AGRO-ECOLOGICAL WATER AND CROP MANAGEMENT PRACTICES' EFFECT ON RICE YIELD AND WATER PRODUCTIVITY IN LOWLANDS: A META-ANALYSIS

Bio Zimé SOUNON OROU*(1;2) ; André ADJOGBOTO(1) ; P.B. Irénikatché(1) AKPONIKPE, Marnik Vanclooster(2)

* Author: biozimsounon@yahoo.com

(1) Laboratoire d'Hydraulique et de Modélisation Environnementale (HydroModE-Lab), Faculté d'Agronomie (FA), Université de Parakou (UP), 03 BP : 351 Parakou, Bénin

(2) Earth and Life Institute, Université catholique de Louvain, Croix du Sud 2, Box 2, B-1348, Louvain-la-Neuve, Belgium

BACKGROUND

- Demand for rice is projected to increase by 130% of consumption between 2010 and 2035 in Africa (Seck et al., 2012)
- Therefore, more than 75% of global rice production occurs in flooded conditions (Datta et al., 2017; Fonteh et al., 2013)
- climate change become remarkable in West Africa and exert considerable pressure on the food production systems. The rains do not come on time and arrive in the middle of the season, causing flooding (Derbile et al., 2016)
- To ensure food security and sustainable water management for agriculture, there is an urgent need to increase crop production per unit volume of water used in the agricultural sector and thus improve water use efficiency

RESEARCH OBJECTIVES

- identify all water management practices in lowland rice production
- assess different practices according to rice grain yield and water productivity

MATERIAL AND METHODS OF RESEARCH

- Meta-analysis was focused on water management practices in rice production systems.
- Only papers on which field experiments has been conducted
- Continuous flooding was compared to another water management practices (Saturated soil, Alternative wetting and drying (AWD), Aerobic rice systems)

