-1} respectively. The overall NR during the dry season in the BRN irrigation schemes was 1,162,870 TZS ha^{-1}. Relative to other districts, results showed that in the wet season, ARR was significantly ($P \leq .05$) greater in Mbarali (138.5%) district and 323% in Kilombero district during the dry season. These results forms a baseline data from which BRN project can use to help in sustainable production and a useful pathway for interventions on the improvement of rice production and utilization, harnessing its contribution to food and income security for sustainable development and livelihoods.

Keywords: Urea; minjingu phosphates; 2,4-D; big results now; paddy; productivity; farm yard Manure.

1. INTRODUCTION

Rice (*Oryza sativa* L.) is the second most important food and commercial crop after maize (*Zea mays* L.) and it is among the major sources of employment, income and food security in Tanzania. Tanzania is the second largest producer of rice in Southern Africa after Madagascar with production level of 1.1 million tons of milled rice [1,2] against consumption needs of about 1.39 million tons. In 2013/2014, it was reported that rice production capacity is about 1.2 million tons, of which around 300,000 tons of milled rice was exported to other countries. Rice is mostly grown in Mwanza, Shinyanga (Bariadi & Maswa), Morogoro (Kilombero, Wami - Dakawa); Tabora (Igunga), Kilimanjaro (Lower Moshi), Coast (Rufiji, Lindi), Mbeya (Mbarali, Kyela, Kapunga) and Rukwa Regions. However, 25% of the national rice production comes from Kyela and Mbarali districts in Mbeya Region and Kilombero, Kilosa, Morogoro Rural and Mvomero districts in Morogoro Region. Rice production in Tanzania is mainly done by small and medium scale commercial rice farmers. The area under rice cultivation by 2012 was 720,000 ha and the long term average yield per hectare (2003 – 2012) was very low, 1.8 t ha^{-1}. Tanzania has the capacity to produce an average of 3.8 t ha^{-1} annually during the rainy season if small scale commercial farmers were to adopt improved farming practices. However, when irrigation is combined with good agricultural practices, rice yield can reach up to between 7 and 10 t ha^{-1}.

The impact of agricultural inputs such as organic and inorganic fertilizers and pesticides has been found to be positive. The term pesticide covers a wide range of compounds including insecticides, fungicides, and herbicides [3]. Weeds reduce yield of dry land crops by 37–79 per cent [4]. Severe infestation of weeds, particularly in the early stages of crop establishment, ultimately accounts for a yield reduction of 40 per cent. Herbicides provided both an economic and labour benefit. However, crop production in Tanzania is faced with low use of agrochemicals such as fertilizer and consequently low crop productivity. Tanzanian farmers for example, use an average of only 9 kg ha^{-1} of fertilizers compared with 16 kg ha^{-1} in SADC countries; 27 kg ha^{-1} in Malawi and 279 kg ha^{-1} in China. Similarly, the market has failed to absorb all the fertiliser and seed stocks supplied by traders. For example, during 2007/08 to 2009/10 seasons between 15 and 30 per cent surplus of fertilizer stocks were not absorbed by the market. Likewise, the annual supply of improved seeds is about 12,000 t yr^{-1} or 10 per cent of the total estimated seeds requirements of 120,000 t yr^{-1}. However, even the small amount supplied was not fully absorbed as 6 per cent remained with the stockists. Agricultural inputs, primarily seed, fertilizer and pesticides, have an enormous potential to leverage the efforts of hard-working farmers if used appropriately and timely.

Rice (*Oryza sativa* L) production depends on the optimum combination of right inputs to achieve remarkable yield. For example, chemical fertilizers affected rice production positively with a marginal physical return of about 6.2 kg of paddy for one additional kg of fertilizer [5,6,7]. Results of several studies have also indicated that application of N and P fertilizers increased grain yield of rice by increasing the magnitude of its yield attributes [8,9,10]. Increase in yield attributing characters was associated with better nutrition and increased nutrient uptake. This resulted into better and healthy plant growth and development [8,11], leading to the greater production of dry matter and its translocation to the sink [12]. Panda [10] reported increased dry matter and grain yield production due to increased N and P uptake in response to their external supply.

The access and use of intensive inputs in agriculture has enabled an increase in food production and standard of living, providing food and livelihood possibilities where they may have been previously limited. If food productivity has to increase in order to meet the demands of the estimated 45 million people in Tanzania [13], it is essential that the right inputs get into the hands of farmers. Improved inputs lead to greater productivity, which not only increases farmers' incomes but also has the potential to increase food security and poverty alleviation. We will have a much better chance of winning the race against hunger and poverty if we drive a well-tuned high-performance and appropriately equipped vehicle backed by the best talents.

Against this background, rice production and productivity, market prices and use of agricultural inputs by farmers in the 78 BRN irrigation schemes was assessed during the baseline survey. Proper use and timely availability of agricultural inputs is one of the important factors often suggested to affect production and productivity, yield and farmers income. The aim of this study was therefore to assess the status of production and productivity of rice crop grown in the area; quantity of agro inputs, their costs and per cent of famers using the inputs during the wet and dry seasons.

2. MATERIALS AND METHODS

2.1 The Study Area

The selected regions and districts are located in the Eastern and Southern Irrigation Zones of Tanzania. The Eastern Zone comprises of Morogoro administrative region and Southern Zone comprises of Katavi, Iringa, Mbeya and Rukwa administrative regions (Table 1). Rainfall in the area is erratic. Generally, rains falls between October and April. However, most rains falls between December and March and generally fall in short intervals with an average of 957 mm per annum or 137 $mm.month^{-1}$ (Figs. 1.1 and 1.2).

