

1 **Paddy (*Oryza sativa* L.) production status and use of agricultural inputs in selected Districts of the Eastern and Southern Regions of** 2 **Tanzania**

3 **Abstract**

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

13
14 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
15 the dry season. Results also showed that Mbarali District had 28 per cent of the total area under paddy cultivation during the wet
16 season compared with 23, 17 and 13 per cent of the total area for Kilombero, Mlele and Mpanda Districts respectively. Data also
17 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, 8,158.25 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 is 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.

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 rice cultivated area 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 packages, 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 largely 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 stage 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 this small amount supplied is not fully absorbed as 6 per cent remain with 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 optimum combination of production inputs to achieve remarkable yield. For example, chemical fertilizer 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 increase grain yield of rice by increasing the magnitude of its yield attributes [8, 9, 10]. Increase in yield attributing characters is associated with better nutrition and increased nutrient uptake which result in better and healthy plant growth and development [8,11], leading to greater dry matter production and its translocation to the sink [12]. [10] Reported increased dry matter production including grain yield of rice due to increased N and P uptake in response to external supply of both N and P fertilizers.

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 is going to increase 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 vehicle backed by the best talent and appropriately equipped.

Against this background, rice production and productivity, market prices and use of agricultural inputs by farmers in the 78 selected 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.

81

82 **MATERIALS AND METHODS**

83

84 **The Study Area**

85

86 The selected regions and districts are located in the Eastern and Southern Irrigation Zones of Tanzania. The Eastern Zone comprises
87 Morogoro administrative region and Southern Zone comprises of Katavi, Iringa, Mbeya and Rukwa administrative regions (Table 1).
88 Rainfall in the area is erratic. Generally, rains falls between October and April. However, most rains falls between December and
89 March and generally fall in short intervals with an average of 957 mm per annum or 137 mm.month⁻¹ (Figs. 1-1; 1-2).

90

91 **Sampling procedure and sources of data**

92

93 A two-stage sampling procedure was employed to obtain necessary data. The baseline survey was conducted in 78 irrigation schemes
94 previously selected for irrigation development in the big results now (BRN) program. The survey was conducted by six (6) teams
95 consisting of members of different departments/expertise from the Ministry of Agriculture Food and Cooperatives (MAFC) and Local
96 Government Authorities (LGAs) within the 78 irrigation schemes. The second stage involved field visit and focus group discussion (FGD)
97 where each team conducted field visit and interview a group that comprised of 10 irrigator's organization (IOs), 10 village leaders and
98 10 farmers selected randomly in the target irrigation schemes, thus making a total of 2,340 respondents from the 78 irrigation. Data
99 was analysed using Microsoft Excel, STATISTICA program software [14] and FAO model value chain analysis software [15].

100

101 Both primary and secondary data from the 78 BRN irrigation schemes were collected in March, 2014 during the baseline survey. The
102 primary data collection involved the use of a well-structured questionnaire designed to capture the critical information needed to
103 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).

Analytical Techniques

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]:

$$GMR = TR - TVC$$

Where

GMR = Gross Margin Revenue (TZS.ha⁻¹)

TR = Total Revenue (TZS.ha⁻¹)

TVC = Total Variable Cost (TZS.ha⁻¹)

127 *Average rate of return (ARR)*

128

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

131

$$132 \quad ARR = \left(\frac{GMR}{TVC} \times 100 \right)$$

133 **Where**

134

135 ARR = Average Rate of Returns

136 GMR = Total Gross Marginal Revenue (TZS.ha⁻¹) and

137 TVC = Total Cost of Production (TZS.ha⁻¹)

138

139 *Statistical Analysis*

140

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

144

145 **RESULTS AND DISCUSSION**

146

147 The well-being of large populations around the world including Tanzania depends on access, stability and availability of food [20].

148 This is especially true in the developing world with predominant subsistence small holder farmers for whom the on-farm agriculture and

149 off-farm agricultural labour provides the main source of food and income [21]. The agricultural sector in Tanzania provides 85 % of
 150 exports employs 75 % of the workforce, contributes 75 % of foreign exchange earnings and about 28.9 % to national GDP. The aim
 151 of the baseline survey was to get the reality on the ground and current status of 78 paddy irrigation schemes identified for BRN
 152 implementation so as to inform subsequent designs and envisaged implementation of BRN activities. Specifically, the survey focused,
 153 among others, on current levels of paddy production and productivity and agricultural inputs such as agrochemicals and pesticides. The
 154 rationale behind the baseline survey was based on the results of the agricultural lab which showed significantly low crop production in
 155 Tanzania. The baseline survey was therefore conducted to develop benchmark information and conduct gap analysis on the status of 78
 156 BRN selected irrigation schemes.

