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Fostering seed circulation for sustainable agriculture

From local to global

Farmers' seed networks have made vital contributions to crop diversity since the origin of agriculture. They provide an effective means of access to seed not only locally between farmers, but also over long distances, as illustrated by historic (e.g. spread of farming in sub-Saharan Africa with Bantu migration) and recent (e.g. African rice as a slave agricultural heritage in the Americas) introductions. This has enabled farmers to reshape—by selection, cultivation and further seed exchange—and adapt their crops. However, the role of farmers' seed networks—within which 80-90% of all seeds still circulate—with regard to biodiversity conservation and the development of sustainable agriculture in response to global climate change has only recently begun to be considered by researchers and policymakers[1]. Through several research projects under way in West Africa (Cerao, Coex, Amma2050, SeedAttach)*, we assessed the role of crop diversity and farmers' seed systems in boosting resilience to climate change. At the local scale in Senegal, our findings highlighted that family and neighborhood social networks were pivotal to the reintroduction of a long-cycle millet landraces, offering farmers a new option in their cropping strategies geared towards climate change adaptation. Farmers' seed systems must thus be preserved for the functions and services rendered within agrosociosystems. At the regional scale, mapping the projected genomic vulnerability of pearl millet by the year 2050, we showed that farmers are likely to need to source seeds beyond their traditional social ranges so as to better meet their needs for varietal adaptation to climate change[2]. The use of adapted genetic resources should be implemented at different scales while respecting the diversity with regard to value systems and access rights for multiple actors[3]. **This research has highlighted the role of farmers' seed systems in reviving crop diversity, empowering local farmers, and the need for their consideration in seed policy and genetic resource conservation**.

* Amma2050, African Monsoon Multidisciplinary Analysis 2050 (Natural Environment Research Council/UKAID): www.amma2050.org/fr/Home

Cerao, Self-adaptation of tropical agro-socio-ecosystems to global changes? A long term study for ecological intensification of cereal production in West African savannas (ANR): https://anr.fr/en/funded-projects-and-impact/funded-projects/project/funded/project/b2d9d3668f92a3b9fbbf7866072501ef-f76a020d40/?tx_anrprojects_funded%5Bcontroller%5D=Funded&cHash=c32e0eea8f12931b19f0a10116168a3

Coex, Adaptative Governance for the Coexistence of Crop Diversity Management System (Agropolis Fondation): www.agropolis-fondation.fr/CoEX-418?lang=fr

SeedAttach (Agropolis Fondation), Community seed banks for social justice and conservation of biodiversity? Networks of actors and dynamics of seed attachment

▲ ***Diversity of sorghum grains in Cameroon.*** *© A. Barnaud/IRD*

◀ ***Harvesting sorghum in Cameroon.*** *© A. Barnaud/IRD*

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(3) Jankowski F., Louafi S., Kane N.A., *et al.,* 2020. From texts to enacting practices: defining fair and equitable research principles for plant genetic resources in West Africa. *Agric Hum Values,* 37: 1083-1094. https://doi.org/10.1007/s10460-020-10039-3

Conservation agriculture and maize yields in sub-Saharan Africa

Conservation agriculture (CA) is promoted in sub-Saharan Africa as an agroecological practice that increases crop productivity in a sustainable way. CA is not simply a single technology but a package of management practices whose actual implementation varies among farmers. The effects on crop yields are therefore complex. We conducted a meta-analysis on the effects of the three CA principles, i.e. no-tillage, mulching and crop rotation/intercropping, and related management practices and contexts on maize productivity in sub-Saharan Africa[1]. We noted **a significant average 8.4% increase in maize yields when the three CA principles were implemented concomitantly**. Crop yield benefits resulted principally from mulching and crop rotations or intercropping (Figure next page). It was also found that yield benefits with CA were greatest under limited rainfall conditions and when herbicides were applied. Crop residue mulching provides groundcover and adds organic matter to the soil, thereby enhancing soil functioning. This can increase crop productivity, especially in low-input cropping systems with limited external nutrient inputs. Mulching also reduces soil water evaporation loss and increases soil water infiltration, so crops make more effective use of rainfall.

Crop rotations and intercropping disrupt pest and disease habitats and life cycles and the cropping system benefits from higher soil nitrogen levels when legumes are involved in the rotation. Herbicide treatments boost the CA performance, since chemical weeding is generally more effective than mechanical (hand)weeding in managing the increased weed pressure in the absence of tillage. Yet the adoption of mulching and crop rotations is not easy for many smallholder farmers in sub-Saharan Africa who manage mixed crop-livestock systems. Crop residues have several other uses on farms, especially livestock feed. Legumes are often overlooked as rotation crops or intercrops, since functional markets are generally lacking for their sale. Finally, sustainability concerns regarding herbicide use highlight the need for alternative effective weed control strategies for smallholders adopting CA.

