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Assessment of rice self-sufficiency in 2025 in eight African countries

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ABSTRACT

Most African countries are far from self-sufficient in meeting their rice consumption; in eight countries the production: consumption ratio, ranged from 0.16 to 1.18 in 2012. We show that for the year 2025, with population growth, diet change and yield increase on existing land (intensification), countries cannot become fully self-sufficient in rice. This implies that for the future, a mixture of area expansion and imports will be needed on top of yield gap closure. Further research is needed for identification of most suitable new land for rice area expansion and areas that should be protected.

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1. Introduction

Faced with a growing population and increasing per capita rice consumption, countries and their policy makers have three options to meet future demand for rice: increase imports, increase rice area and increase production per unit area. Often, growing needs are met through a combination of these three options. But in some cases one or more of these solutions are not possible, or only to a limited extent. Such is the case when biophysical limits to yield increase have been reached, or where all of the suitable land is already being used for agriculture or cultivation of specific crops. It is therefore relevant to quantify the biophysical opportunities and limits. Many African politicians have formulated ambitious plans for increasing production (Seck et al., 2012, 2013, www.riceforafrica.org). It is therefore timely to investigate the quantitative relationship between self-sufficiency or import levels on the one hand and yield gap closure and area expansion on the other hand. We do not make (political or societal) statements on which mixture of imports, area expansion and yield increase is most desirable or most realistic politically. Rather, we compute the window of opportunities between these key variables. Rather we aim to quantify trade-offs between imports and area expansion for rice cultivation. These trade-offs depend on uncertain future trends in per capita consumption and yield increase. We therefore present different scenarios to quantify the range of possible outcomes. Such an analysis is also relevant in the context of studies on "intensification" (raising yields on existing fields through yield gap closure). Most recent studies consider intensification the most desirable option, due to concerns about land availability and quality, and the need to protect natural ecosystems (Tilman et al., 2002; Cassman et al., 2003; Koning and van Ittersum, 2009; Foley et al., 2011; Pretty et al., 2011; Ramankutty and Rhemtulla, 2012; Garnett et al., 2013; Hall and Richards, 2013).

In Africa, with its rapid population growth, agricultural area has been expanding and is likely to continue. This expansion has occurred because yield increase on existing land has been too slow to keep up with growing consumption in most African countries (Pretty et al., 2011). The future required agricultural area can be estimated based on extrapolation of current trends in yield and consumption (e.g. Balmford et al., 2005). Such approaches have been criticized (e.g., van Ittersum et al., 2013) because such extrapolations may lead to yield projections above the biophysical upper limits imposed by solar radiation, temperature, and water supply (which is impossible). Quantification of the biophysical upper limits to yield increase through the use of crop growth models may help more realistic quantification of the extent to which self-sufficiency can be achieved through intensification.

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Since 2000, both rice harvested area and yield have been increasing in Sub-Saharan Africa (SSA) (Fig. 1a and b). However, the ratio between production and consumption (*P*/*C* ratio), which is an indicator for self-sufficiency, has been far below one for a considerable time (Fig. 1c), indicating that most countries in SSA are still far from being self-sufficient in rice. Meanwhile, the population (UN, 2014, Fig. 1d) and per-capita consumption are expected to continue to increase. If growth in yields cannot keep track of growth in consumption then either more area, more imports, or a combination of these two will be needed.

With a growing population and changing diets policy makers have basically three options to meet future consumption needs: (1) increase yields, (2) increase imports and (3) area expansion. A conceptual model of the decision-making space is shown in Fig. 2. For a given population and at given yield levels and diet, any linear combination of area and imports can fulfill the population's needs. If population grows or if per capita consumption grows, then either more imports or more area will be needed. If yields increase then less imports or less area will be needed. The area in between the dashed lines shows the biophysical boundaries within which choices are made. These lines are dashed because they reflect uncertainty about future trends in population growth, diet change and yield increase. There is a clear trade-off between the political choice to reduce imports (which may require further area expansion) and the political choice to reduce area expansion (and remain dependent on international markets for imports). The biophysical boundaries within which this economic, societal and political decision making will take place are still not well quantified.

The objective of this paper is to quantify the trade-offs between area expansion and import dependency at different levels of yield increase and diet change. We present scenarios for the year 2025 for eight African countries. We choose this relatively near time horizon since it is meaningful for most African policy makers. The objective of this study is to assess self-sufficiency scenarios with a longer time horizon suffer from increased uncertainty of population growth scenarios (Hopfenberg and Pimentel, 2001; Alexandratos, 2005; Dyer, 2013), increased uncertainty in estimates of available area (Andriesse, 1986; Windmeijer and Andriesse, 1993; Young, 1999; Ramankutty et al., 2002; You et al., 2011; Byerlee et al., 2014), and uncertainty about climate change impacts (which for rice in Africa have not yet been clearly quantified). The choice of seven SSA countries was driven by the Global Yield Gap Atlas project (GYGA, www.yieldgap.org) on which the results presented here are based. Egypt was included as a benchmark for an African country where yield gaps are expected to be small.

