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Full Length Research Paper

Analysis of irrigation water productivity in water scarcity context in the Bama rice farming plain, Burkina Faso

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Nowadays, due to rain variability with a groundwater decrease, water resource became scarce in the main irrigated plains in Burkina Faso. Thus, rice is gradually being replaced by other crops which have low water need principally in Bama irrigated plain during off-season. This study aimed to analyze the efficiency of current irrigation practices during dry season rice farming in Bama plain. Hence, fifteen peasant crop-production practices in their plot of 0.5 ha during 2018 off-season from February to June have been followed. The irrigation water supplied was much lower than rice water requirements, average 61% of ETR. In addition, 28.8% of the yield has been determined by quantity of water applied with average water productivity of 0.8kg.m^{3}.

Keywords: water productivity; water scarcity; rice farming plain; off-season, yield.

INTRODUCTION

Worldwide, irrigated rice farming uses 24 to 30% of fresh water (Bouman et al., 2007) and can attain 86% in the available water in main productions areas (Dixit et al., 2016). According to (Rahman et al., 2015), more than 75% of rice is produced in irrigated land. In Burkina Faso, irrigated rice farming was started in 1960s (SNDR, 2011). Irrigable land potential are estimated at around 233,500 ha, and of which around 14% are currently exploited (PNSR, 2012). These irrigated rice plains nowadays occupies 23% of rice areas and provides almost 48% of national rice production. However, these irrigated rice farming wastes water (Dixit et al., 2016). Its water productivity is generally low (Tuong et al., 2005). At Bama rice farming plain in Burkina Faso, water resource provided by the Kou River was enough to meet the need of all the plain in the 1980's. However, nowadays, due to rain variability (Bama Nati et al., 2019) with a groundwater decrease, lack of good water management practices (Wellens et al., 2009) and the degradation of irrigation channels (GE-eau, 2009) water resource became very scarce to farm all the surface of the plain during off season (Bélem and Oscar, 2013). Sometimes, the flow at the head of the plain decreases until 1.4 m3 / s, which is not enough to meet the water requirement of 1260 ha of rice (Wellens et al., 2009). In 1980's average rice yield was 7 t ha^{-1} versus 4 t ha^{-1} nowadays (Bathily, 2012). Thus, rice is gradually being replaced by other crops such as market gardening, maize and tubers in the off-season (Millogo, 2013). However, in order to sustain off-season rice farming in this Bama plain, it is important to increase water productivity. Hence the present study aimed to analyze the efficiency of current irrigation practices during off season in Bama plain.

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MATERIAL AND METHOD

Study area

With 1260 ha (Wellens et al., 2009), irrigated plain of Bama is located at 11 ° 22 'N and 4 ° 22' W, in Hauts

