Tropentag 2025
September 10-12, 2025

Conference on International Research on Food Security, Natural Resource Management and Rural Development
organised by the University of Bonn, Bonn, Germany

"Reconcile land system changes with planetary health"

Water ecology and climate change aspects - *414*

Influence of irrigation on land use intensity and specific income for small farms in Togo

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ABSTRACT

Planetary Health is a solutions-oriented, transdisciplinary field and social movement focused on analysing and addressing the impacts of human disruption to Earth's natural systems, on human health and all life on Earth. One way of addressing this is balancing productivity and conservation. A key priority also highlighted in SDG12 focused on responsible consumption and production with a goal of ensuring sustainable consumption and production patterns. Agriculture is key production areas in the world with mining and forestry using the three major resources affected by climate change: land, water and energy with an impact on millions of individuals worldwide.

Addressing the planetary health by improving efficiency in the use of land, water and energy is a working solution which can be implemented in agricultural systems to adapt to global challenges while ensuring sustainable use of those resources. Smart solar irrigation seems to be a practical translation of this solution as it is a key pillar of smart farming for better decision-making and resource efficiency geared towards enhancement of productivity with minimal environmental impact. Indeed, smart solar irrigation contributes to land, agricultural and water productivity with intensification of farming systems. This paper seeks to analyse how irrigation in crop systems may enhance efficiency on land and water resources for food production. This is explored through three parameters: land use intensity, water productivity and revenue over small farms in west Africa (Togo). Data from 40 small farms in west Africa collected between December 2024 and february 2025 serve as a basis. Analysis addresses two key questions: how much land and water can we save with intensification of farm systems? for the same culture is there a difference in land intensity and revenue between farm systems using irrigated farming and those rainfed. The goal being to produce more food with less natural resources.

Keywords: Irrigation, land, planetary health, smallholder farms, water

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INTRODUCTION

Agriculture contributes more than 40% of Togo's GDP and employs nearly 65% of its active population. Also, arable lands expand over 3.6 million hectares, which is 60% of the Togolese territory. Out of this area, 1.4 million hectares or 41% of the total area are sown. According to FAO (1996) the potential of irrigable land was of 180 000 ha of which only 1.3% were equipped with irrigation system. Updates from Aquastat. In 2021 indicate that 7 860 ha are equipped of which 80% under exploitation. This increase is due to recent water development programs promoting irrigated farming with globally five irrigation techniques: basin, furrow, sprinkle, micro sprinkle and drip. In 2021 according to NIRAS (2021) only 3% of the existing water resources are used for irrigation in Togo and 2.6% of fully irrigable land potential. Major crops sown are cereals (maize, rice, sorghum, millet), tubers (yam, cassava) and some cash crops (cotton, coffee, cocoa, palm oil, sugar cane and soybean). Besides these, lots of farmers produce vegetable crops (okra, onion, tomato, pepper, eggplant, carrot, cabbage and legumes) which are generally irrigated or grown in hydromorphic soils in marshy areas or bordering streams.

Most programs on irrigation in Togo invested on large areas where thousands of farmers are installed. 02 GIZ programs recently oriented their support towards small holder individual irrigated farming since 2023 Sun4Water and ProSAC. This aligns with Togo perspective on climate change mitigation as beyond 2030 objective, Togo has committed to make progress towards a long-term low-carbon development and climate resilience strategy through its national development plan (PND 2018-2022) and the government roadmap 2025. In this context, the country has developed a plan covering 2020-2024 and which includes nine programs to accelerate transformational changes towards low-carbon and climate-resilient development, with a fast-growing population (2.3% population growth per year) and ambitious contribution to greenhouse gas reduction (11.14% reduction between 202 and 2025). These two objectives contribute to planetary health as it may reduce greenhouse gas emission, optimize the use of existing natural resources and reduce pollution of existing living habitats.

This paper seeks to analyze how irrigation in crop systems may enhance the efficiency on land and water resources for food production. Analysis addresses two key questions: how much land and water can we save with intensification of farm systems? for the same culture is there a difference in land intensity and income between farm systems using irrigation.

MATERIALS AND METHODS

The climate in Togo is divided into 4 seasons which 2 are humid: long rainy season (march to July) and short rainy season (september and october). The methodology is based on the analysis of data from 40 smallholder farms in four regions of Togo cutting across three agro-ecological zones of the country: coastal, humid highlands and soudano-sahelian. Data were collected through interview of farm manager and participatory observation. These data were used to determine the land use intensity and specific income estimate for selected irrigated and non-irrigated farms for a specific largely grown crop: the corete (Corchorus olitorius).

Land use intensity

Land use intensity (LUI) is a known socio-ecologic metric that attempts to calculate how much land is required in order to obtain a certain product. Erb et al. (2013) highlighted the multidimensional nature of land-use intensity and summarized several approaches to its estimates. Boserup (2014) defines the intensification of agriculture as the increasing frequency of cropping cycles in shifting cultivation systems, that is, increasing inputs of land to the production system. Land use activities take place in production systems, which are defined as integrated socio-ecological systems with both biophysical (e.g. soils, climate, topography) and socio-economic properties (e.g. institutions, market integration, population). Land-based production then encompasses all activities that convert some combination of inputs into outputs, dependent on the properties of the system (Erb et al., 2013). In our specific case main inputs are irrigation or rain, and land use (production cycle, area sown). The output is the declared productivity of the farm for various crops, as the production is based on farmer’s responses to a field survey in the 40 farms. As such the land intensity for the agricultural use of land for a specific crop is measured in terms of crop produced per year either under irrigation or not on a given land area and frequency. It shows the productivity of land, which may be compared with other possible uses.

