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Management of emerging pests through crop diversification in wheat-based cropping systems in the Horn of Africa and MENA region

Traditionally smallholder farmers in the Middle East and North Africa (MENA) grow different field crops for food, income, soil fertility and animal feed. However, due to increased government incentives and high market demands, farmers tend to grow wheat year after year on vast expanses of arable land, while the demand for food legumes is filled through huge imports. In many parts of MENA, wheat monocropping is a chronic production challenge, leading to poor soil health and rust epidemics that cause crop losses and incur high production costs. The reduction in crop and variety diversification also forces farmers to buy more expensive pulse crops to fulfil household food needs in East African highland areas. Crop diversification approaches are thus required to avoid a shortage of important crops for nutritional security and to mitigate climate change and farming system transitions that favor new diseases, parasitic weeds and insect pests.

Two interventions were conducted to diversify wheat monocropping and manage parasitic weeds of temperate food legumes in the highlands of Ethiopia. ILRI-ICARDA implemented validated crop technologies and scaling to reduce wheat monocropping while promoting temporal crop and variety diversification in this region. Farmers preferred high-yielding and disease-resistant durum wheat cultivars, while barley and food legumes were scaled out using informal seed systems. **The approach increased productivity, minimized cereal rust epidemics and improved sustainable wheat-based production systems**. The second intervention focused on managing weeds (*Orobanche* spp.) affecting food legumes through crop diversification. The intervention involved selection and promotion of non-host alternative crops (fenugreek, linseed, and common bean) in farmers' fields in the northeastern highlands of Ethiopia. In conclusion, spatiotemporal crop diversification should be further investigated and promoted as an effective crop production approach to minimize the impact of new and emerging pests on the livelihoods of farming communities and on the erosion of cereal and food legume genetic resources in MENA and East African highland areas.

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For further information

• Bishaw Z., Yigezu Y.A., Niane A., Telleria R.J., Najjar D. (eds), 2019. *Political economy of the wheat sector in Morocco: seed systems, varietal adoption, and impacts.* ICARDA, Beirut, 300 p. https://repo.mel.cgiar.org/handle/20.500.11766/8505

• Michler J.D., Josephson A.L., 2017. To specialize or diversify: agricultural diversity and poverty dynamics in Ethiopia. *World Development*, 89: 214-226. https://doi.org/10.1016/j.worlddev.2016.08.011

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▲ *Selection of non-host species for crop diversification to manage parasitic weeds in northeastern Ethiopia.* © *ICARDA*

Agroecological protection of fruit and vegetable crops in Réunion

Horticultural crops are—alongside sugarcane—the main agricultural outputs in Réunion. The use of pesticides to control animal pests, plant pathogens and weeds, as widely practiced since the 1980s, has shown its limits: low efficiency and profitability, negative environmental and health impacts, ecological imbalances, etc. Since the late 2000s, collective approaches based on agroecological crop protection (ACP) principles have been developed and implemented as a sustainable alternative to pesticide use for horticultural production. Vegetable crops (Cucurbitaceae: chayote, zucchini, pumpkin; Solanaceae: tomato) and fruit crops (mango) were considered. ACP is an agroecologically-oriented approach based on two main principles: the promotion of plant and animal biodiversity in agroecosystems; and maintenance and improvement of soil health in cultivated plots.

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◀ *Maize trap plants placed around a zucchini crop plot, as one of the agroecological levers used to control fruit flies.* © *J.-P. Deguine/CIRAD*

These initiatives involved many partners from the agricultural sector, with farmers being at the core of the system. They were conducted in several stages before, during and after partnership R&D projects. The performance of agrochemically-controlled horticultural cropping systems was compared with that of agroecological cropping systems in commercial fields (Table). **The results were very encouraging[1,2,3]: drastic reduction or even elimination of pesticides (especially herbicides and insecticides), restoration of biodiversity (e.g. arthropods) and ecological functioning of agroecosystems (fruit and vegetable production), reduction of production costs without loss of production, reduction of labor time and increased farmer satisfaction**. For example, two-thirds of the chayote (*Sechium edule*) cropping area is now under organic farming with agroecological practices. This research has given rise to new projects focused on diversified cropping systems, while generic drivers of the adoption of innovative agroecological cropping systems have also been proposed.