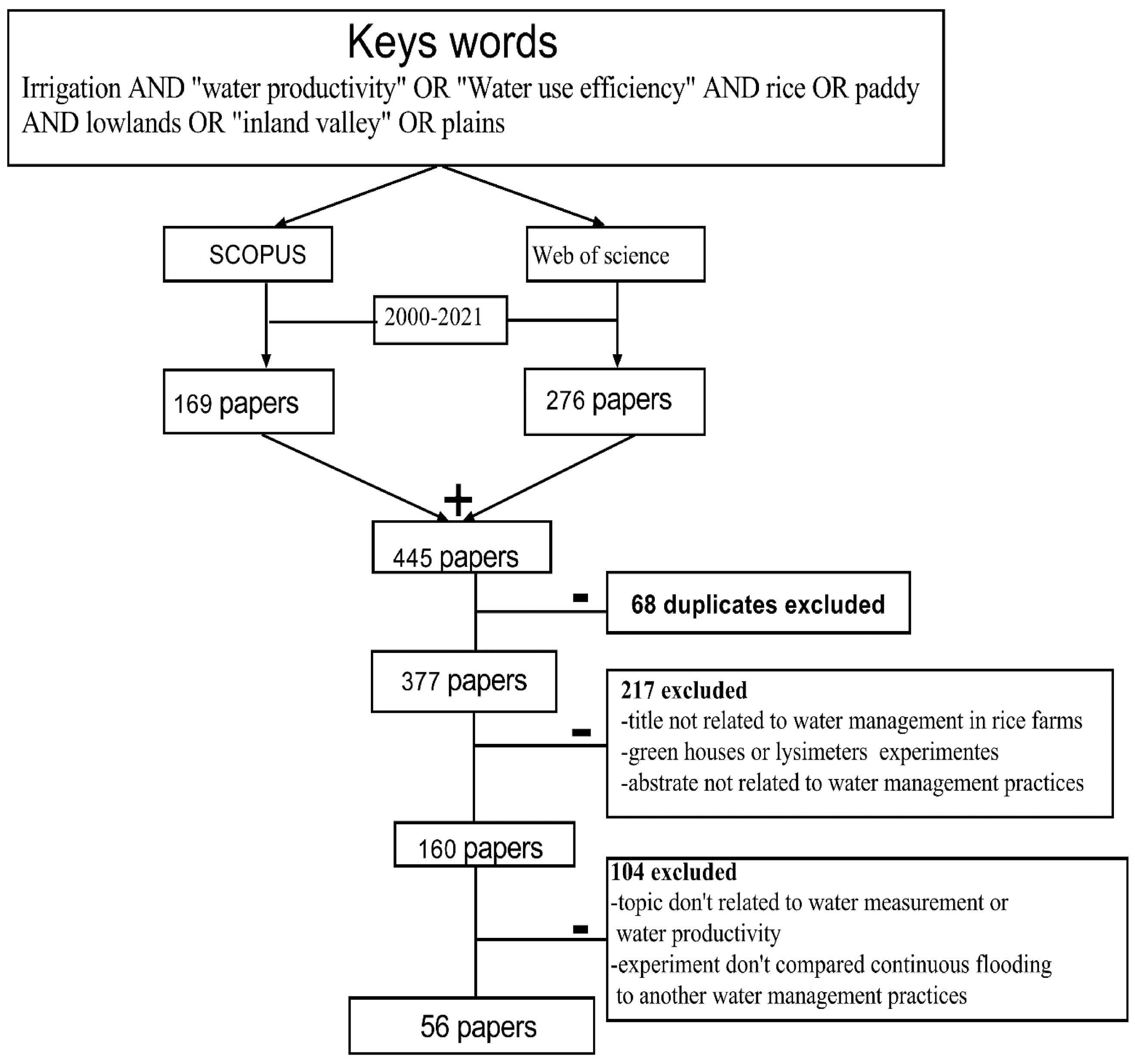
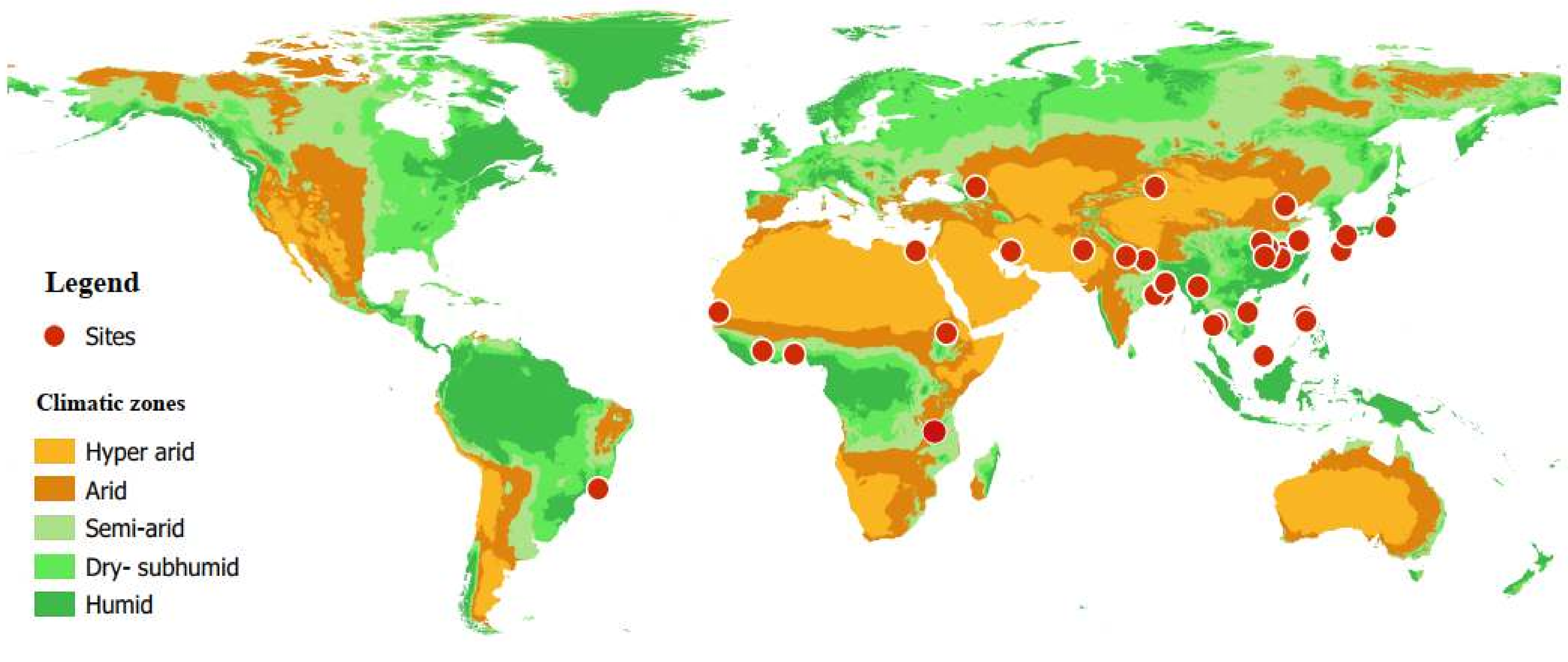