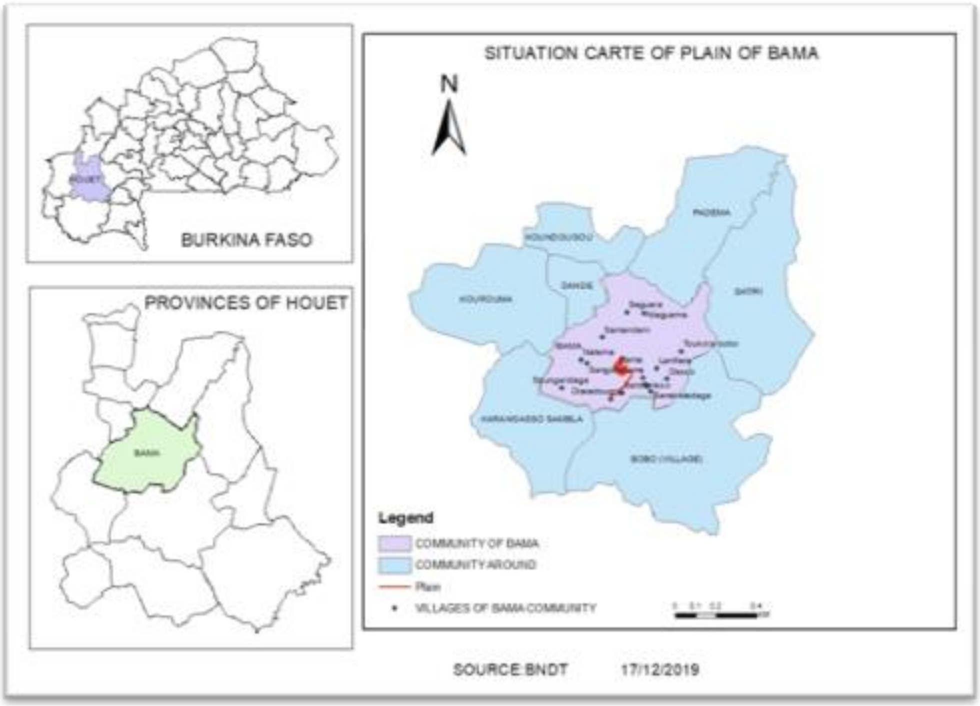

Figure 1. Localization of the Bama rice plain.

Table1. varieties used.

variety	Days	Number of small holders farmer peasant used this variety
Orylux 6 (improve variety)	105	2
Samangrin (variété locale)	90	4
TS2 (improve variety)	120	8
FKR19 (improve variety)	115	1

Bassins region, Burkina Faso (Sanou et al. 2016) (figure 1). Climate in the area is south soudanian (Guinko, 1984) with average rainfall of 1000 mm. Temperatures during dry season range from 17 and 37 ° Celsius (Barro, 2004). Water is taken directly in the Kou river to irrigate the plain (Dembélé et al., 2005).

Fields management

This study was conducted in fifteen peasant plots of 0.5 ha during off-season 2018 from February to June. The following table 1 gives us the distribution and the characteristics of the four varieties of rice used. At harvest, Grain yields were measured at 12 m^2.

Rice water requirements

The data used provide from the climate (weather station) of Bama plain. Reference evapotranspiration (ET0) (Allen et al., 1998), was calculated by using software Cropwat 8.0. The maximum evapotranspiration of the rice (ETM):

$$ETM = ETo \times Kc$$

We took crop coefficient (Kc) = 1, 1.5 and 0.7 depending on the growth phases.

Irrigation management and water applied

During dry season 2018, producers had water twice a week for two hours.

The flow (F) entering on each plot was measured by using a tank of 15 liters and a stopwatch to measure the time (t) to fill it

$$F = {}^{15l}/_{t}$$

Irrigation water applied (IW):

$$IW = F \times T \times N$$

Where: T = irrigation time and N = number of irrigation

And water applied 15 days after transplanting to harvest (WA):