Table 1. Area under paddy grown during the wet and dry seasons in the 78 BRN irrigation schemes

Region	District	No of irrigation schemes	Rice area (ha)	No of irrigation schemes	Rice area (ha)
		Wet season		Dry season	
Iringa	Iringa Rural	11	7,710	2	0
Mbeya	Kyela	2	459	2	459
	Mbarali	34	18,284	11	0
Rukwa	Sumbawanga	1	250	1	15
Katavi	Mlele	3	11,339	1	0
	Mpanda DC	4	8,432	2	0
Morogoro	Kilombero	9	15, 026	5	476
	Morogoro R	4	2,330	2	80
	Mvomero	3	460	3	1,440
	Kilosa	7	1,848	3	354
Total	**10**	**78**	**66,139**	**32**	**2,824**

Source: Baseline survey (2014)

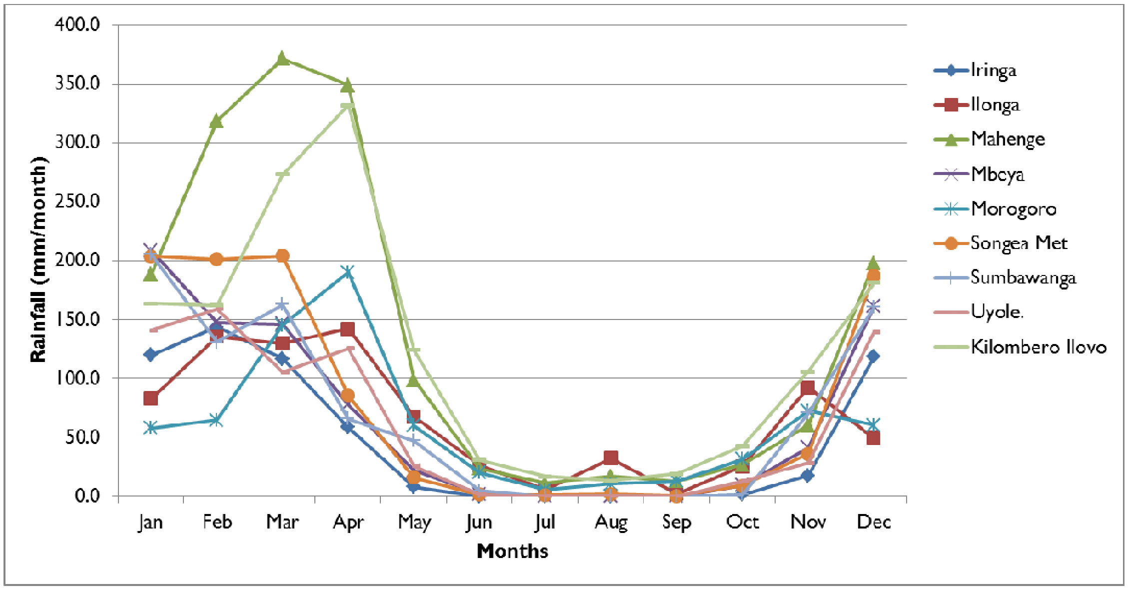

Fig. 1.1. Climatic data representative of the selected areas

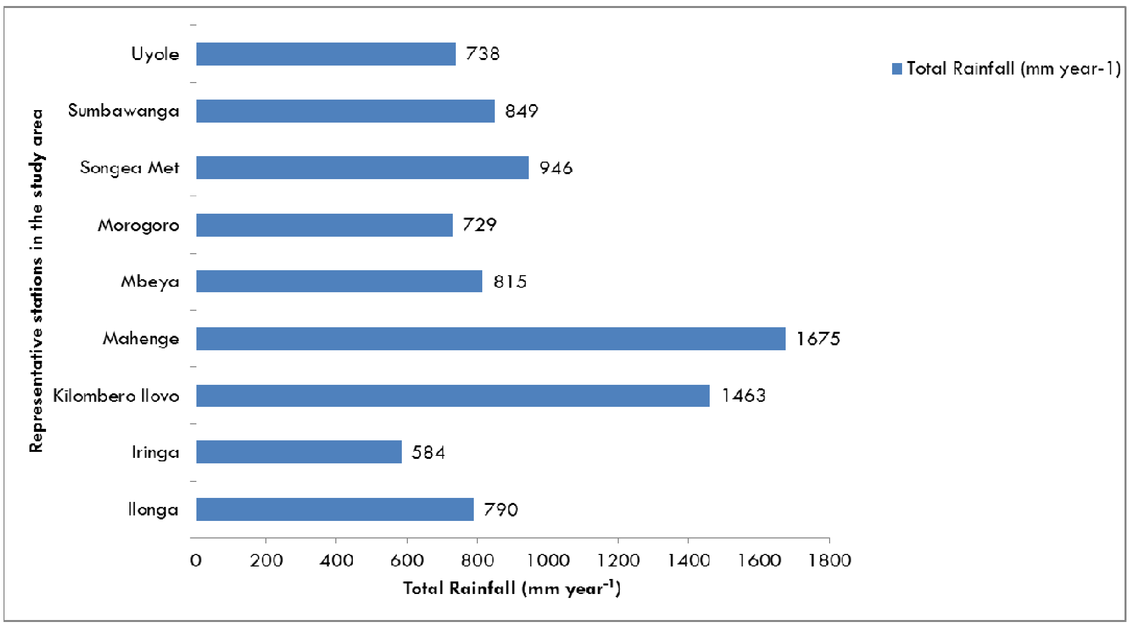

Fig. 1.2. Total annual rainfall from stations representative of the selected areas