Fig 1: Articles selection criteria for the meta-analysis

Data collection

- Data collection were done in each of 56 scientific published paper;
- Collected rice grain yield, water productivity, water quantity, crop establishment methods, crop densities



Data analysis

- water productivity would be the ratio of the yield by the amount of water used (Kambou et al., 2014)

$$WP = \frac{\text{Grain yield}}{\text{Amount of water used}} \text{(Eq. 1)}$$

Amount of water used: (irrigation water) + (rainfall)

- response ratio (RR) was used as a measure of the effect size in the meta-analysis(Hedges et al., 1999; Lajeunesse, 2015)

$$\ln(RR) = \ln\left(\frac{x_t}{x_c}\right) \text{(Eq. 2)} .$$

xt represents treatment, xc as control value.

- intra-column variance (Var) associated with each RR value was calculated from the standard deviation associated with each yield.

$$Var = \frac{sdt^2}{nt{*}x_t{}^2} + \frac{sdc^3}{nc{*}x_c{}^2} \text{(Eq.3)}$$

- statistical meta-analysis will be performed using OpenMEE (Wallace et al., 2017) software (Brown University, Providence, USA)

RESULTS

- Yields decreased by 11.1% and 37.5% respectively in the AWDs and Aerobic systems compared to the continuous flooded system (fig 3-a).
- Water productivity increased by 25.7%, 32.9%, and 25.6% in AWDm, AWDs and Aerobic systems respectively (fig 3-b)

