ON-FARM EXPERIMENTATION PROCESS TRIGGERS FARMERS' ZEAL TO TEST TECHNOLOGIES IN MAIZE SYSTEMS OF EMBU COUNTY, KENYA

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ABSTRACT

Using on-farm experimentation (OFE) approach, this study was carried out to validate a package of soil moisture and fertilizer nitrogen management practices, and to track farmer adoption of better agronomic practices in maize systems of Embu County, Kenya. Crop residue mulch in combination with calcium ammonium nitrate fertilizer, and a soil conditioner (hydrogels) coupled with slow-release urea were validated against farmer practices. Both management practices increased maize grain yield compared with farmers' practice. Stakeholders observed that these practices improved plant density and vigour, increased grain yield, reduced weed and pest pressure. The OFE process facilitated quick adoption and testing of technologies by farmers. At the onset of the third experimentation season, farmers began to experiment on a range of practices, especially mulching and optimal plant density.

INTRODUCTION

Despite enormous investment in research to improve the productivity of maize systems of Embu County, farmers hardly adopt high yielding agronomic practices. Low adoption could partly be attributed to approaches used in the research process. Researchers have traditionally used on-farm experiments to generate data but without the involvement of the farmer, either at design of experiments, data collection or interpretation of the results (Kummer et al., 2017). To improve bridge the gap in knowledge generation and transfer, and promote innovation by both researchers and farmers, and other stakeholders, it is important to rethink the way experiments are conducted (Richardson et al., 2021). Besides the large pool of stakeholders in co-creation of knowledge, OFE creates value proposition that distinguishes it from other participatory approaches in research. Often, this value arises from farmers being able to access information they can trust (Lacoste et al., 2022). To accelerate farmer experimentation and innovation, this study co-designed experiments with farmers and stakeholders to validate water and nitrogen management practices in maize systems of Embu County, Kenya.

METHODS

On-farm experiments (OFE) were carried out in two environments in the maize growing region of Embu County, in eastern Kenya. The OFE sites were in the upper midland (UM) zones UM3 and UM4, and lower midland (LM) zones LM3 and LM4. Prior to the establishment of experiments, farmers engaged in focus group discussions with researchers to identify relevant management practices for improved productivity of maize. In a bottom-up consultation process, farmers prioritized fertilizer and soil moisture management as the most pressing issues. Subsequently, farmers and researchers co-designed treatment combinations that could address the identified problems. Due to the large pool of treatments, management packages were designed in two distinct plots. The highest best management package (BMP1) comprised the use of soil conditioners (hydrogels) and a slow-release nitrogen (N) source of 'KynoPlus S®' while the next highest management package (BMP2) consisted of the application of 3 t/ha crop residue as mulch and calcium ammonium nitrate (CAN) as N source. The two researcher-managed plots were compared with farmers' business as usual plots. However, it was agreed that practices would change from season to season depending on experiences gathered. In this case, based on learning from the first experimental cycle, treatments were amended during the second season to include a uniform application of 5 t/ha of manure in both BMP1 and BMP2, and the farmer continued business as usual operations but with integration of knowledge from the OFE process.

While plot sizes varied from farm to farm, BMP1 and BMP2 were each allocated at least 900 m2, a size that is comparable with farmers' plots. Data were collected in researcher-managed (BMP1 and BMP 2) and farmer business as usual plots. Prior to harvesting, experiment host farmers, neighbours and other stakeholders were invited to evaluate the performance of the experiments. Farmers were asked to select preferred treatment plots based on their own criteria. The farmers were given three categories of choice per treatment plot, either poor performance, average performance or best performing treatment. The selection exercise was followed by a dialogue to document the criteria applied and farmer perception about the demonstrated management practices.

RESULTS

Yield and farmer selections

Figure 1 presents results from farmer evaluation of experimental plots. Overall, farmers' plots were least preferred by the respondents.

These selections were a true reflection of crop yield performance. Generally, plots applied with hydrogels outperformed those treated with applied with crop residue. However, in UM3/4 sites, differences in grain yield between hydrogel and mulched plots were small, and sometimes not significant. However, in the drier LM3/4 sites, hydrogel plots consistently and largely out-performed mulched plots.

Learning and evolution of farmer practice

Figure 2 shows the evolution of farmer learning from business-as-usual operations to the implementation of better management practices for improved water and nitrogen management. Farmers provided diverse feedback on their learning and presented a range of practices they were willing to test and implement in their plots in the ensuing seasons. At the on-set of the third experimentation season (2023 short rains), majority farmers implemented at least one practice learnt from the engagement with the project. Although farmer perception was not measured, farmers demonstrated confidence with the experimentation process and trusted the results. Indeed, more farmers were enthusiastic to either join the project or test technologies in their farms.