2.2 Sampling Procedure and Sources of Data

A two-stage sampling procedure was employed to obtain necessary data. The baseline survey was conducted in 78 irrigation schemes previously selected for irrigation development in the big results now (BRN) program. The survey was conducted by six (6) teams consisting of members of different departments/expertise from the Ministry of Agriculture Food and Cooperatives (MAFC) and Local Government Authorities (LGAs) within the 78 irrigation schemes. The second stage involved field visit and focus group discussion (FGD) where each team conducted field visit and interview a group that comprised of 10 irrigator's organization (IOs), 10 village leaders and 10 farmers selected randomly in the target irrigation schemes, thus, making a total of 2,340 respondents from the 78 irrigation. Data was analysed using Microsoft Excel, STATISTICA program software [14] and FAO model value chain analysis software [15].

Both primary and secondary data from the 78 BRN irrigation schemes were collected in March, 2014 during the baseline survey. The primary data collection involved the use of a well-structured questionnaire designed to capture the critical information needed to address effective implementation of agricultural Big Results Now (BRN) in the 78 irrigation schemes. Information collected included potential area, predominant crops grown, use of agricultural inputs (i.e. fertilisers, agrochemicals and seeds), crop production and productivity, and cost of production during the wet (*first cropping season*) and dry season (*second cropping season*). Data obtained by using the questionnaires were triangulated by key informant interviews and focus group discussions. The secondary data were obtained from Journals and other printed materials from the respective Local Government Areas (LGAs).

2.3 Analytical Techniques

2.3.1 Gross margin analysis

The gross margin analysis (GMA) was used to evaluate the costs and returns to rice production. GMA was used not only because it is one of the easiest and common method to determine profitability but also because it is one of the best methods of estimating profits of an enterprise [16,17]. It refers to the total income derived from an enterprise less the variable costs incurred in the enterprise. Farm GM provides a simple method for comparing the performance of enterprises that have similar input requirements for capital and labour [18]. The gross margin analysis embarked upon in costs and returns to rice production is expressed as follows [19]:

$$GMR = TR - TVC \qquad (1)$$

Where

GMR = Gross Margin Revenue (TZS.ha^{-1})
TR = Total Revenue (TZS.ha^{-1})
TVC = Total Variable Cost (TZS.ha^{-1})

2.3.2 Average rate of return (ARR)

Average rate of return (ARR) was also obtained. This was done by dividing total gross marginal revenue (GMR) by the total cost of production (TVC), multiplied by 100 as follows:

$$ARR = \left(\frac{GMR}{TVC} \times 100 \right) \qquad (2)$$

Where

ARR = Average Rate of Returns
GMR = Total Gross Marginal Revenue (TZS.ha^{-1}) and
TVC = Total Cost of Production (TZS.ha^{-1})

2.4 Statistical Analysis

Data collected were analysed statistically using One-Way ANOVA. The analysis was performed using the software of STATISTICA program 2014 (Stat Soft Inc., Tulsa, OK, USA); Microsoft Excel, and FAO model value chain analysis software [15]. Fisher's least significant difference (LSD) was used to compare treatment means at $P \leq .05$ [14].

3. RESULTS AND DISCUSSION

The well-being of large populations around the world including Tanzania depends on access, stability and availability of food [20]. This is especially true in the developing world with predominant subsistence small holder farmers for whom the on-farm and off-farm agricultural labour provides the main source of food and income [21]. The agricultural sector in Tanzania provides 85 per cent of exports, employs 75 per cent of the workforce, contributes 75 per cent of foreign exchange earnings and about 28.9 per cent to the national GDP. The aim of the baseline survey was to get the reality on the ground and current status of the 78 paddy irrigation schemes identified for BRN implementation so as to inform subsequent designs and envisaged implementation of BRN activities. Specifically, the survey focused, among others, on current levels of paddy production and productivity as well as agricultural inputs such as agrochemicals and pesticides. The rationale behind the baseline survey was based on the results of the agricultural lab which showed significantly low crop production in Tanzania. The baseline survey was therefore conducted to develop benchmark information and conduct gap analysis on the status of 78 BRN irrigation schemes.

3.1 Predominant Crop and Area under Cultivation

Results of the baseline survey showed that different crops were grown during the wet and dry seasons. Crops grown in the wet season (*masika*) with supplementary irrigation include rice (*Oryza sativa* L), maize (*Zea mays* L), beans (*Phaseolus vulgaris* L), millet (*Pennisetum glaucum* L), sorghum (*Sorghum bicolor* Munch), onions (*Allium cepa* L), tomatoes (*Solanum lycopersicum*) and different kinds of vegetables. Of the crops observed during the baseline survey, paddy was found to dominate over the others as it was grown on a total area of 66,139 ha. However, during the dry season the trend was different as less area i.e. 2,824 ha was put under rice production (Table 1). The greater area under cultivation observed during the wet season for rice compared with dry season suggests the presence of sufficient water through rainfall which falls within the crop growth and development period in addition to supplementary irrigation. Results showed that the largest area under cultivation during the wet season was found in Mbarali District followed by Kilombero, Mlele, and Mpanda Districts respectively. These areas were 28, 23 and 17 per cent of the total area under cultivation respectively. The greater area under cultivation during the wet season in Mbarali District was probably due to presence of larger number of irrigation schemes compared with other Districts. Results also indicate that BRN irrigation schemes in Mvomero District cultivated 51 per cent of the total paddy area during the dry season probably due to reliable source and supply of irrigation water.