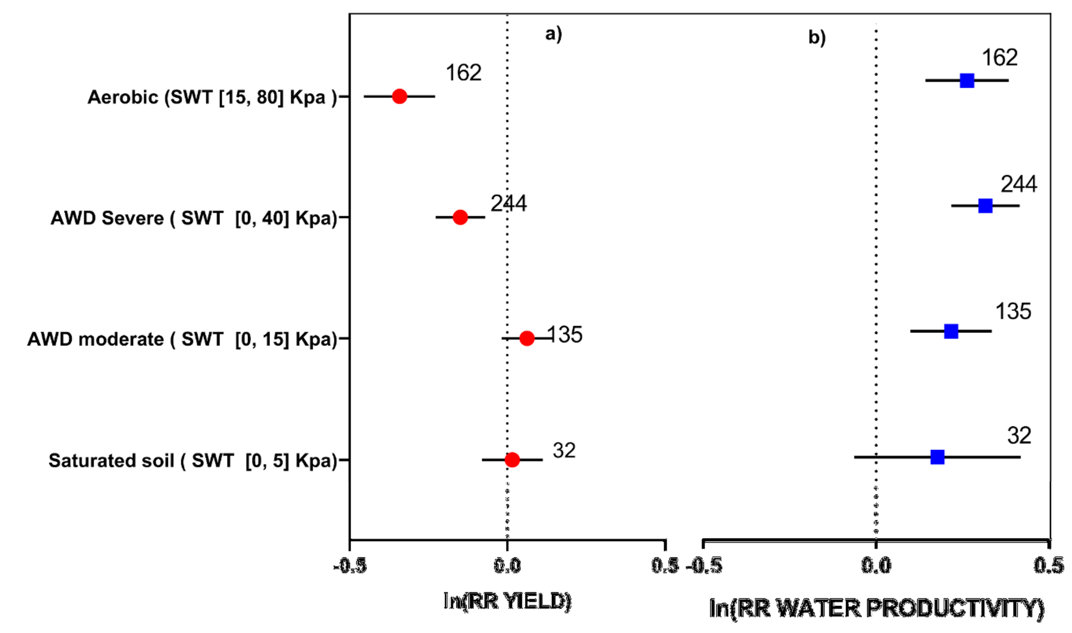


Fig3: influence of water management practices on rice grain yield , water productivity: a) grain yield and b) water productivity

- Yield decreased by 14.6 % on direct sowing severe AWD and 39.4% when rice was transplanted into an Aerobic system compared to the practice of continuous flooding (fig 4-a).
- Water productivity was improved by 23.9%, 37.8% and 20.8% in AWDm, AWDs and Aerobic systems respectively when rice was transplanted compared to continuous flooding (fig 4-b).

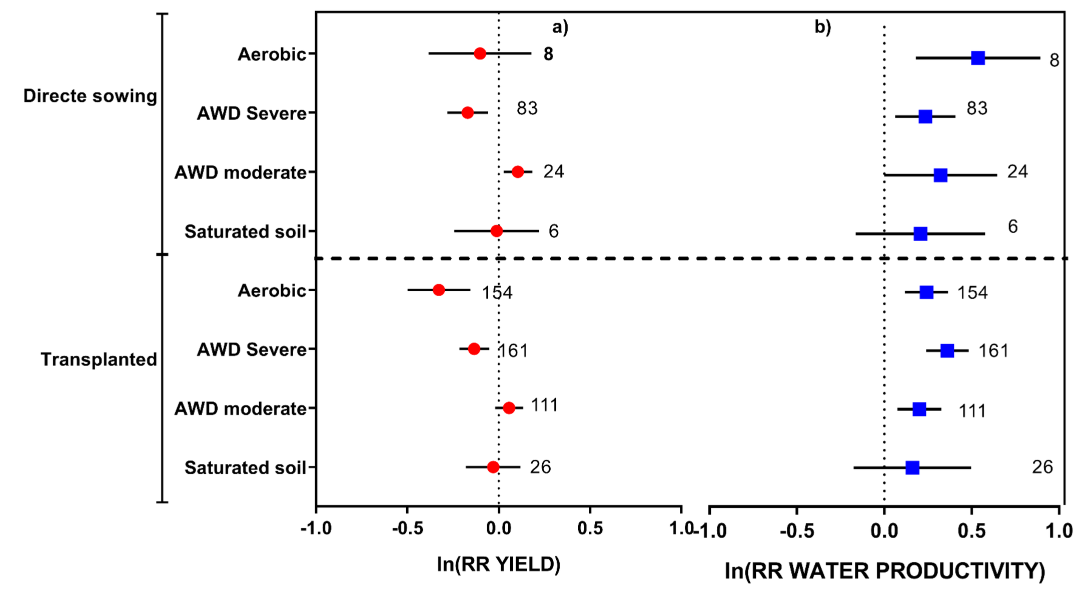


Fig 4 : interaction between water management practices and rice crop establishing method DDS(Dry Direct sowing) and TP: Transplanted

- Rice yield was increased by 9.8% under AWDm for the density class of]25; 50] and remained indifferent to the other density classes in relation to the continuous flooding practice.
- Yield decreased on the plots under AWDs by 8 %, 7.5 %, 17.8 %, 19.1 % respectively for the density classes]25, 50];]50 ,75];] 75,100], > 100 plants/m² compared to continuous flooding.
- Water productivity was improved by 9.8% in AWDm for seedling densities belonging to]25, 50]. It was increased by 51.1% for densities below 25 plants/m², but decreased by 8% and 17.8% respectively for semi density classes belonging to]25, 50];]50 ,75].
- Water productivity increased by 40.8% for densities below 25 plants/m² and decreased by 26.2% for densities in the]25, 50].