157

158 **Predominant crop and area under cultivation**

159

160 Results of the baseline survey showed that different crops were grown during the wet and dry seasons. Crops grown in the wet season
 161 (*masika*) with supplementary irrigation include rice (*Oryza sativa* L), maize (*Zea mays* L), beans (*Phaseolus vulgaris* L), millet (*Pennisetum*
 162 *glauca* L), sorghum (*Sorghum bicolor* Munch), onions (*Allium cepa* L), tomatoes (*Solanum lycopersicum*) and different kinds of vegetables.
 163 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
 164 66,139 ha compared with 6,182 ha of maize. However, during the dry season the trend was different as more maize was grown in an
 165 area of 4,601 ha compared with 2,824 ha of rice (Table 1). The greater area under cultivation observed during the wet season for
 166 rice compared with maize suggests the presence of sufficient water through rainfall which falls within the crop growth and development
 167 period in addition to supplementary irrigation. However during the dry season, the trend was reversed as rice is more water consuming
 168 than maize such that farmers opt to grow maize than rice. Results showed that the largest area under cultivation during the wet season
 169 was found in Mbarali District followed by Kilombero, Mlele, and Mpanda Districts respectively. These areas were 28, 23 and 17 per
 170 cent of the total area under cultivation respectively. The greater area under cultivation during the wet season in Mbarali District was
 171 probably due to presence of larger number of irrigation schemes compared with other Districts. Results also indicate that BRN irrigation

172 schemes in Mvomero District cultivated 51 per cent of the total paddy area during the dry season probably due to reliable source and
173 supply of irrigation water.

174

175 **Use of Agricultural Inputs and Accessibility of Input Subsidy**

176

177 Baseline survey results showed that common fertilizers used in rice fields in the 78 BRN irrigation schemes range from organic to
178 inorganic. Organic fertilizers are farm yard manure (FYM) and compost which are found locally. Inorganic fertilizers and rice seeds
179 available in the study area include Booster, Calcium Ammonium Nitrate (CAN), Di-Ammonium Phosphate (DAP), Farm Yard Manure
180 (FYM), Minjingu Rock Phosphate (MRP), Urea, Sulphate of Ammonia (SA), and paddy seeds (SARO5). Similarly, the pesticides used
181 include 2,4-D, Attakan, Booster, Ivory M-72 or Victory M-71, Karachi, Karate, Lincoln, Ridomil, Roundup and Selecron. These agro
182 inputs are mostly imported by the private sector except for Minjingu Rock Phosphate (MRP) which is processed and packed in Tanzania
183 by a private company. The data showed that out of 78 BRN irrigation schemes, 59 received 545 tons of different input subsidies and
184 19 were not. Results also showed that 7,189 farmers from Mbarali, Mlele, Kilombero and Mvomero Districts received 545 tons of
185 different inputs subsidies (Fig. 2). Maize and rice (i.e. SARO5) are cereals with potential high responses to significant investments in
186 inorganic (and organic) fertilizer application.

187

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

195

196 Organic matter (OM) resulting from organic manure/compost is a very important parameter of soil fertility and productivity as it plays
197 number of important roles in soil including soil physical structure, sink for plant mineral elements, medium for biological activities,
198 provides nutrients to the soil, improves water holding capacity and helps the soil to maintain better aeration for seed germination and
199 plant root development [26]. Use of compost can be beneficial to improve OM status in soil because compost is a rich source of nutrients
200 with high OM content. Depletion of nutrients and poor OM contents of soils can only be replenished by applying compost to these soils
201 [27]. It has been reported that yield and yield components of rice and wheat increased significantly with the application of different
202 organic materials but compost proved the most superior in this regard [27]. However, when compost is combined with chemical fertilizer
203 further enhanced the biomass and grain yield of both crops [28, 29]. For example, [29] showed that crop yields significantly increased
204 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
205 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
206 proved superior to farmyard manure as well as sesbania green manure.

207

208 **Quantity and costs of agricultural inputs and pesticides used in paddy production during wet season**

209

210 Analysis of agricultural inputs was carried out in order to determine the quantities and costs used in paddy production during wet and
211 dry seasons. The data shows that the quantity of Urea used was higher followed by farm yard manure (FYM), Minjingu, DAP and CAN
212 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
213 Mbarali District used about 52.2 per cent of the total urea and 44 per cent of the total DAP used for wet season paddy growth. On
214 the average, the main fertilizers were used by between 29 and 46 per cent of the farmers in the irrigation schemes.

215

216 The costs of inputs used in paddy production during the wet season followed similar trend just as the quantity of fertilizers (Fig. 2). The
217 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

218 1,078,703,000. When these inputs were ranked, Urea was used by farmers from 58 irrigation schemes followed by DAP and Minjingu
219 which were used by farmers from 26 and 18 irrigation schemes respectively.

220

221 Results of the baseline survey showed that during the wet season, 2, 4-D was used more by farmers from 39 BRN irrigation schemes
222 followed by Karate in 24 and booster in 8 irrigation schemes. Quantitatively, 89,907 litres of 2, 4-D was used followed by 29,308
223 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
224 litres were used followed by Mbarali, Kilombero and Mpanda DC District irrigation schemes where 20,768; 16,696 and 15,500 litres
225 were used respectively. The data showed that Karate was more used in Morogoro Rural where 5,000 litres were used followed by
226 Mbarali, Kilombero and Kilosa Districts with 3,539; 1,575 and 1,273 litres respectively.

227

228 The costs of inputs used in paddy production during the wet season followed similar trend just as the quantity of pesticides (Fig. 5). The
229 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
230 353,036,000 respectively. When these inputs were ranked, 2,4-D was used by farmers from 58 irrigation schemes followed by Booster
231 and Karate which were used by farmers from 26 and 18 irrigation schemes respectively.

