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Research Application Summary

The benefits and productivity of cereal-legume intercropping with and without supplementary irrigation in the semi-arid highlands of Tigray, Ethiopia

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Abstract

Low soil fertility and limited water availability are the major hampering factors to crop production in the semi arid highlands of Ethiopia. Thus poverty and hunger is evident to the ever increasing population in the country. Comprehensive integration of nitrogen (N)-fixing leguminous species with cereals supported with supplementary irrigation could greatly improve soil fertility, moisture availability and increase livestock feed-base, resulting in food security and improved livelihoods. In line with this, a study was conducted at Mekelle University main campus in the northern highlands of Ethiopia to evaluate the benefits and productivity of cereal-legume intercropping under rainfed conditions and with supplementary irrigation, during the 2015/16 rainfall season. Bread wheat (*Triticum aestivum* L.) was intercropped with lentil (*Lens culinaris* Medik) and dekoko (*Psium aestivum* var. *abyssinicum*). Results indicated that intercropping increased significantly the grain yield of wheat up to 30.5% under rainfed conditions in wheat-lentil mixture and a noticeable yield increase was also noted in wheat-dekoko intercropping, and supplementary irrigation increased the yields by up to 100%. Higher Land Equivalent Ratio (LER) of 1.83 and 2.38 and LEC (0.82 and 1.34) were registered for wheat-lentil intercropping under rainfed and supplementary irrigation, respectively. Monetary equivalent index (MAI) was also higher (7,937.2 ETBr and 20,642 ETBr) respectively for rainfed and supplementary irrigation in wheat-lentil mixture.

Keywords: Cereal-legume, dekoko, Ethiopia, intercropping, rainfed, supplementary irrigation

Résumé

La faible fertilité des sols et la disponibilité limitée de l'eau sont les principaux facteurs qui entravent la production agricole dans les zones de haute altitude semi-arides de l'Ethiopie. Ainsi, la population sans cesse croissante est confrontée à la pauvreté et à la faim. L'intégration complète des espèces légumineuses fixatrices de l'azote (N) avec des céréales soutenue par une irrigation d'appoint pourrait grandement améliorer la fertilité et la réserve en eau du sol et augmenter l'alimentation du bétail pour ainsi assurer la sécurité alimentaire

et améliorer le niveau de vie des populations. Dans cette optique, une étude a été menée sur le campus principal de l'Université Mekelle dans les régions de haute altitude du nord de l'Ethiopie pour évaluer les avantages et la productivité des cultures intercalaires de céréales et de légumineuses dans des conditions pluviales et l'irrigation d'appoint, au cours de la saison pluvieuse 2015/16. Blé panifiable (*Triticum aestivum* L.) a été intercalé avec la lentille (*Lens culinaris* Medik) et dekoko (*Psium aestivum* var. *Abyssinicum*). Les résultats ont révélé que la culture intercalaire a augmenté de manière significative le rendement de grain de blé jusqu'à 30,5% dans des conditions pluviales dans le l'association blé-lentilles. Une augmentation de rendement notable a également été notée dans la culture intercalaire de blé-dekoko, et l'irrigation d'appoint a augmenté les rendements jusqu'à 100%. Le Ratio d'équivalence en terre de 1,83 et 2,38 et LEC (0,82 et 1,34) ont été enregistrés pour l'association blé-lentilles dans le système pluviale et l'irrigation d'appoint, respectivement. L'indice d'équivalence monétaire était également plus élevé (7 937, 2 EtBr et 20 642 EtBr), respectivement, pour l'agriculture pluviale et l'irrigation d'appoint dans l'association blé-lentilles.

Mots clés: céréales-légumineuses, dekoko, l'Ethiopie, les cultures intercalaires, pluviale, l'irrigation d'appoint

Background

In the semi-arid highlands of Ethiopia where smallholder farmers are dependent on rainfed subsistence farming as a means of livelihood and food security, there is an increasing threat to crop production due to the effects of climate change. Due to the short periods of rainfall or total lack of rainfall during crop productive stage, farmers in the region have experienced severe crop failures over the past decade (Araya and Stroosnijer, 2010). It is hypothesized that comprehensive integration of N-fixing leguminous species with cereals supported with supplementary irrigation could greatly improve soil fertility, moisture availability and increase livestock feed-base, resulting in food security and improved livelihoods. The objective of this study was to assess the benefits and productivity of cereal-legume intercropping with supplementary irrigation in the semi arid highlands of Tigray, Ethiopia.