3.2 Use of Agricultural Inputs and Accessibility of Input Subsidy

Baseline survey results showed that common fertilizers used in rice fields in the 78 BRN irrigation schemes ranged from organic to inorganic. Organic fertilizers are farm yard manure (FYM) and compost which are found locally. Inorganic fertilizers and rice seeds available in the study area include Booster, Calcium Ammonium Nitrate (CAN), Di-Ammonium Phosphate (DAP), Farm Yard Manure (FYM), Minjingu Rock Phosphate (MRP), Urea, Sulphate of Ammonia (SA), and paddy seeds (SARO5). Similarly, the pesticides used included 2,4-D, Attakan, Booster, Ivory M-72 or Victory M-71, Karachi, Karate, Lincolin, Ridomil, Roundup and Selecron. These agro inputs were mostly imported by the private sector except for Minjingu Rock Phosphate (MRP) which was processed and packed in Tanzania by a private company. The data showed that out of 78 BRN irrigation schemes, 59 received 545 tons of different input subsidies and 19 were not. Results also showed that 7,189 farmers from Mbarali, Mlele, Kilombero and Mvomero Districts received 545 tons of different inputs subsidies (Fig. 2). Rice (i.e. SARO5) is a cereal with potential high responses to significant investments in inorganic (and organic) fertilizer application.

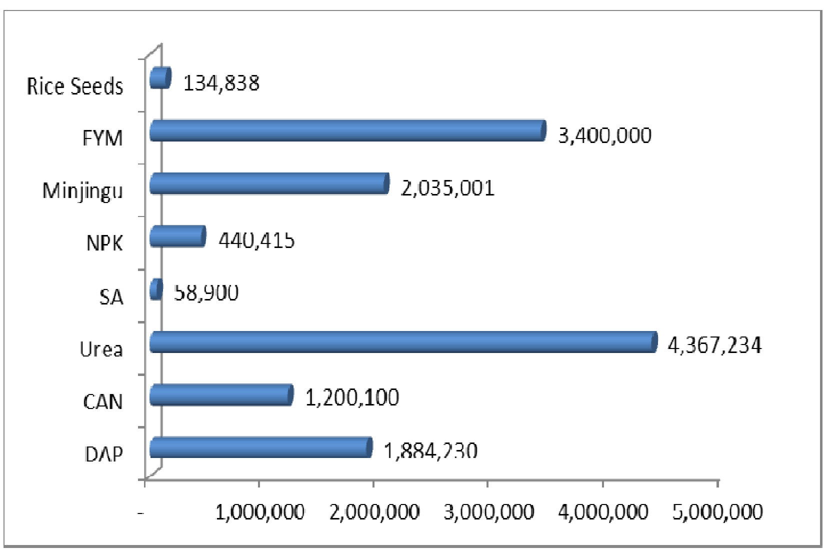

Fig. 2. Quantity of inputs used in the 78 irrigation scheme

The distribution of fertilizers in Tanzania is done by importers and stockists/agro-dealers that have low distribution capacities and often put premium prices due to monopoly power to cover for their transport costs to rural areas. Most of these agro inputs were available on subsidy to address farmers challenge on the high costs of imported inputs and ensure increased productivity. [22, 23] reported the role and importance use of inputs and input subsidy for increased productivity for different types of agricultural products. Previous study revealed that reduced costs of subsidized inputs increased farmer's profitability and reduces risks [24]. Conventional arguments for subsidies in agricultural development have focussed on the promotion of increased agricultural productivity through the adoption of new technologies [25].

Organic matter (OM) from organic manure/compost is considered as an important parameter of soil fertility and productivity for it plays a number of important roles in the soil. These roles include improvement of soil physical structure, provides sink for plant mineral elements, a medium for biological activities, provides nutrients to the soil, improves water holding capacity and helps the soil to maintain better aeration for seed germination and plant root development [26]. Use of compost can be beneficial to improve OM status in soil because compost is a rich source of nutrients with high OM content. Depletion of nutrients and poor OM contents of soils can only be replenished by applying compost to these soils [27]. It has been reported that yield and yield components of rice and wheat increased significantly with the application of different organic materials but compost proved the most superior in this regard [27]. However, when compost is combined with chemical fertilizer further enhanced the biomass and grain yield of both crops [28,29]. For example, [29] showed that crop yields significantly increased with the use of compost in combination with chemical fertilizer (i.e. 3.94 t ha^{-1} for rice and 5.73 t ha^{-1} for wheat), FYM (3.36 t ha^{-1} for rice and 4.38 t ha^{-1} for wheat) and Sesbania green manure (i.e. 2.86 t ha^{-1} for rice and 3.50 t ha^{-1} for wheat). However, compost proved superior to farmyard manure as well as *Sesbania sesban* L. green manure.