232

233 **Quantity and costs of agrochemicals and pesticides used in paddy production during dry season**

234

235 The total quantity and costs of agricultural inputs in paddy grown during the dry season are summarised in Fig.3. Results indicated that
236 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
237 used more by farmers followed by Minjingu and DAP compared with other types of fertilizers. The corresponding costs for these inputs
238 were TZS 639,835,000, 100,353,000 and 115,755,000 respectively.

239

240 With regards to the pesticides, it was observed that 2,4-D herbicide was used by more farmers in the visited irrigation schemes
241 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
242 Karate corresponding to TZS 177,473,000 and TZS 49,525,000 respectively. The largest portion was used in Kilosa, Mvomero Districts
243 in Morogoro Region and Kyela District in Mbeya Region.

245 **Crop production and average price of rice during the wet season**

247 Results of rice yield and market prices during the wet season are shown in Table 2. It was observed that paddy yields significantly ($P \leq$
248 .05) varied across the 78 BRN irrigation schemes within the 10 districts. For instance, Sumbawanga District in Rukwa Region recorded
249 significantly ($P \leq .05$) greater yield ($5.3 \pm 0.24 \text{ t ha}^{-1}$) followed closely by Mlele, Kilosa and Iringa rural districts compared with the
250 rest of the districts. The overall total mean yield of rice in the 78 BRN irrigation schemes during the wet season was recorded as
251 $3.84 \pm 0.17 \text{ t ha}^{-1}$. The price of paddy during the wet season was significantly ($P \leq .05$) greater in Kyela District ($800,000 \pm 64,663 \text{ TZS}$
252 ton^{-1}), followed by Mbarali District ($662,240 \pm 53,528 \text{ TZS ton}^{-1}$) compared with other districts. The overall average price of rice during
253 the wet season in the 78 BRN irrigation schemes was $539,343 \pm 27,942 \text{ TZS ton}^{-1}$.

255 **Crop production and average prices of rice during dry season**

257 The yield of rice and market prices during the dry season are shown in Table 3. The data indicated significantly ($P \leq .05$) greater rice
258 yield ($6.3 \pm 0.4 \text{ t ha}^{-1}$) in Mkula irrigation scheme, Kilombero district, followed by Sakalilo irrigation scheme ($5.3 \pm 0.3 \text{ t ha}^{-1}$) in
259 Sumbawanga District compared with other Districts. The overall total mean yield of rice during the dry season in the 78 BRN irrigation
260 schemes was $4.2 \pm 0.4 \text{ t ha}^{-1}$. The price of rice in the dry season was significantly high ($675,000 \pm 62,354 \text{ TZS ton}^{-1}$) in Mkula irrigation
261 scheme, Kilombero DC and ($625,000 \pm 57,735 \text{ TZS ton}^{-1}$) 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)

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 ($P \leq .05$) 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.

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 ($P \leq .05$) higher in Mbarali (1,473,528.7±236,501.2TZS.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 ($P \leq .05$) NR followed by Sumbawanga compared with other Districts with BRN rice 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.

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

290

291 **Conclusion**

292

293 The primary objective of this study was to assess the status of paddy production and productivity in the 78 BRN irrigation schemes in
 294 Tanzania which is needed to cope with projected changes in production and productivity with a view to address economic hardships
 295 and food security in selected regions of eastern and western Tanzania. The data highlighted the current status of production and
 296 productivity of rice; quantity of agro inputs and their costs and per cent of famers using the inputs during the dry and wet seasons.

297

298 **References**

299

- 300 [1] Match, M. A. (2010). Value Chain Analysis of Rice and Maize in Selected Districts in Tanzania: A research report submitted to
 301 Agricultural Council of Tanzania. 21pp.
- 302 [2] FAOSTAT. (2010). Food and Agricultural Organization of the United Nations database
- 303 [3] Md. W. Aktar, D. Sengupta, Chowdhury, A. (2009). Impact of pesticides use in agriculture: their benefits and hazards. A review
 304 article. Interdisc. Toxicol. 2(1): 1–12. doi: 10.2478/v10102-009-0001-7
- 305 [4] B. Behera, and Singh, S.G. (1999). Studies on Weed Management in Monsoon Season Crop of Tomato. Indian J Weed Sci.
 306 31(1–2): 67.
- 307 [5] R. Bernier, and Dorosh, P.A. (1993). Constraints on Rice Production in Madagascar: The Farmer's Perspective, CFNPP working
 308 paper 34, Cornell University.
- 309 [6] Randrianarisoa, J.C. (2001). The effects of Land Quality and Natural Shocks on Land and Labour Productivity on Rice in
 310 Madagascar's Highlands, Michigan State University, Ms Thesis.