Literature summary

Despite the significant growth in the production and yield of small cereals in Ethiopia since 2010 (Gray, 2014), their production is complex with large variations in crop types and agroecosystems. Several factors could explain this; but soil degradation has been reported as the leading cause of declining wheat productivity among rural smallholder farmers in the country (IFPRI, 2005). The exploitative way of subsistence farming coupled with poor agronomic practices and low use of external amendments is the major cause of land degradation (Temesgen *et al*., 2014). This calls for adjustments in agronomic practices that optimize rain water utilization, coupled with supplementary irrigation during mid season dry spells (Araya *et al*., 2010). Intercropping cereals with N-fixing legumes and practices that maximize soil coverage and reduce runoff have been suggested for the restoration of degraded soils in the country (Coxhead and Ygard, 2008).

Study description

The study was conducted at Mekelle University main campus, southern Tigray in northern Ethiopia which is on longitude 13^0 30'N and latitude 39^0 29'E at altitude ranging from 2100-2600m above sea level (Solomon, 2001) and around 780 kilometers north of the Ethiopian capital Addis Ababa. The area is characterized by a mean annual rainfall of 600mm which is highly variable and uni-modal,70–80% of which falls in between June–September, also referred to as *Kiremt* season (Araya *et al*., 2010).

Research application

The research treatments included intercropping wheat (*Triticum aestivum* L.) with lentil (*Lens culinaris* Medik) and dekoko (*Pisum sativuum* var. *abyssinicum)* in a ratio of 1:1 and application of supplementary irrigation from the booting stage of wheat and flowering stage of the legumes till maturity.

The study demonstrated that cereal-legume intercropping could strengthen the resilience of the dryland farming community to climate change and also improve their productivity in terms of diverse harvestable food and feeds per unit area. Intercropping wheat with dekoko and lentil increased the yield of wheat by 13.6 and 30.5 percent, respectively, under rainfed conditions (Table 1). Supplementary irrigation also increased its yield significantly. Intercropping also proved more superior to sole cropping in terms of farm land equivalent ratio (LER), monetary advantage index (MAI) and returns per investment. Generally, the land equivalent coefficient (LEC) was greater than 25% (Table 2). Although supplementary

Table 1. The yield and yield components of wheat as influenced by supplementary irrigation and intercropping with lentil and dekoko

	Rainfed	Supplementary irrigation	Sole wheat	Wheat + lentil	Wheat + dekoko
Grain yield (tha^{-1})	0.45	0.9	0.59	0.77	0.67
Biomass yield (tha^{-1})	1.31	1.76	0.68	2.08	1.83
Total grain weight (g)	21.44	34.89	26.83	27.83	29.83

Table 2. Land equivalent ratio (LER), Land equivalent coefficient (LEC) and Monetary advantage index (MAI) of wheat intercropping with lentil and dekoko

Treatment	Rainfed					Supplementary Irrigation				
	LER			LEC	MAI	LER			LEC	MAI
	Wheat	Legume	Total	-	-	Wheat	Legume	Total	-	-
Wheat + Lentil	1.06	0.77	1.83	0.82	7,937.20	1.47	0.91	2.38	1.34	20,642
Wheat + Dekoko	0.78	0.46	1.24	0.36	4,983.90	1.38	0.52	1.9	0.72	22,500

irrigation resulted in significant yield increase in both cases, farmers who cannot afford to apply it can obtain considerable yield increase through intercropping. This could subsequently help these smallholder farmers to boost their production and remain resilient to the changing climate. The results from this study serve to guide policy makers and implementers in promoting the diversification of self-sustaining farming systems in order to tackle the impacts of climate change in this area.

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