* http://gamour.cirad.fr/site
** https://ecophytopic.fr/recherche-innovation/concevoir-son-systeme/rescam-reseau-dexperimentations-de-systemes-cultures
*** www.agriculture-biodiversite-oi.org/Biophyto
**** https://ecophytopic.fr/dephy/conception-de-systeme-de-culture/projet-st0p

Recommended agroecological practice	Vegetable crops (Cucurbitaceae)		Fruit crops (mango)
	Chayote	Courgette	Mango
Discontinuation of conventional insecticide treatments	Yes	Yes	Yes
Discontinuation of herbicide treatments	Yes	Yes	Yes
Sanitation (augmentorium)	Yes	Yes	Yes
Permanent vegetation cover	Yes	No	Yes
Trap plants	No	Yes	Yes
Flower strips	No	No	Yes
Refuge plants	No	No	Yes
Reduction of mineral fertilization	Yes	No	No
Organic amendments	Yes	Yes	Yes
Traps	Yes	Yes	Yes
Use of adulticide bait	No	Yes	Yes
Curative measures*	No	No	No

▲ ***An ordered and methodical strategy for agroecological crop protection, adopted for experiments on Cucurbitaceae and mango in Réunion*** *(in Deguine* et al.*, 2019b).*
Chayote and courgette are considered separately (with other field crops such as pumpkin and cucumber being pooled with courgette) since chayote is grown on arbours and can be managed as a perennial crop. Courgette, on the other hand, is a field vegetable with a short cycle. In the table, 'Yes' means that the practice is recommended and 'No' that the practice is not recommended.
** In these curative measures, the use of chemical pesticides is considered to be a last resort and must only be used in an optimized and targeted way, with as little impact as possible so as not to jeopardize biological control.*

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(1) Deguine J.-P., Jacquot M., Allibert A., Chiroleu F., Graindorge R., Laurent P., Albon B., Marquier M., Gloanec C., Lambert G., Vanhuffel L., Vincenot D., Aubertot J.-N., 2018. Agroecological protection of mango orchards in Réunion. *Sustainable Agriculture Reviews*, 28: 249-308. https://doi.org/10.1007/978-3-319-90309-5_8

(2) Deguine J.-P., Atiama-Nurbel T., Vanhuffel L., Cresson C., 2019a. Recent advances in organic cultivation of chayote (*Sechium edule*) in Reunion Island. *Organic agriculture*, 10: 135-143. https://doi.org/10.1007/s13165-019-00255-5

(3) Deguine J.-P., Aubertot J.-N., de Cambiaire J.-C., Cresson C., Fares M., Lambert G., Marquier M., Nurbel T., Laurent P., Vanhuffel L., Vincenot D., 2019b. Development of agroecological horticultural systems in Réunion. *In* Côte F.-X., *et al.* (eds): *The agroecological transition of agricultural systems in the Global South*. Agricultures et défis du monde collection, AFD, Cirad, Éditions Quæ, Versailles: 127-140.

• IPSIM-CHAYOTE website: a tool to help farmers predict, discuss and manage chayote fly damage in Réunion: https://pvbmt-apps.cirad.fr/apps/ipsim-chayote/?lang=en

Promoting a new *Cotesia* species as a first biological control agent against the invasive Mediterranean corn borer in France

Insect parasitoids play an important role in in limiting phytophagous insect populations. Because they often have a narrow host-range, many parasitoid species are used for pest insect control. A research program on the diversity of Lepidoptera stemborers and their parasitoids in sub-Saharan Africa has led to the characterization of a new parasitoid species, *Cotesia typhae* (Hymenoptera, Braconidae), specialized on a single host species[3]. The latter, *Sesamia nonagrioides*, mainly causes damage to maize in southern Europe where damage rates often increase due to mild winters, lack of authorized insecticides and lack of a biocontrol agent. A Kenyan *C. typhae* strain was found to have high parasitic success on European *S. nonagrioides* host populations[1]. A French-Kenyan research program* is currently investigating the potential of this parasitoid to control the pest via yearly releases, while addressing the following aspects: (i) mechanisms of parasitism success and specificity; (ii) risk of establishment in the French environment; (iii) conditions of success in greenhouses; and (iv) mass-rearing techniques.

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▲ ***From left to right:***
Cotesia typhae *female antennating a* Sesamia nonagrioides *larval dejection at the tunnel entrance. © C.J. Parisot/EGCE*
C. typhae *female ovipositing dozens of eggs into* S. nonagrioides larva. *© R. Benoist, EGCE*
C. typhae *nymphal cocoons formed around the host body after completion of larval endoparasitic development. © L. Kaiser/EGCE*