- 311 [7] J.C. Randrianarisoa, and Minten, B. (2001). Agricultural Production, Agricultural Land and Rural Poverty in Madagascar. Mimeo.
312 Antananarivo: FOFIFA/Cornell University.
- 313 [8] Thakur, R. B. (1993). Performance of summer rice (*Oryza sativa*) to varying levels of nitrogen; *Indian J. Agron.*; 38(2):187–190.
- 314 [9] A. S. Channabasavanna, and Setty, R. A. (1994). Response of broadcast rice (*Oryza sativa*) to level of nitrogen, phosphorus
315 and potassium and time of N application; *Indian J. Agron.*; 39(3):457–459; 1994.
- 316 [10] S.C. Panda, Panda, P.C. and Nanda, S. S. (1995). Effect of levels of N and P on yield and nutrient uptake of rice; *Oryza*;
317 32:18–20.
- 318 [11] K. Kumar, and Rao, K. V. P. (1992). Nitrogen and phosphorus requirement of upland rice in Manipur; *Oryza*; 29:306–309.
- 319 [12] P. K. Dalal, and Dixit, L. (1987). Response of newly developed medium duration and high yielding rice genotypes to nitrogen;
320 *Indian J. Agron.*; 30(1):114–116.
- 321 [13] PHC. (2012). Population and Housing Census (PHC), Tanzania
- 322 [14] R.G.D. Steel, Torrie, J.H. (1980). Principles and procedures of statistics: A biometrical approach, Second Edition. McGraw Hill,
323 New York.
- 324 [15] VCA Software, (2008). FAO VCA-Tool: Software for Value Chain Analysis
- 325 [16] Bashir Ahmad, S.H. (2004). Factors Affecting Profitability and Yield of Carrot in Two Districts in Punjab. Pakistan: International
326 Journal of Agriculture Biology.
- 327 [17] Erbaugh, D. (2008). Profitability analysis of sorghum farming and its influence on sorghum value chain in Tanzania: A case study
328 of Singida and Simanjaru. Tanzania.
- 329 [18] Forestry, A.F. (2009). Farm Gross margins. State Government of Victoria.
- 330 [19] J.O. Olukosi, and Erhdor, P.O. (1988). Introduction to Farm Management Economics. Agitab Publishers, Samaru-Zaria, P.O. BOX
331 561. pp.77-83.
- 332 [20] J. Schmidhuber, and Tubiello, F. (2007). Global food security under climate change. *PNAS* 104 (50): 19703–19708
- 333 [21] T. Ito, and Kurosaki, T. (2009). “Weather risk, wages in kind, and the off-farm labor supply of agricultural households in a
334 developing country,” *American Journal of Agricultural Economics*, 91 (3), 697–710.
- 335 [22] D. Byerlee, T. Jayne, and Myers, R. J. (2006). “Managing food price risks and instability in a liberalizing market environment:
336 Overview and policy options.” *Food Policy* 31(4): 275-287.
- 337 [23] P.B.R. Hazell, C.Poulton, S.Wiggins & Dorward, A. (2007). The Future of Small Farms for Poverty Reduction and Growth.
338 International Food Policy Research Institute, Washington, D.C., USA. Available at:
339 <http://dx.doi.org/10.2499/97808962976472020vp42>
- 340 [24] Dorward, A. (2009). Rethinking agricultural input subsidy programmes in a changing world. Paper prepared for the Trade and
341 Markets Division, FAO (available at
342 http://www.fao.org/es/esc/common/ecg/586/en/Dorward_FAO_Subsidy_Paper_FINAL.pdf).
- 343 [25] Ellis, F. (1992). Agricultural policies in developing countries. Cambridge, Cambridge University Press

- 344 [26] Zia, M.S. (1993). Soil Fertility Evaluation and Management for Flooded lowland rice soils of Pakistan. Ph. D. Dissertation, Kyoto
 345 University, Japan.
 346 [27] Sarwar, G. (2005). Use of compost for crop production in Pakistan. *Ökologie und Umweltsicherung*. 26/2005. Universität
 347 Kassel, Fachgebiet Landschaftsökologie und Naturschutz, Witzenhausen, Germany
 348 [28] G. Sarwar, N. Hussain, H. Schmeisky, and Muhammad, S. (2007). Use of compost an environment friendly technology for
 349 enhancing rice-wheat production in Pakistan. *Pakistan Journal of Botany*, 39(5): 1553-1558
 350 [29] G. Sarwar, N. Hussain, H. Schmeisky, S. Suhamad, M. Ibrahim, and Ahmad, S. (2008). Efficiency of various organic residues for
 351 enhancing rice-wheat production under normal soil conditions *Pak. J. Bot.*, 40(5): 2107-2113
 352
 353
 354
 355
 356
 357
 358
 359

360 **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

361 **Source:** Baseline survey (2014)