$$WA = IW + ER$$

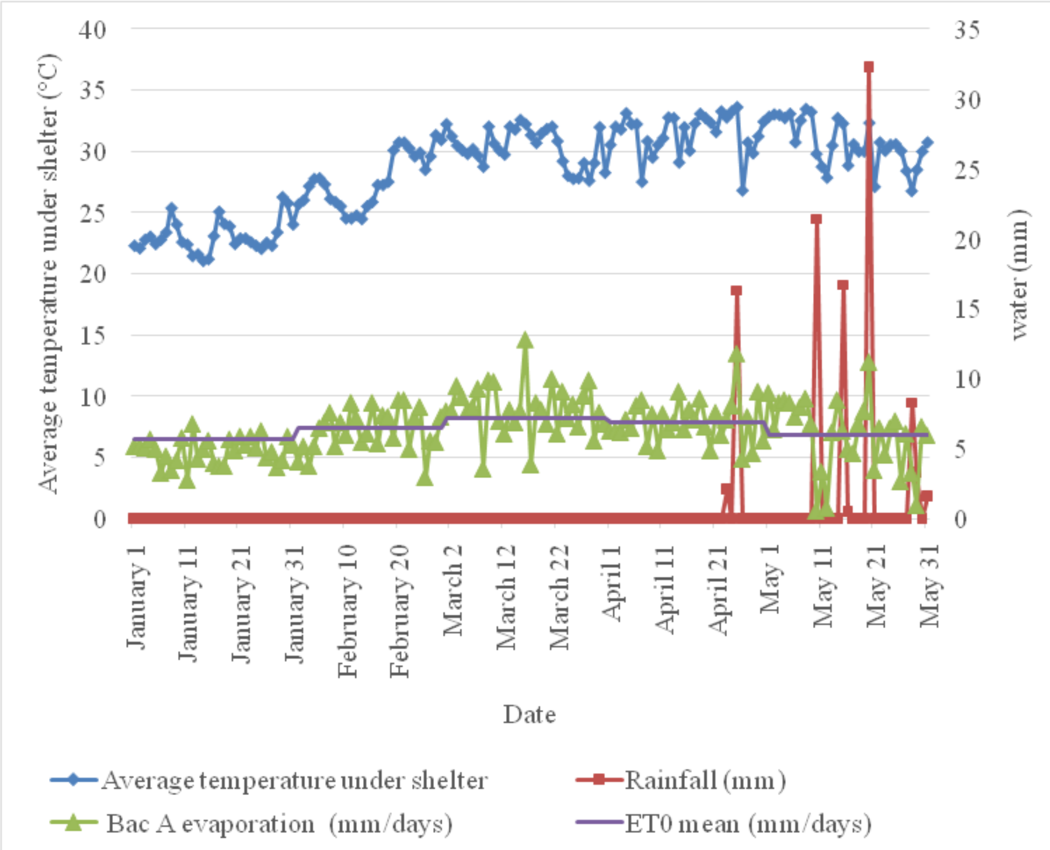

Figure 2: evolution of climatic data during off season rice farming, 2018 in Bama plain.

ER= total effective rainfall = 0.9×total rainfall

Yield

At harvest, the grain yields were determined in 12 m^2 installed in each plot.

Water productivity

Water productivity (Bouman et al., 2006):

$$AWP = yield / WA$$

Where:

AWP is water applied productivity in kg.m ^{3}

Yield in $kg.ha^{-1}$

And WA in $m^3.ha^{-1}$

RESULT

Climate parameters evolution during dry season 2018 is in figure 2. It showed a variation of average temperatures throughout rice growing with a maximum (33.7 ° C) in April and a minimum (21 ° C) in January. No rain from January to mid-April, and 102.5 mm recorded in May-June. The ET0 increases January to March with maximum of 7.17 mm per day, then decreases from April to May.

The irrigation water supplied was much lower than rice water requirements (Figure 3). In fact, the average quantity of water brought was 526 mm, while the average rice water need during this farming period was estimated at 857 mm.

Yields are scattered around the regression line (Figure 4) and 28.8 % of the yield have been determined by quantity of water applied. FKR19 and TS2 have optimized water (Table 2).

DISCUSSION AND CONCLUSION

Nowadays, available water for irrigation of Bama rice plain during dry season has decreased drastically, leading to a reduction in area farmed. Thus, barely 63% of the plain was farmed during off-season 2018. However, climatic conditions in the region characterized by high temperatures increase the water requirements of rice (Tabbal et al., 2002) under these conditions of water scarcity (Bama Nati et al., 2019). The 526 mm of water applied represented 61% of ETR of rice during off season 2018 in Bama plain because, (Bouma et al., 2006, Belder et al., 2004) have reported that water consumption