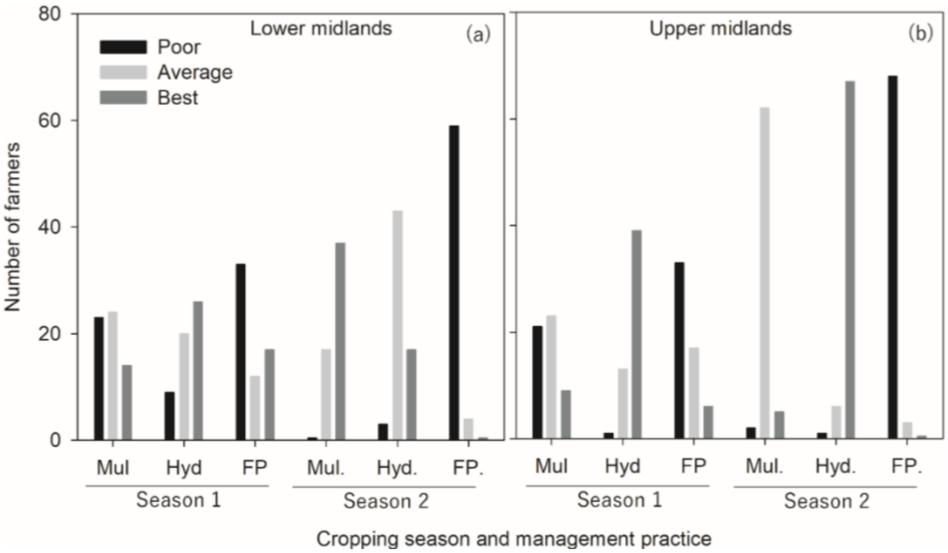

Figure 1. Farmers' selection of management practices during 2022 short rains (season 1) and 2023 long rains (season 2) in lower midland zones (a) and the upper midland zones (b). 'Mul' denotes mulched plots, 'hyd' indicates plots with hydrogels and 'FP' is farmer's practice.

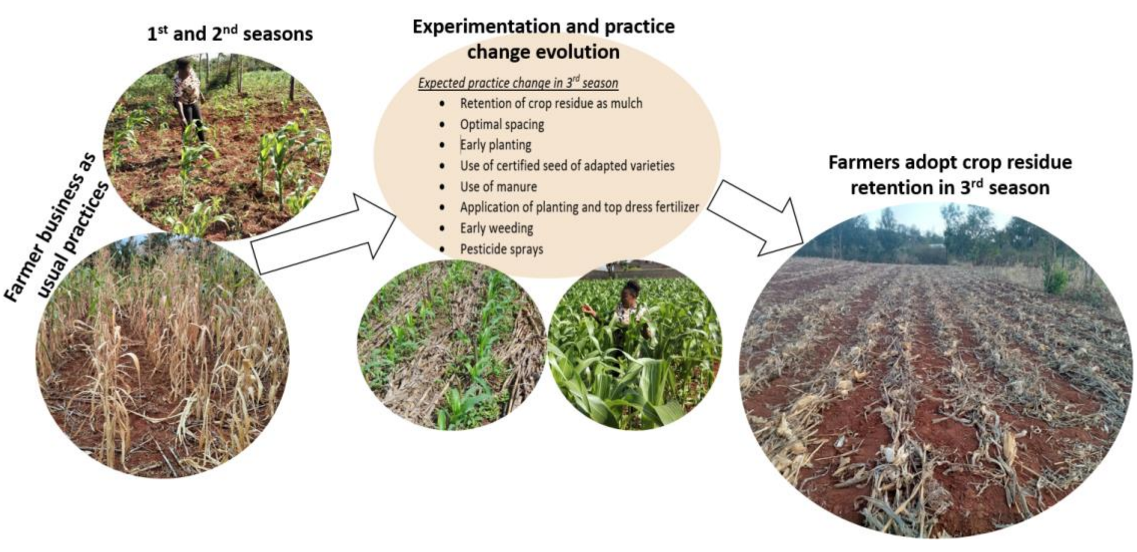

Figure 2. Evolution of farmer management practices as the project entered the third season.

DISCUSSION

The two researcher-managed plots optimized crop management practices unlike in the farmer plots where there were delays in weeding, fertilizer application and pest control. However, the study did not measure significant differences between the two plots. This implies that both hydrogels and mulch potentially conserved soil moisture at similar efficiency. Similarly, the application of calcium ammonium nitrate or the slow-release nitrogen fertilizer formulation did not show differences in maize yield. However, based on the unit price of nitrogen in each formulation, gross margin analyses (not shown) pointed to significantly higher returns per unit area with the use of slow-release fertilizer compared with calcium ammonium nitrate. Nonetheless, either of the fertilizer formulation ought to be applied at an optimal rate, at the right crop stage and placed near the root zone to maximize plant uptake (Bruulsema, 2021).

Adoption of residue retention among smallholder farmers, and especially those in mixed crop-livestock systems of Embu is constrained by the competing uses of crop residue (Jaleta et al., 2012; Baudron et. Al., 2014). In Embu, crop residues are primarily used as animal feed or sold improve household incomes. Through the OFE project farmers evaluated the benefits of mulch in improving maize yield, an outcome that fundamentally changed the farmers' mindset in the allocation of more crop residue to conserve moisture. Improved moisture conservation would open a window for better utilization of nutrients and reduce drought stress. In addition, farmers learnt the importance of better agronomic practices to improve maize yield. Key among the practices, farmers are willing to experiment are early planting, optimal plant density, early weeding, optimal fertilization based on the weather outlook, and use of manure.

In this study, the OFE approach accelerated knowledge transfer and practice change. This was demonstrated in the ability of farmers to take only two seasons of experimentation to start to adopt and test weather-resilient management practices such as mulching of soils with crop residue. This was a significant shift from the status quo where farmers remove crop residue for livestock feed or sale.

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