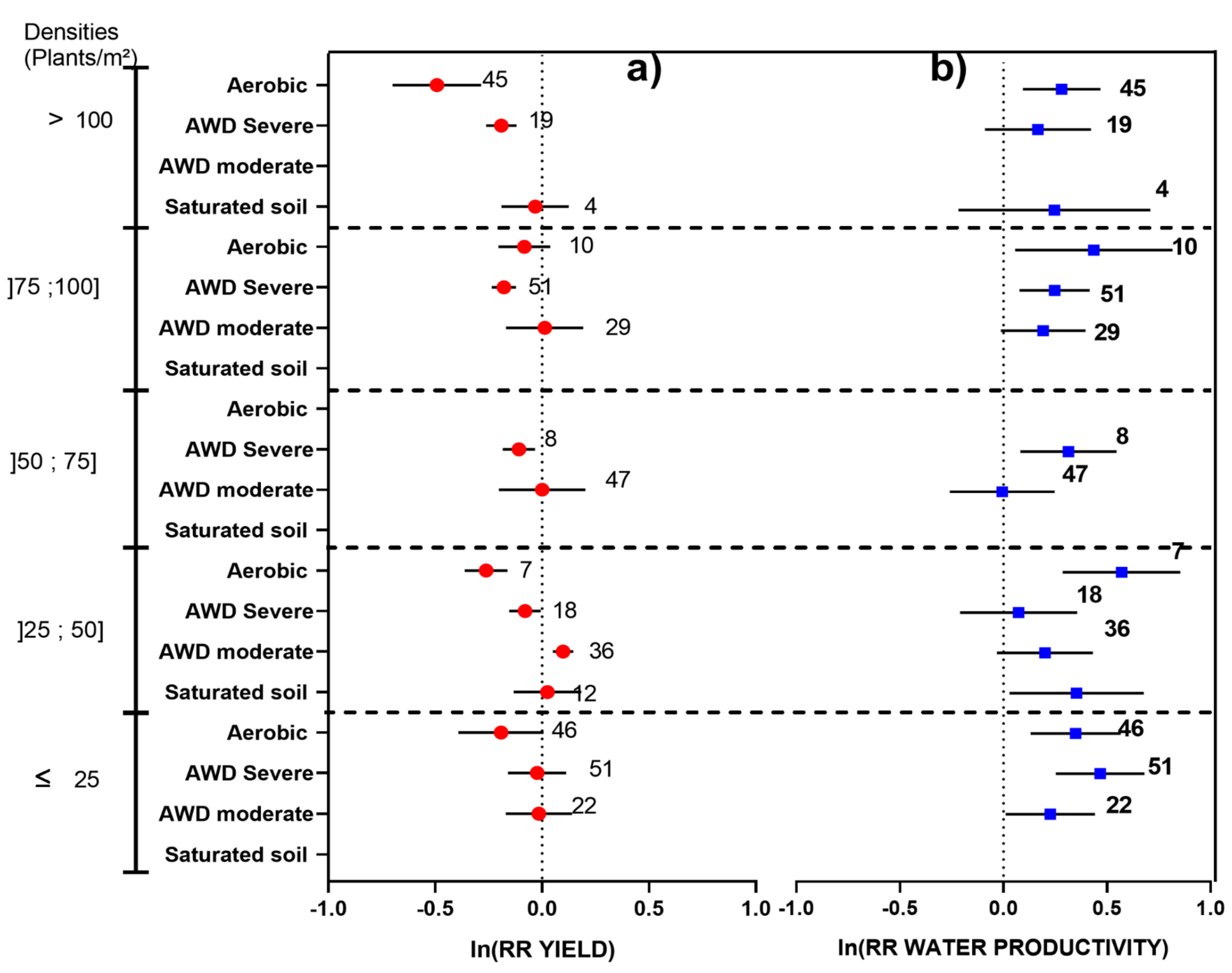


Figure 5 : interaction between water management practices and rice crop density

CONCLUSION

The practice of Safe Alternative Wetting and Drying moderate can be used in a climate change context to saving water and seed and conserve yields compared to continuous flooding. The application of this practice with rice transplanting to contribute to water use efficiency in lowland rice cultivation.

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