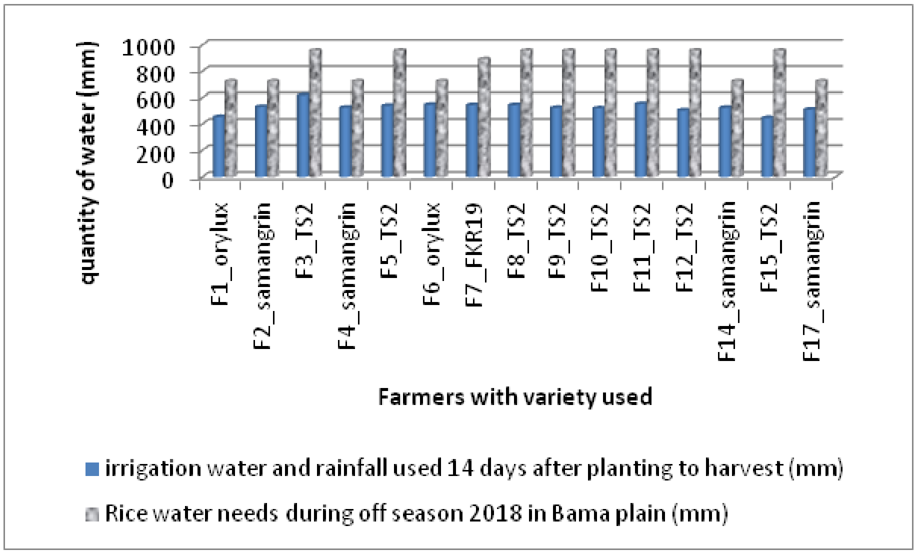

Figure 3. Water applied versus rice w ater requirement.

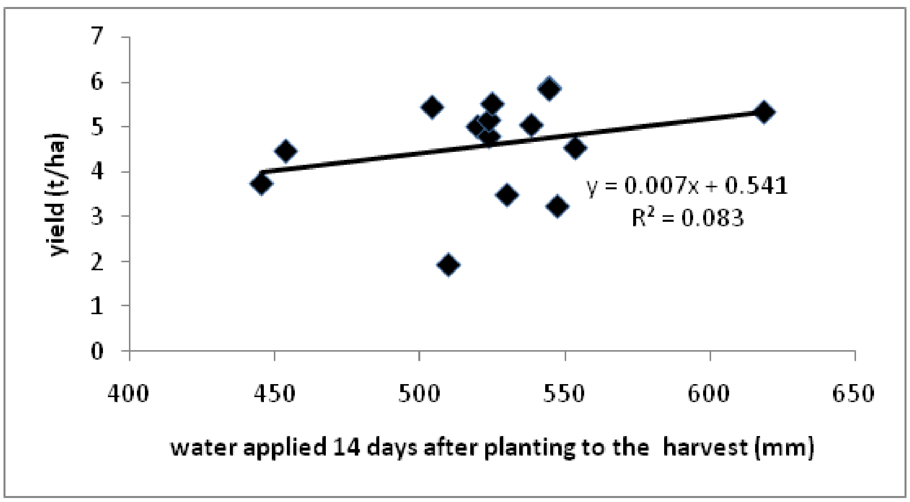

Figure 4. rice yield versus w ater applied dur ing off season 2018.

Table 2. Water productivity during off season rice farming.

	varieties			
	TS2	Samangrin	Orylux6	FKR19
Water productivity (kg/mm)	9.36	5.97	7.88	10.76

was 600–900 mm under continuous flooding. In addition, 28% of the yield is dependent on the amount of water applied. In fact, the fifteen producers have not the same crop-production practices because the variety used (Bhaduri, 2017, personal communication), quantity and quality of fertilizer provided (Bali et al., 1995, Michiel et al., 2010, Quanbao et al., 2007) and weed and pest management also influence yield. The average productivity of the water supplied 15 days after sowing until the harvest of 0.849 kg m^{-3} in this water scarcity is very satisfactory insofar as Bouman and Tuong concluded that water productivity in continuous flooded rice was typically 0.2–0.4 kg m^{-3} in India and 0.3–1.1 kg m^{-3} in the Philippines (Bouman et al., 2001).

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