3.3 Quantity and costs of Agricultural Inputs and Pesticides used in Paddy Production during *wet* Season

Analysis of agricultural inputs was carried out in order to determine the quantities and costs used in paddy production during the wet and dry seasons. The data shows that the quantity of Urea used by farmers was greater ($P \leq .05$) followed by farm yard manure (FYM), Minjingu,

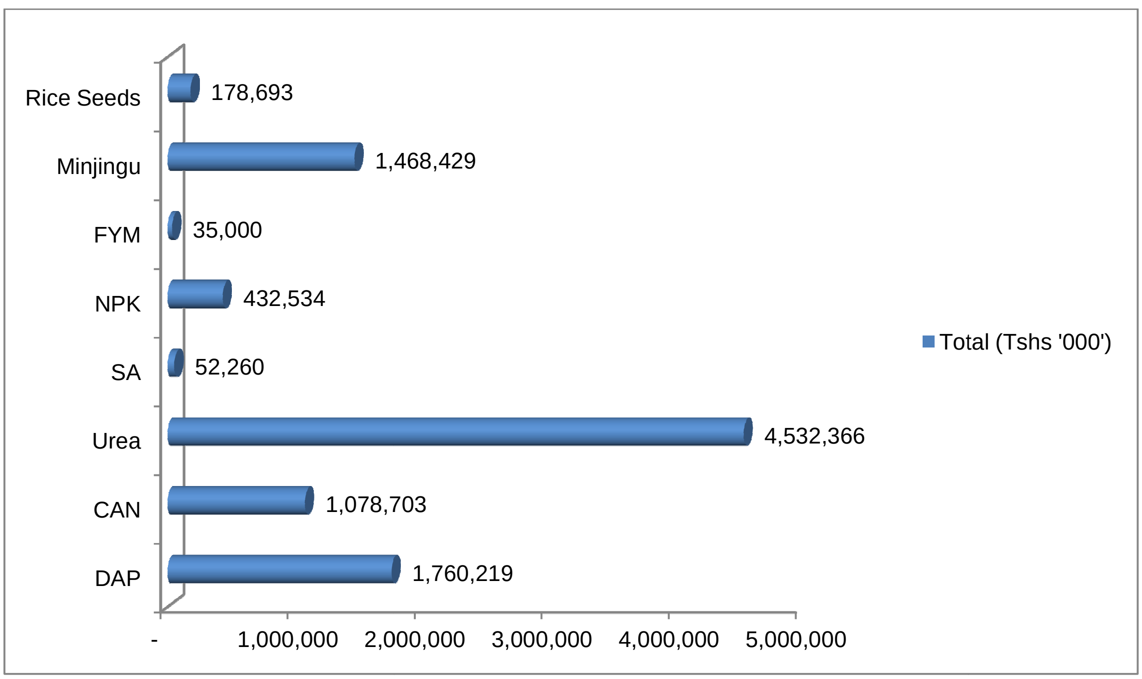

Fig. 3. Total costs of agricultural inputs (Tshs '000') in rice grown during the wet season in the 78 BRN irrigation schemes

DAP and CAN (i.e. Urea > FYM > Minjingu > DAP > CAN) with quantities 4,367,234 kg, 3,400,000 kg, 2,035,001 kg, 1,884,230 kg and 1,200,100 kg respectively (Fig. 2). Irrigation schemes in Mbarali District used about 52.2 per cent of the total Urea and 44 per cent of the total DAP used for paddy growth during the wet season. On the average, the main fertilizers were used by between 29 and 46 per cent of the farmers in the irrigation schemes. The costs of inputs used in paddy production during the wet season followed similar trend just as the quantity of fertilizers (Fig. 2). The overall total cost of Urea was Tshs. 4,532,366,000 followed by DAP Tshs 1,760,219,000, Minjingu Tshs 1,468,429,000 and CAN Tshs 1,078,703,000. When these inputs were ranked, Urea was used by farmers from 58 irrigation schemes followed by DAP and Minjingu which were used by farmers from 26 and 18 irrigation schemes respectively.

Results of the baseline survey showed that during the wet season, 2, 4-D was the herbicide that was used by more farmers from 39 BRN irrigation schemes followed by Karate in 24 and booster in 8 irrigation schemes (i.e. 2,4-D > Karate > Booster). Quantitatively, 89,907 litres of 2, 4-D was used followed by 29,308 litres of Booster and by 12,021 litres of Karate respectively. The 2, 4-D was more prevalent in Mlele District where total of 24,750 litres were used followed by Mbarali, Kilombero and Mpanda DC District irrigation schemes where 20,768; 16,696 and 15,500 litres were used respectively. The data showed that Karate was more used in Morogoro Rural where 5,000 litres were used followed by Mbarali, Kilombero and Kilosa Districts with 3,539; 1,575 and 1,273 litres respectively. The costs of inputs used in paddy production during the wet season followed similar trend just as the quantity of pesticides (Fig. 5). The overall total cost of 2,4-D was TZS 939,261,000 followed by Booster and Karate with total overall costs of TZS 193,860,000 and 353,036,000 respectively. When these inputs were ranked, 2,4-D was used by farmers from 58 irrigation schemes followed by Booster and Karate which were used by farmers from 26 and 18 irrigation schemes respectively.