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

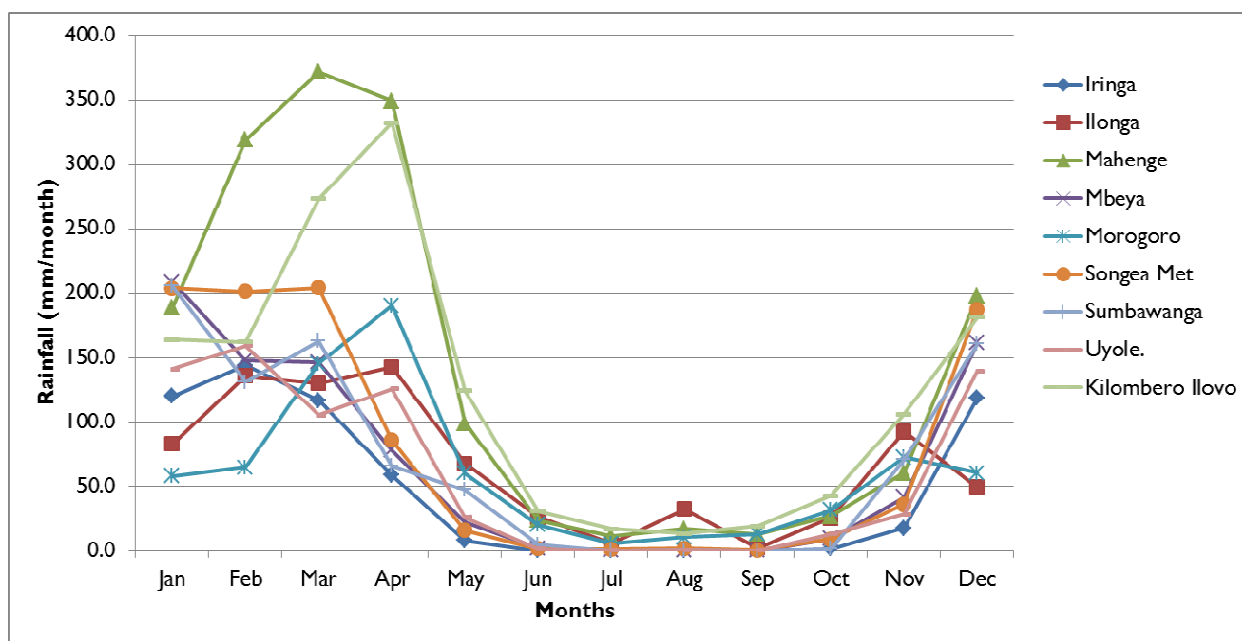
Region	District	Yield (t.ha ⁻¹)	Py (TZS.ton ⁻¹)	TVC (TZS.ha ⁻¹)	NR/MR (TZS.ha ⁻¹)	TA (ha)	TNR/TMR (TZS)	TNR/TMR (TZS 'bill')	ARR
Iringa	Iringa R	4.22bc	597,222bc	1,200,000b	1,340,432.9a	7,710	10,334,737,827.2b	10.3b	110b
Mbeya	Kyela	1.95f	800,000a	1,125,000b	446,648.0b	459	205,011,432.0de	0.2de	39cd
	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

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

365
 366 **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

367 Py: Crop yield price; TVC: Total Variable cost; NR/MR: Net revenue/Marginal revenue; TA: Total area; TNR: Total net revenue;
 368 TMR: Total marginal revenue; ARR: Average rate of return; CV: Coefficient of variation
 369



370
 371
 372 **Fig.1-1: Climatic data representative of the selected areas**
 373

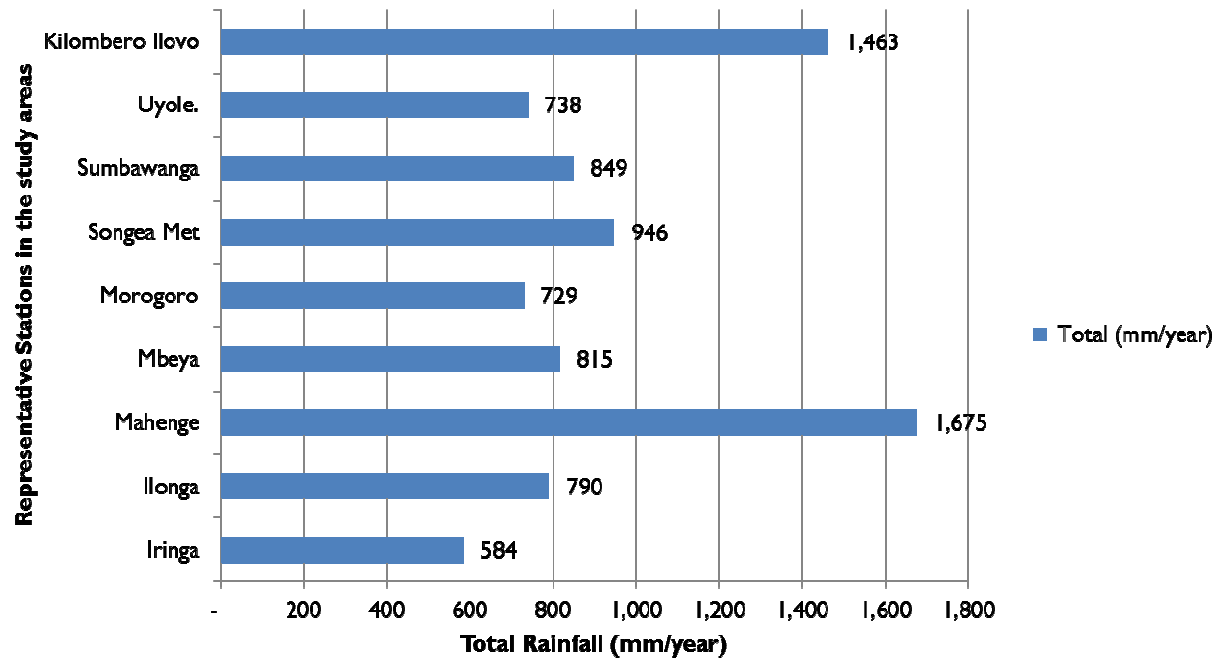


Fig.1-2: Total annual rainfall from stations representative of the selected areas

