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The GREAT LIFE Project: Growing Resilient Agriculture Through Crop Diversification With Millet And Sorghum

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Introduction

Recent climate changes have had widespread impacts on human and natural systems. Appropriate adaptation options can alleviate detrimental effects of a warmer and drier climate as well as can better exploit favorable conditions. The most cultivated summer cereal crop in North Italy is maize, but frequently it requires a massive irrigation. In a warmer and drier climate, maize could have difficulty to adapt to the new climatic conditions. The aim of this study is to discover possible **productive alternatives to maize as summer crop**, together with the best agronomical practices for the cultivation of two resilient cereals: proso millet and grain sorghum.

Materials and Methods

Millet, sorghum and maize were cultivated with conservative and organic farming techniques. The crop rotation scheme consisted of the succession of summer crops (maize/millet/sorghum) with wheat and pea, interspersed by green manure. No irrigation or fertilizations were applied during the growing period of summer crops. The demo trials were placed in two farms, located in the Emilia-Romagna region, characterized by different pedo-climatic conditions, for two growing seasons (2019 and 2020). During growing season, the principal morphological, physiological and agronomic traits of the plants were monitored. Soil characteristics and soil moisture were monitored, as well as the crop water balance. In addition, pit-fall traps samplings were performed to monitor the presence of arthropods as bioindicators of diversity. Besides the field trials, a comparison between maize and sorghum crops cultivated in Po Valley was carried out, with the Life Cycle Analysis methodology, to understand the current environmental impacts of the crops.

Results

Yields were overall better in 2019, with a mean of 7.44 t/ha for sorghum and 3.46 t/ha for millet, while, in 2020, climatic conditions limited the yield of sorghum while millet, with a mean yield of 3.25 t/ha, showed good resilience and more stable yields. Maize showed an overall limited development and registered low production in both years (Table 1).

The **water consumption** for millet was lower (159 l/m2) than for other summer cereals (210 l/m2 for maize and 193 l/m2 for sorghum); these preliminary results demonstrate the high resilient performances of millet. However, sorghum, with a slightly higher water consumption than millet, can achieve better production yields due to genetic improvement activities realized in the last decades. Therefore, these preliminary results highlight the good stability in agronomic performances and the low input requests of millet and sorghum.

Crop	Plant height (cm)	Soil coverage (%)	Panicle (n°/m2)	Grain/panicle (g)	Yield (t/ha)
Millet 2019	115.20 ± 5.74	93.33 ± 7.64	221.00 ± 28.51	3.11 ± 0.56	3.46 ± 0.03
Maize 2019	151.60 ± 18.36	21.67 ± 10.41	11.00 ± 1.73	64.27 ± 36.31	6.35 ± 2.22
Sorghum 2019	134.67 ± 9.15	86.67 ± 5.77	31.67 ± 3.79	22.33 ± 0.50	7.44 ± 1.29
Millet 2020	91.60 ± 5.07	60.00 ± 11.60	292.14 ± 34.57	2.49 ± 1.14	3.25 ± 0.04
Maize 2020	133.47 ± 12.94	20.00 ± 11.60	3.33 ± 0.58	31.11 ± 8.87	1.07 ± 0.50
Sorghum 2020	104.67 ± 6.30	20.00 ± 11.60	15.67 ± 5.51	14.65 ± 4.42	2.56 ± 1.60

Table 1 – Means of the principal agronomical parameters monitored in two years of cultivation in the two experimental farms

Arthropods abundance as **bioindicators of biodiversity** was registered and then compared in two production systems, conventional and organic. The results indicated that conservative agriculture practices, that implicate low-tillage, cover cropping, and crop rotation schemes with legumes, had a good impact on agricultural biodiversity.

The **LCA** comparison between maize and sorghum crops cultivated in Po Valley involved a total area of 1298 hectares (913 ha of maize and 385 ha of grain sorghum), monitoring the cultivation practices and external inputs employed (Figure 1).

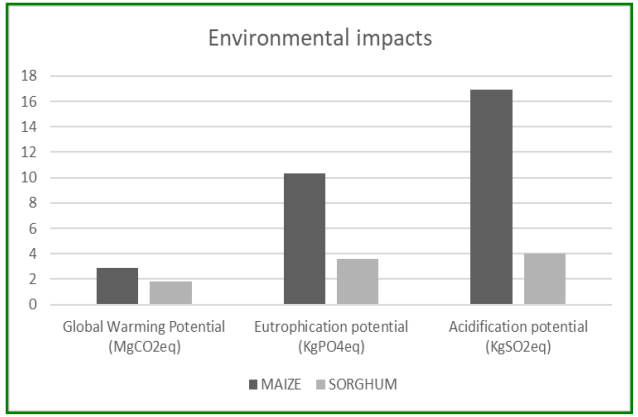

Figure 1 – Means of environmental impacts of maize and sorghum in Po Valley's farms surveyed in the study

Conclusions

The preliminary results suggest that millet or sorghum are better adapted than maize to rainfed organic farming conditions, given the lower water consumption values compared to maize, at the harvest ripening stage. The higher and more stable yields that millet and sorghum registered in the two years of trial, compared to maize, suggest them as a possible and sustainable alternative as summer cereal crops for the future climate changing scenarios, in combination with conservative agricultural practices. The LCA study confirms that, currently, fewer input are used for the cultivation of sorghum and the quantities of pollutants released for all impact categories are higher for the cultivation of maize than of sorghum.

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