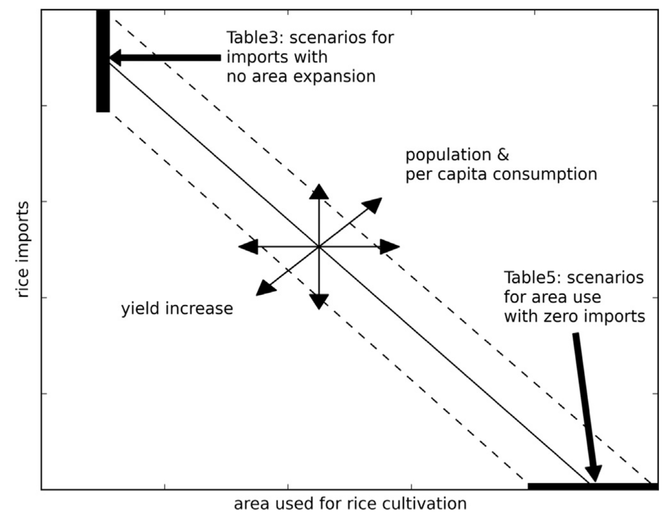

Fig. 2. Conceptual model of trade-offs between area and imports, with effects of yield increase, population growth and growth in per capita consumption.

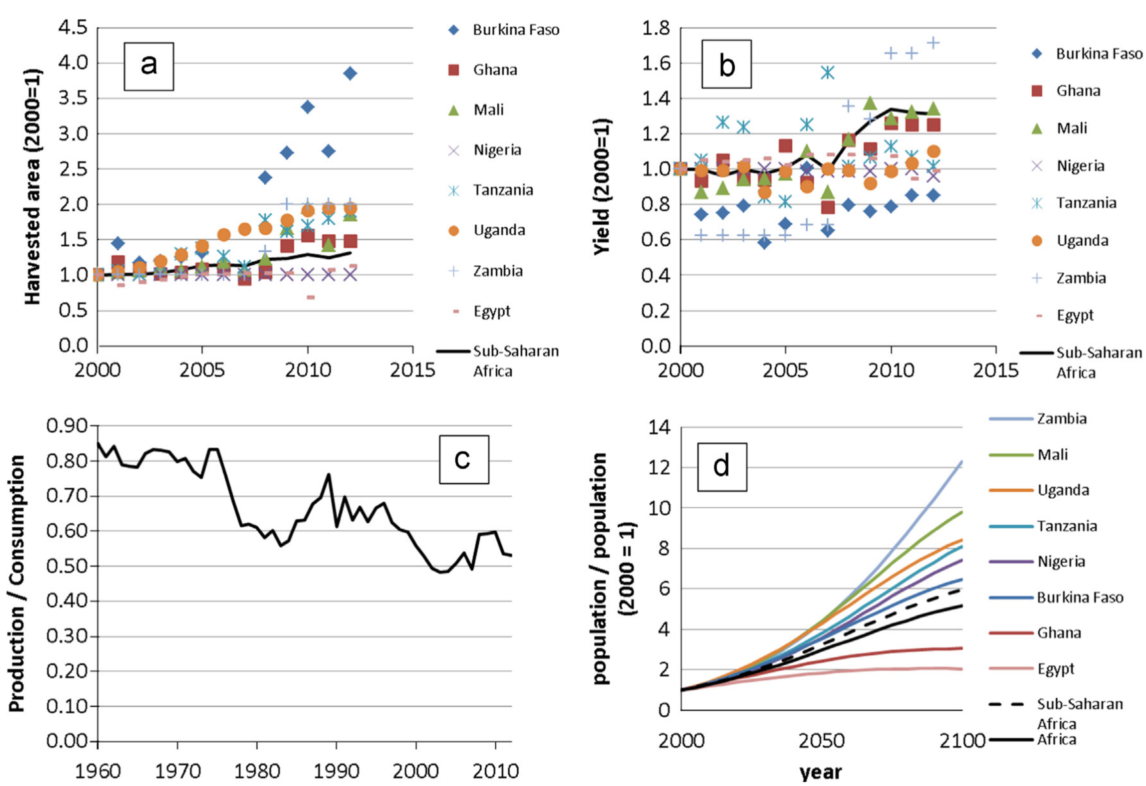

Fig. 1. Trends in harvested area (a), yield (b), production/consumption (c) and population (d). (Based on USDA (2014) and UN (2014)).

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