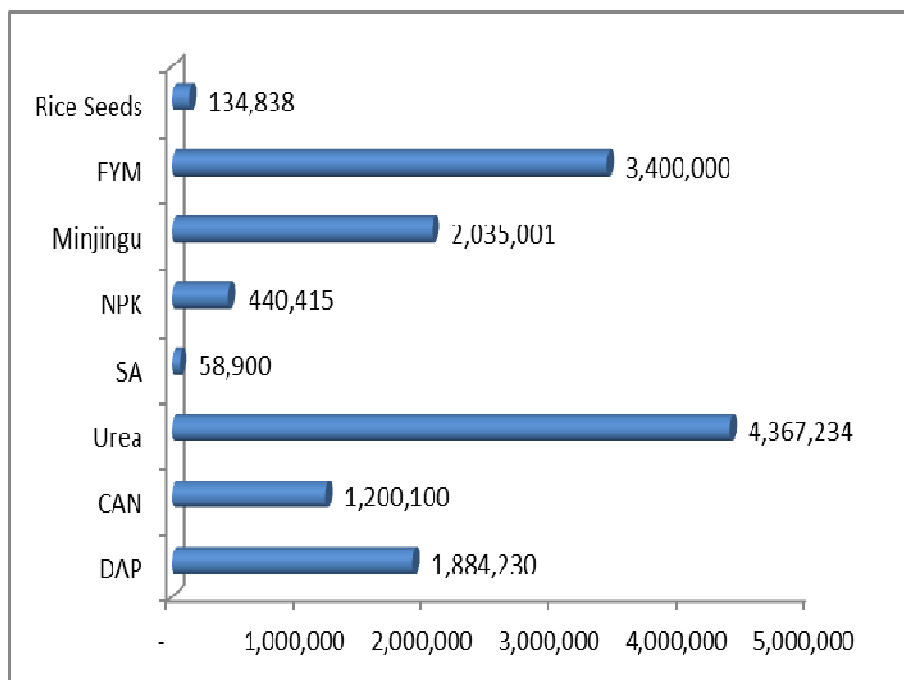


Fig. 2: Quantity of inputs used in the 78 irrigation scheme

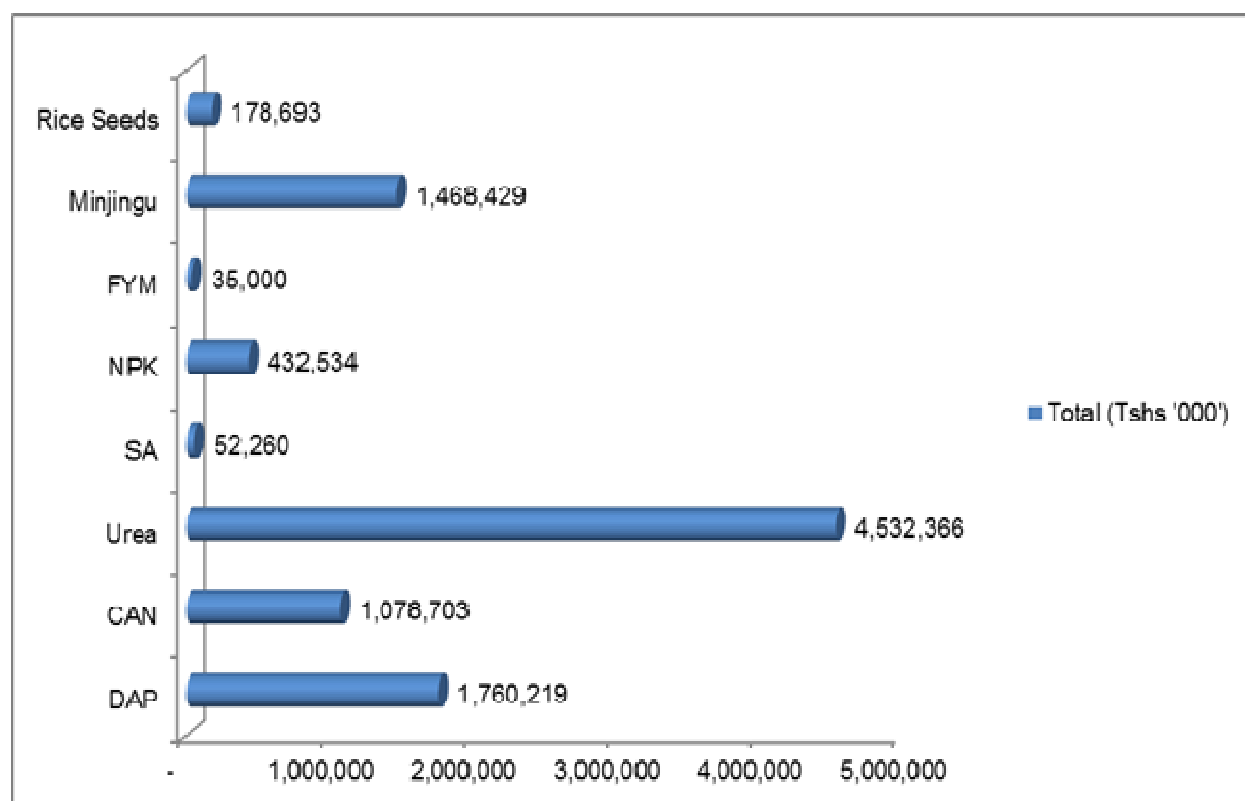


Fig. 3: Total costs of agricultural inputs (Tshs '000') in rice grown during the wet season in the 78 BRN irrigation schemes