LUI (production Unit) = Percentage duration of use of the land in the year for a cycle (%) x number of growing cycles a year x Number of hectares sown in a cycle (ha) x productivity /(unit per ha)   eq. 1

Specific income

Specific income in this paper is the income per unit area for a year considering the various production cycles in a year for a specific crop. It only considers the "focus crop" as defined by Shipman et al. and does not include other crops neither off farm income.

*Specific income = income per cycle*number cycles a year/ cropped area sold   eq.2*

Money value used in Togo is franc CFA. It was converted into Euros with conversion factor of 655.957 for 1 Euro.

RESULTS AND DISCUSSION

Land use intensity for vegetable farming on hydromorphic soils in Togo

Some of the vegetable produced in smallholder farms in Togo include eggplant, carrot, beet, cabbage, corete). This is done in dry season in marshy areas with water table decrease for a limited period of the year as some of those areas are floodable in rainy season (June to October).

Table 1: Land use intensity and specific income for non-irrigated farms on hydromorphic soils for corete production

Irrigation	Growing period	Area sowned (ha)	Percentage use of the land in a Year	growing cycle a year	Productivity (basket per ha for 1 cycle)	Land use intensity	Specific yearly income (Euro/ha)
No	Nov-March	0,12	41,7%	2	720	72	2 287
No	Dec-Feb	0,25	25,0%	1	208	13	909
No	Dec-may	0,12	50,0%	2	864	104	3 430
No	Dec-may	0,25	50,0%	2	864	216	1 646

In non-irrigated farm growing fresh vegetables on hydromorphic soils in the dry season in Togo with production cycle using land 3 months a year for only 1 cycle the land use intensity is very low compared to farms having two cycles on same soils but with longer production cycle (5 – 6 months a year). Though the productivity could be influenced by farm practices and farm inputs, it can be observed that longer production period yields better productivity and higher land use intensity (72 – 216)., table 1 shows the highest value of land use intensity is 72 for 0.12 ha and 2 production cycles in the dry season (November to March) in hydromorphic soils which are regularly flooded between June and October in the year. Extending the growing period on those soils to the month of May or June may offer an extra cycle and income to farmers with supplementary irrigation or adequate rain.

Table 2: Land use intensity and specific income for irrigated farms on hydromorphic soils for corete production

Irrigation	Growing period	Area sown (ha)	Percentage use of the land in a Year	growing cycle a year	Productivity (basket per ha for 1 cycle)	Land use intensity	Specific yearly income (Euro/ha)
Yes	Dec-Feb	0,12	25,0%	1	832	25	813
Yes	Dec-Feb	0,5	25,0%	2	384	96	585
Yes	Dec-may	0,18	50,0%	2	864	156	2 287
Yes	Dec-June	0,3	58,3%	3	960	504	2 744

Table 2 shows comparable productivity and land use intensity for same area and growing cycle with slight differences. As such irrigation for vegetable production on same period and growing cycle on hydromorphic soil doesn't yield a significant difference in productivity and land use intensity. Nevertheless, it helps extending growing period and provide an extra cycle in the same area, avoiding an extension of the cropped area, then making more with same land resource. Thus addressing four of the eight outcome Amede et al. (2023) indicated for sustainable farming for smallholder farms in Africa, namely water productivity, climate adaptation, crop productivity and low energy production.

Though hydromorphic lands are characterized by a periodical flooded episodes the use intensity for rainy season can be increased by changing the crops grown and adapt floodable crops like rice to better manage existing land and water resources during the flood period (June to October) which is sufficient long to produce any variety of rice. The only constraints associated with such a decision might be to harvest rice fresh and provide dry solutions out of the farm.

Specific income of smallholder vegetable farms in Togo

An overview of declared income for smallholder farms in Togo producing vegetables indicates that specific income in non-irrigated farms ranges from 909 to 3 430 Euros per hectare, while in irrigated farms it ranges from 585 to 2 744 Euros per hectare. Better income is recorded for farms having 2-3 growing cycles, globally greater than 1 600 Euro per hectare yearly. It is within the range proposed by Dittoh et al. (2013) for surface water small irrigated farms in west Africa, 991 and5 567 Euros. They suggest to move to higher value crops and more profitable markets to improve on the specific income from small vegetable farms in West Africa.

Comparing table 1 and 2, there cannot be indicated a specific direct contribution of irrigation on the improvement of specific income for farms in hydrographic soils for the production in dry season with the same number of growing cycles. Rather irrigation contributes to add a third cycle which yields to additional income to the farmer. So, the contribution of irrigation to specific income increase is indirect and mainly associated to extension of growing period with added growing cycle.

CONCLUSIONS AND OUTLOOK

On hydromorphic soils in Togo irrigation does not yield a specific difference in productivity and land use intensity if 1 or 2 cycles are considered per year in the dry season. It rather helps to extend production to a third extra growing cycle with improved land use intensity and better use of existing water resources, driving additional artificial energy for pumping. In the other hand introducing irrigation may not increase per unit area income for the same area, growing cycle, but rather provide for the extra growing cycle and better selling prices of crops due to early harvest, better produce and availability of produce when prices are high on the market. At the end introducing irrigation increase land use intensity and improve gross income with the same land area, limiting as such land expansion for the benefit of human and nature.

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