3.4 Quantity and costs of Agrochemicals and Pesticides used in Paddy Production during Dry Season

The total quantity and costs of agricultural inputs in paddy grown during the dry season are summarised in Fig. 3. Results indicated that the amount of Urea used was 578,063 kg followed by Minjingu 195,875 kg and DAP 93,875 kg. The data showed that Urea was used more by farmers followed by Minjingu and DAP compared with other types of fertilizers. The corresponding costs for these inputs were TZS 639,835,000, 100,353,000 and 115,755,000 respectively. With regards to the pesticides, 2,4-D herbicide was used by more farmers in the visited irrigation schemes followed by Karate compared with other pesticides (Fig. 4). The overall quantity of 2,4-D was 8,158.25 litres and 2,319.75 litres of Karate corresponding to TZS 177,473,000 and TZS 49,525,000 respectively. The largest portion was used in Kilosa, Mvomero Districts in Morogoro Region and Kyela District in Mbeya Region.

3.5 Crop Production and Average Price of Rice during the Wet Season

Results of rice yield and market prices during the wet season are shown in Table 2. It was observed that paddy yields significantly ($P \le .05$) varied across the 78 BRN irrigation schemes within the 10 districts. For instance, Sumbawanga District in Rukwa Region recorded significantly ($P \le .05$) greater yield (5.3 ± 0.24 t ha^{-1}) followed closely by Mlele, Kilosa and Iringa rural districts compared with the rest of the districts. The overall total mean yield of rice in the 78 BRN irrigation schemes during the wet season was recorded as 3.84±0.17 t ha^{-1}. The price of paddy during the wet season was significantly ($P \le .05$) greater in Kyela District (800,000±64,663 TZS ton^{-1}), followed by Mbarali District (662,240±53,528 TZS ton^{-1}) compared with other districts. The overall average price of rice during the wet season in the 78 BRN irrigation schemes was 539,343±27,942 TZS ton^{-1}.

3.6 Crop Production and Average Prices of Rice during dry Season

The yield of rice and market prices during the dry season are shown in Table 3. The data indicated significantly ($P \le .05$) greater rice yield (6.3±0.4 t ha^{-1}) in Mkula irrigation scheme, Kilombero district, followed by Sakalilo irrigation scheme (5.3±0.3 t ha^{-1}) in Sumbawanga District compared with other Districts. The overall total mean yield of rice during the dry season in the 78 BRN irrigation schemes was 4.2±0.4 t ha^{-1}. The price of rice in the dry season was significantly high (675,000±62,354 TZS ton^{-1}) in Mkula irrigation scheme, Kilombero DC and (625,000±57,735 TZS ton^{-1}) in Makwale irrigation scheme in Kyela District compared with (404,762±37,390 TZS ton^{-1}) in Sakalilo irrigation scheme in Sumbawanga District. The overall average price of rice during the dry season in the 78 BRN irrigation schemes was 557,676±31,530 TZS ton^{-1} (Table 3).

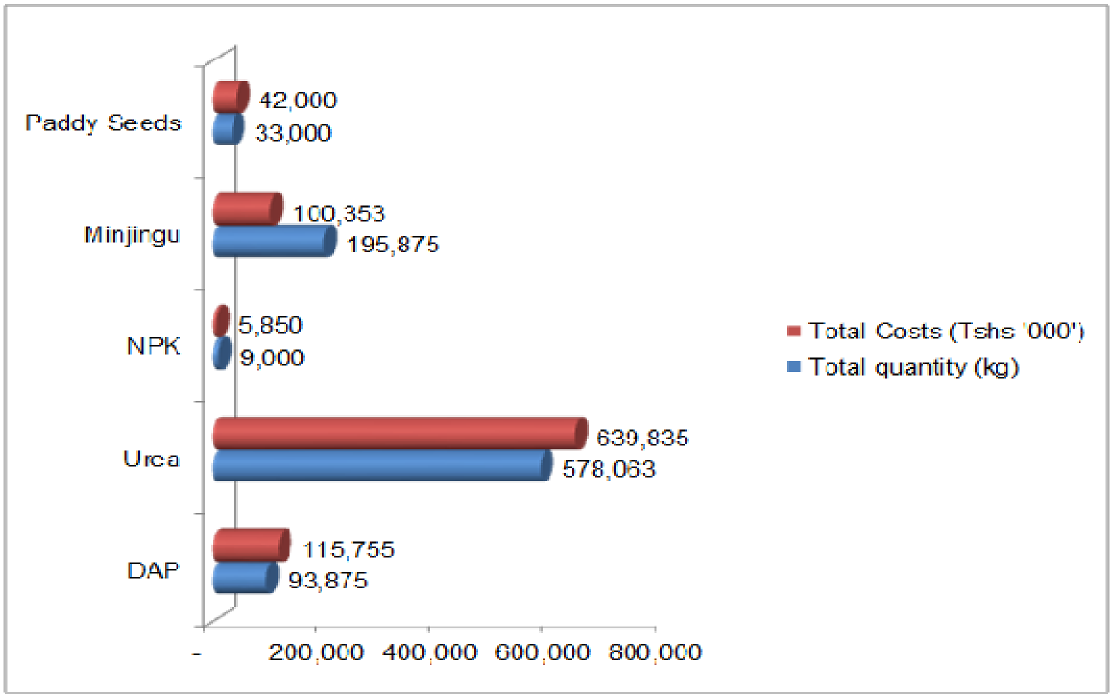

Fig. 4. Total quantity and costs of inputs used by farmers in dry season paddy in 78 selected BRN irrigation schemes