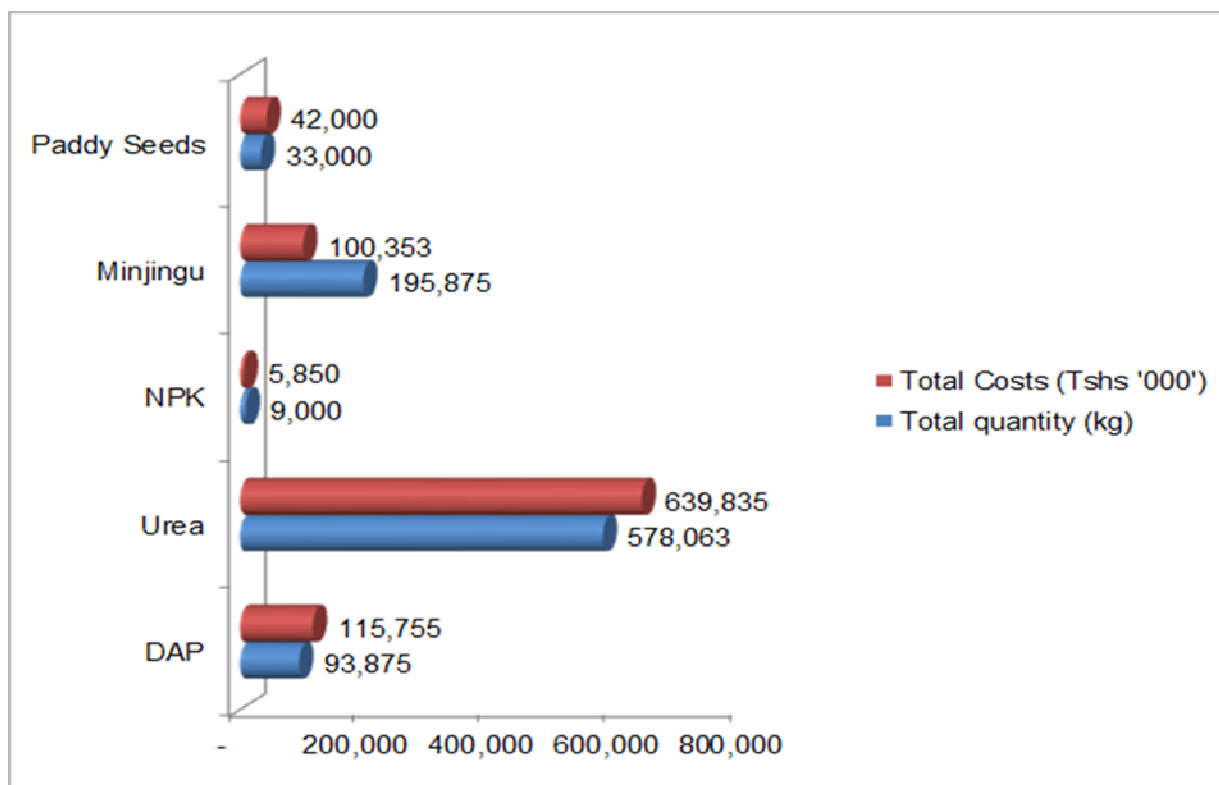


Fig. 4: Total quantity and costs of inputs used by farmers in dry season paddy in 78 selected BRN irrigation schemes

