SUSTAINABILITY OF MAIZE PRODUCTION WITH FARMERS' PRACTICES AND REDESIGNED CROP MANAGEMENT PRACTICES IN CRV AND JIMMA OF ETHIOPIA

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[1*]Workneh Bekere Kenea, [1]Amsalu Nebiyu, [2]Tesfaye Balemi
[1]Department of Horticulture and Plant Sciences, Jimma University, P.O. Box 307, Jimma, Ethiopia; [2]Crop Production Specialist, Food and Agriculture Organization, Semera Field Office, Semera, Ethiopia
*e-mail: tolawaq@gmail.com, +251-921235304

ABSTRACT

In this study, sustainability of maize production with farmer's practice (FP), redesigned plant density plus current fertilizer use (RDCF), current plant density plus redesigned fertilizer use (CDRF), and redesigned plant density plus redesigned fertilizer use (RDRF) were assessed at household level based on social, agronomic, economic and environmental principles. Farmers' preference, farm household (maize) grain self-sufficiency, gross margin, and nitrogen use efficiency were used as indicators for for the respective principles. The result revealed that the preference of RDRF was 95% and 100% in CRV and Jimma respectively whereas the preference of FP was 45% and 20% in the respective regions. With all production technologies, farmers in both regions could achieve their family grain self-sufficiency but surplus production varied with the technologies used for the production. In CRV, RDRF, RDCF, and CDRF were economically viable to fertilizer use. However, in Jimma, less than 50% of farm households profited from RDRF and CDRF production technologies. In CRV, maize production using all crop management practices was associated with soil mining whereas in Jimma, the use of RDRF technology resulted in 18% environmental sustainability. Based on (average) scores of the indicators, maize production with RDRF showed higher social and economic sustainability in CRV and Jimma whereas maize production with FP was the least sustainable maize system in both regions. We conclude that further redesigning maize management technologies that meet environmental goal is of paramount important for the current and future generations in CRV and Jimma, Ethiopia.

Keywords: Farm household, family grain self-sufficiency, weighted scores, N use efficiency

INTRODUCTION

The concept of sustainability was first used in Sweden in forest management sector (Wiersum, 1995) with the focus on sustainable timber production from sustainable tree production (Prins et al., 2023). Since then, it has been applied in many disciplines across the globe. Sustainability in agriculture refers to the ability of a farm or agricultural system to produce food, fiber, or other products indefinitely without damaging or depleting the resources pool on which it depends. In other words, it is fulfilling the need of the present generation without compromising the ability of future generations to do the same (Rasmussen et al., 2017;Erbaugh et al., 2019). Several studies have assessed sustainability of farming systems based on sustainability dimensions (Ezell et al., 2021). This enables the selection of systems (practices) that fulfill social (Mandipaza, 2022), agronomic, economic and environmental principles. This means that the technologies should be socially acceptable, increase production, economically viable and environmentally safe (Pretty, 2008). Principles are universal ambitious commitments that are explained in terms of indicators. As principles are not directly measurable parameters, indicators are often used. Whereas indicator has been defined by different scholars, the definitions have similar meaning. Indicators are variables that supply information about another variable that are difficult to measure (Büchi et al., 2019;Heink and Kowarik, 2010). Alternatively, indicators are defined as variables for which a quantitative value is determined and compared to a reference value (Girardin et al., 1999). Indicators are very helpful in decision making for policy makers and managers.

Despite the inconsistency of the frameworks and tools, sustainability of farming system has been well studied (Paas et al., 2021) in developed countries. However, such studies are rare in Ethiopian agriculture, especially in staple food crops such as maize. Most studies are focusing on options of yield increase (Srivastava et al., 2019) and other studies unraveled factors associated with yield increase (Abate et al., 2015). This study is therefore conducted to (1) to assess the social, agronomic, economic and environmental performance of technologies used for maize production, (2) to assess the grain self-sufficiency at household level and estimate the land area that is required for farm household grain self-sufficiency in CRV and Jimma, Ethiopia.

MATERIALS AND METHODS

Definitions of maize production technologies

1. Farmer practices (FP): It is the actual plant density and actual fertilizer amount used by farmers.
2. Current density and redesigned fertilizer (CDRF): It is the average plant density used by farmers whereas fertilizer use is re-designed based on 50% potential yield of the crop.
3. Redesigned density and current fertilizer (RDCF): In this production practice, plant density is redesigned (53,333 plant ha^{-1} in CRV and 62,000 plant ha^{-1} in Jimma) but the fertilizer use is the average rate used by farmers in the respective region.
4. Redesigned density and redesigned fertilizer (RDRF): This refers to a production practices in which both plant density and fertilizer uses are redesigned.

Household grain self-sufficiency

Total maize production (t) at household level was obtained from the product of maize cultivation area (ha) and maize yield (t/ha). Maize cultivation areas of the participated farms households were measured using a handheld geographic positioning system essential (area measure) for the participating farm households in 2017. The per capita maize requirement of the farm households was based on an adult male equivalent (AME) of the 2017 family composition. Accordingly, a female was equivalent to 0.82 AME whereas children (0–18 years old) were equivalent to 0.75 AME (FAO, 2001). The per capita maize requirement is 260 kg^{-1} $adult^{-1}$ $year^{-1}$ based on calorie content of the crop.

Technology preference

Participating farmers were invited to evaluate the performance of maize crop grown with each technology at crop maturity, moving from field to field. Simple questionnaires were prepared to assess their preference of the tested technologies (Fertilizer use and plant density). A common starting question was "Is this fertilizer use and plant density important to improve your livelihood by improving maize productivity?". The farmers answered as no, partly or yes. To evaluate this