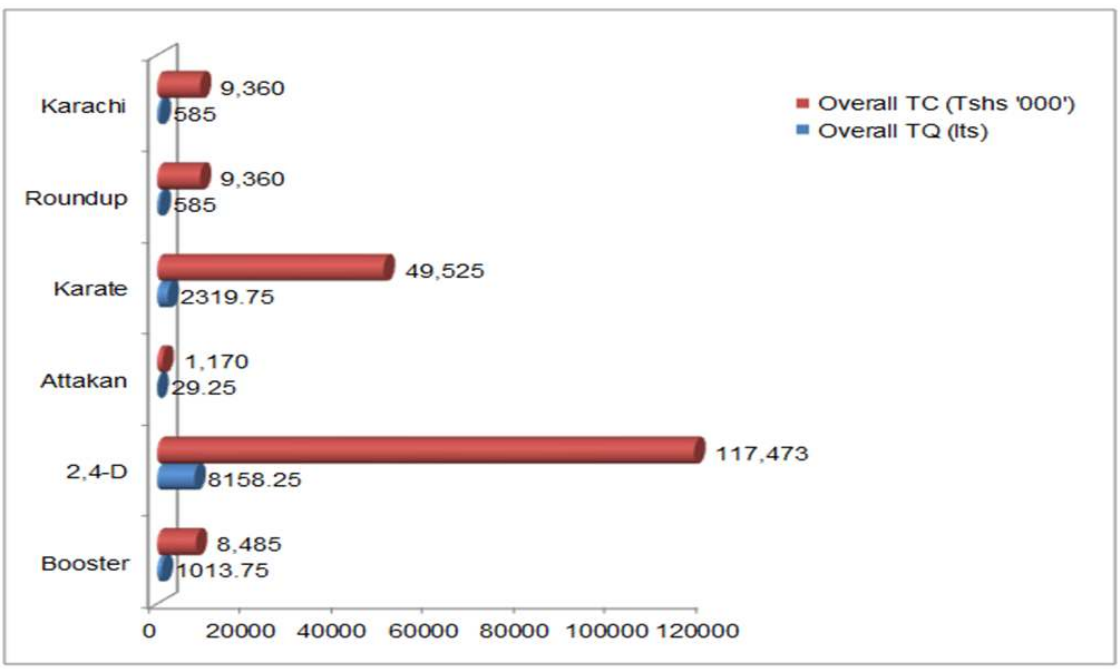

Fig. 5. Total quantity and costs of the agro chemicals used in paddy production in 78 selected BRN irrigation schemes in dry season

Table 2. Total variable cost and net or marginal revenue analysis of paddy yield during the wet season

Region	District	Yield ($t.ha^{-1}$)	Py ($TZS.ton^{-1}$)	TVC ($TZS.ha^{-1}$)	NR/MR ($TZS.ha^{-1}$)	TA (ha)	TNR/TMR (TZS)	TNR/TMR (TZS 'bill')	ARR
Iringa	Iringa R	4.22bc	597,222bc	1,200,000b	1,340,432.9a	7,710	10,334,737,827.2b	10.3b	110b
Mbeya	Kyela	1.95f	800,000a	1,125,000b	446,648.0b	459	205,011,432.0de	0.2de	39cd
	Mbarali	3.78cd	662,240b	1,050,000b	1,473,528.7a	18,284	26,941,998,175.8a	26.9a	139a
Rukwa	Sumbawanga	5.30a	404,762de	975,000b	1,186,256.4a	250	296,564,095.4de	0.3de	120ab
Katavi	Mpanda DC	4.23bc	378,778e	1,000,000b	612,286.2b	8,432	5,162,797,519.2cd	5.2cd	60c
	Mlele	4.37b	319,074f	1,000,000b	403,693.0b	11,339	4,577,475,272.9de	4.6de	39cd
Morogoro	Kilombero	2.86e	574,375bc	1,000,000b	655,195.1b	15,026	9,844,961,355.3bc	9.8bc	64c
	Morogoro R	3.66d	612,500bc	1,000,000b	1,260,031.1a	2,330	2,935,872,424.2de	2.9de	124ab
	Mvomero	3.37de	525,000cd	1,525,000a	255,697.3b	460	117,620,773.3e	0.1e	16d
	Kilosa	4.68b	519,476cd	1,150,000b	1,300,047.2a	1,848	2,402,487,272.2de	2.4de	111b
One way ANOVA statistic									
F-statistic value		**27.4*** **	**10.2*** **	3.7**	7.0***		23.3***	23.3***	22.4***
CV (%)		8.2	14.4	13.6	33.8	-	46.5	46.5	19.3

Py: Crop yield price; TVC: Total Variable cost; NR/MR: Net revenue/Marginal revenue; TA: Total area; TNR: Total net revenue; TMR: Total marginal revenue; ARR: Average rate of return; CV: Coefficient of variation

Table 3. Total variable cost and net or marginal revenue analysis of paddy yield during the dry season