409

410

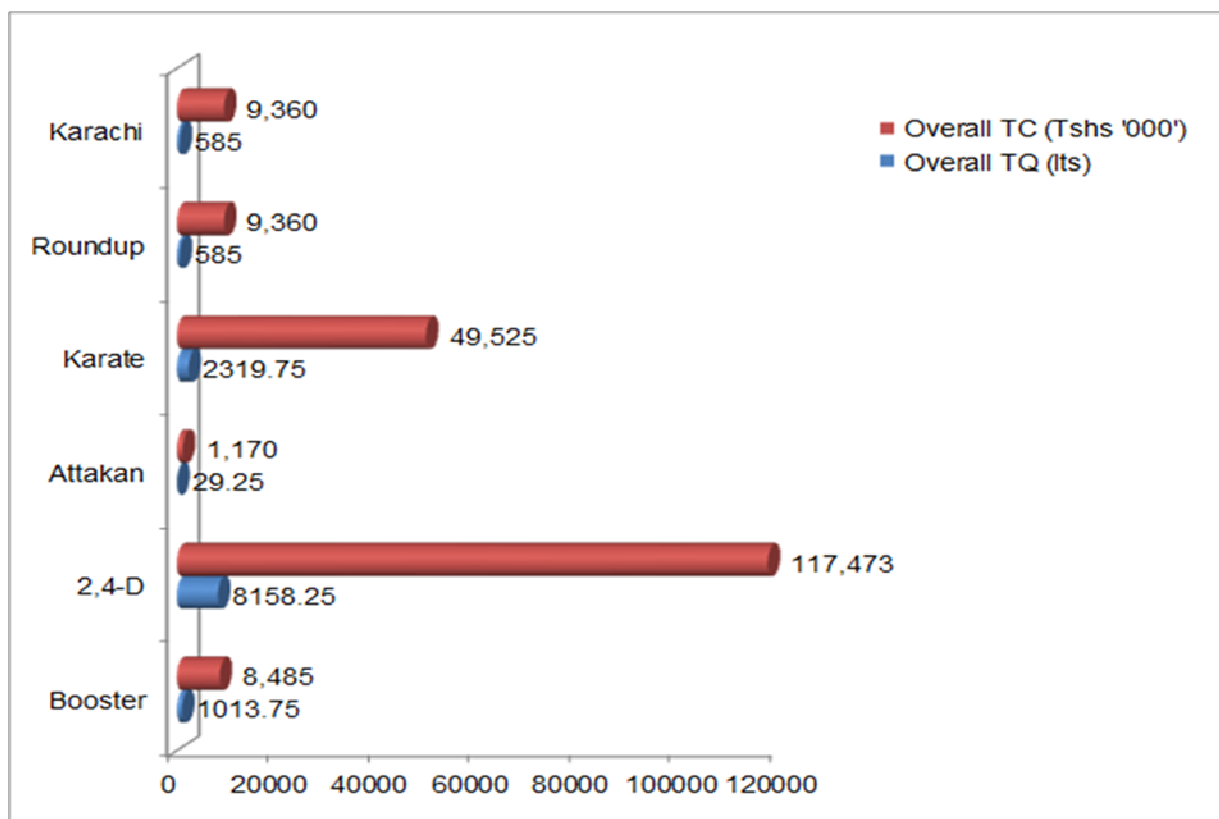


Fig. 5: Total quantity and costs of the agro chemicals used in paddy production in 78 selected BRN irrigation schemes in dry season

411

412

413

414

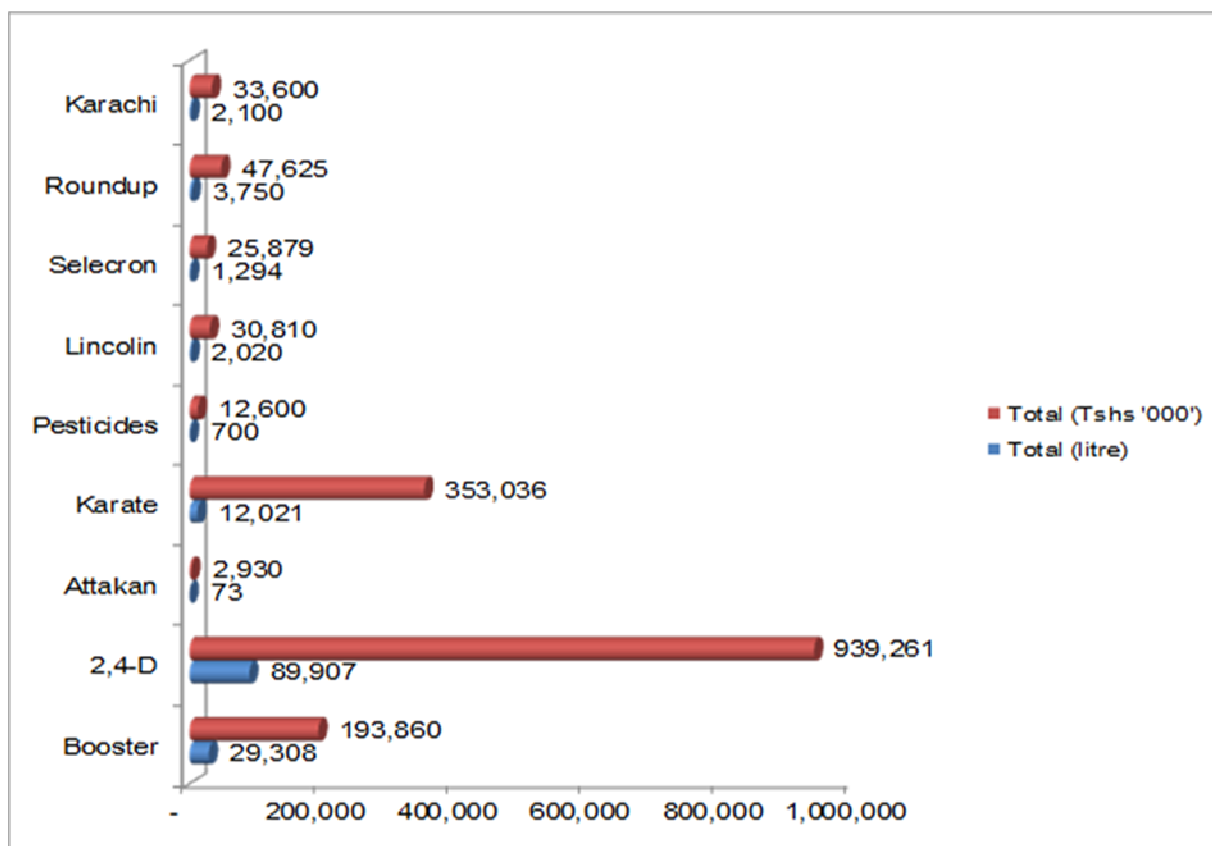


Fig. 6: Total quantity and costs of agrochemicals inputs

415