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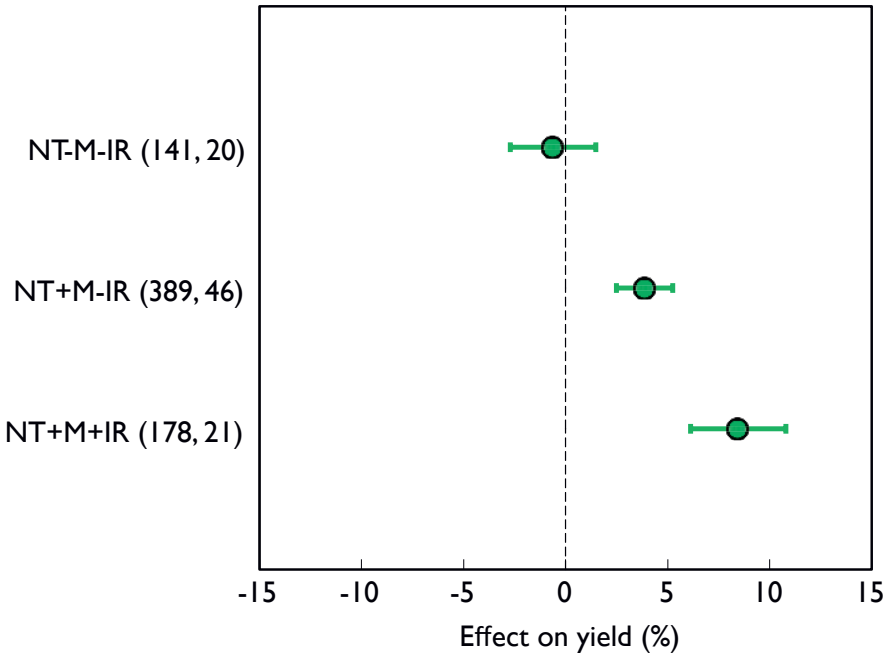

▲ ***Effects of conservation agriculture (CA) relative to conventional tillage (CT) on maize grain yield under different combined CA principles.***
NT-M-IR indicates no- or reduced tillage without crop residue mulching and crop rotation or intercropping, NT+M-IR indicates no- or reduced tillage with crop residue mulching and without crop rotation or intercropping and NT+M+IR indicates no- or reduced tillage with crop residue mulching and crop rotation or intercropping). Values represent mean effect sizes with 95% confidence intervals. The number of observations and studies per category are shown in parentheses. Source: Corbeels et al. *(2020).*

Tree stakes for climbing beans in Rwanda

Population growth and land fragmentation (farm sizes 0.3–0.6 ha) in Rwanda has resulted in reduced agricultural productivity and increased hunger and malnutrition, with 38% of children under 5 years being stunted. Rwanda has the highest bean consumption (29 kg person^{-1} yr^{-1}) in the world. Climbing and bush beans are affordable and highly nutritious. However, vertical production of climbing beans enhances land use efficiency over bush beans, with 0.5–2-fold higher yields. Despite this, climbing bean cropping is hampered by the lack or inadequate supply of stakes, other competing needs for stakes (e.g. firewood), and the high demand for fodder through the 'One-cow-per-poor-family' program.

To sustainably address this situation, the Trees4FoodSecurity project*, through a participatory approach, introduced a range of agroforestry interventions in semi-arid Bugesera and humid Gishwati districts to provide staking options for different contexts. A total of 540 participatory trials involving 387 farmers were set up. In Gishwati, bean yields using *Alnus acuminata* stakes produced **1.7-2.2 t/ha compared to 1.4-1.9 t/ha** with the commonly used *Pennisetum purpureum* stakes. At various sites in Bugesera district (Musenyi, Juru, Rweru and Nyamata sectors), **the use of stakes increased bean yields from the baseline 0.7 t/ha under bush beans to a maximum of 2.5 t/ha under climbing beans**, depending on stake type and field location. Staking options included *Senna spectabilis*, *Gliricidia sepium Calliandra calothyrsus*, *Grevillea robusta, Vernonia amygdalina* and *Lantana camara* stakes, with the latter two generally producing lower yields, probably due to weaker and shorter stakes. Irrespective of the staking treatment, yields were highest in the wetter Rweru sector and lowest in the drier Musenyi sector. The study clearly demonstrated that agroforestry offers a cost-effective and sustainable way of boosting bean production, thereby enhancing food, nutritional and environmental security in Rwanda. The identification of climbing bean varieties well-adapted to the semiarid environmental conditions in Bugesera is recommended.

* Trees4FoodSecurity project: https://bit.ly/2xOwwzV

▶ ***Photo showing climbing beans and bush beans in Juru Bugesera, Rwanda.*** *© J. Nyaga, Rwanda*

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