Region	District	Yield $t.ha^{-1}$	Py $TZS.ton^{-1}$	Area (ha)	TVC ($TZS.ha^{-1}$)	NR/MR ($TZS.ha^{-1}$)	TNR/TMR (TZS 'bill')	ARR
Mbeya	Kyela	2.2d	625,000a	459	1,125,000b	204,417d	0.09b	20c
Rukwa	Sumbawanga	5.3b	404,762c	15	975,000b	1,147,356b	0.02b	121b
Morogoro	Kilombero	6.3a	675,000a	100	1,000,000b	3,173,750a	0.32b	323a
	Mvomero	3.9c	533,333ab	1,440	1,525,000a	515,225cd	0.74a	36c
	Kilosa	3.5c	550,286ab	354	1,150,000b	773,604bc	0.27b	70bc
One way ANOVA								
F-statistic value		**38.4*** **	**3.9* **		**6.8** **	**59.0*** **	**6.4** **	**29.2*** **
CV (%)		10.6	16.2		12.7	22.8	66.9	35

Py: Crop yield price; TVC: Total Variable cost; NR/MR: Net revenue/Marginal revenue; TA: Total area; TNR: Total net revenue; TMR: Total marginal revenue; ARR: Average rate of return; CV: Coefficient of variation

3.7 Cost of Production in the 78 BRN Irrigation Schemes during the Wet and Dry Season

The costs of production for rice during the wet and dry seasons are shown in Tables 2 and 3. During the wet season, these costs (1,525,000.0±118,862.0 TZS ha^{-1}) were greater ($P \le .05$) in Mvomero District compared with the rest of the Districts. The overall total mean of the total variable costs (TVC) during the wet and dry seasons was observed to be 1,102,500±37,258 and 1,155,000±61,616 TZS ha^{-1} respectively.

3.8 Marginal Revenue (MR) of rice Production in the 78 BRN Irrigation Schemes during the Wet and Dry Seasons

The Marginal Revenue (MR) or Net Revenue (NR) for rice grown during the wet and dry seasons were assessed and compared (Tables 2 and 3). During the wet season the NR was significantly ($P \le .05$) higher in Mbarali (1,473,528.7±236,501.2 TZS ha^{-1}), Iringa rural (1,340,432.9±226,951.4 TZS ha^{-1}), Kilosa (1,300,047.2±219,445.7 TZS ha^{-1}), Morogoro rural (1,260,031.1±207,162.1 TZS ha^{-1}) and Sumbawanga (1,186,256.4±196,651.3 TZS ha^{-1}) Districts compared with others. The data also indicated that the overall NR accrued from rice was 893,382.6±93,041.0 TZS ha^{-1}. During the dry season, Mvomero District had greater ($P \le .05$) NR followed by Sumbawanga compared with other Districts with BRN irrigation schemes. Results showed that Kilombero District recorded NR of 3,173,750±201,076 TZS ha^{-1} followed by Sumbawanga District which recorded NR of 1,147,356±131,255 TZS ha^{-1}. The overall NR during the dry season in the BRN irrigation schemes was 1,162,870±287,049 TZS ha^{-1}.

Average rate of return (ARR) was calculated to estimate the profitability status of rice production in the 78 BRN irrigation schemes during wet and dry seasons. Results showed that in the wet season, ARR was significantly ($P \le .05$) greater in Mbarali (138.5±11.7 per cent) district, followed closely by Sumbawanga (124.3±11.0 per cent) and Morogoro rural (120.0±10.8 per cent) districts compared with other districts. During the dry season, ARR was significantly ($P \le .05$) higher (323±40 per cent) in Kilombero district relative to other districts.

4. CONCLUSION

The primary objective of this study was to assess the status of paddy/rice production and productivity in the 78 BRN irrigation schemes which is needed to cope with corresponding projected changes with a view to address economic hardships and food security in selected regions of eastern and western Tanzania. The analysis showed that the overall total area under rice production was 68,963 Ha of which 95.9 per cent was cultivated during wet season and 4.1 per cent during dry season. Of the total area under rice production, 28 per cent came from Mbarali District cultivated during the wet season and 51 per cent from Mvomero District during the dry season. A total of 4,367.2 tons of Urea fertilizer corresponding to ≈TZS 4.53 trillion was applied during the wet season and was the most used type of fertilizer compared with other types. Fifty nine (59) out of 78 BRN irrigation schemes received 545 tons of different agricultural input subsidies. On the average, between 29 per cent and 46 per cent of the farmers in the irrigation schemes used the main types of fertilizers. Herbicide 2,4-D was used by more farmers to control weeds compared with other pesticides. During the wet season, 89,907 litres of 2,4-D corresponding to TZS 177.5 million were used by farmers from 39 BRN irrigation schemes compared with 8,158.3 litres used during the dry season. The overall total mean yield for rice during the wet and dry seasons was 3.84 t ha^{-1} and 4.2 t ha^{-1} with mean prices of 539,343 and 557,676 TZS ton^{-1} respectively. The overall total variable cost (TVC) was TZS 1,102,500 during the wet season and TZS 1,155,000 dry season. During the wet season the net revenue (NR) was significantly higher in Mbarali i.e. 1,473,528.7 TZS ha^{-1} and 1,162,870 TZS ha^{-1} in Kilombero during the dry season. Relative to other districts, analysis showed that in the wet season, the average rate of return (ARR) was greater (i.e. 138.5 %) in Mbarali district and 323 % in Kilombero district during the dry season. These results forms a baseline data from which BRN projects can use to help in sustainable productivity and a useful pathway for interventions on the improvement of rice production and utilization, thus, harnessing its contribution to food and income security for sustainable development and livelihoods.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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