



HAL
open science

Sustainable Intensification of Crop Production Requires Agricultural Equipment Innovation: the Case of Strip-Till for Fine Seedbed Preparation in Silty Soil

Davide Rizzo, Benoît Detot, Andrii Yatskul, Claudia Carolina Ugarte Nano

► To cite this version:

Davide Rizzo, Benoît Detot, Andrii Yatskul, Claudia Carolina Ugarte Nano. Sustainable Intensification of Crop Production Requires Agricultural Equipment Innovation: the Case of Strip-Till for Fine Seedbed Preparation in Silty Soil. XLVII Convegno Nazionale L'Agronomia nelle nuove Agricolturæ (Biologica, Conservativa, Digitale, di Precisione), Sep 2018, Marsala, Italy. hal-03154187

HAL Id: hal-03154187

<https://hal.science/hal-03154187>

Submitted on 15 Mar 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - ShareAlike 4.0 International License



L'Agronomia nelle nuove Agriculturæ
(Biologica, Conservativa, Digitale, di Precisione)

Sustainable Intensification of Crop Production Requires Agricultural Equipment Innovation: the Case of Strip-Till for Fine Seedbed Preparation in Silty Soil

Davide Rizzo^{1,2}, Benoît Detot¹, Andrii Yatskul¹, Carolina Ugarte^{1,3}

¹ Chaire Agro-Machinisme et Nouvelles Technologies, UniLaSalle, Beauvais, FR name.surname@unilasalle.fr

² InTerACT Research Unit, UniLaSalle, Beauvais et Rouen, FR

³ AGHYLE Research Unit, UniLaSalle, Beauvais et Rouen, FR

Introduction

Sustainable intensification of crop production calls for agricultural innovations. In the past, the solution was to bring new land into cultivation, whereas current and prospected trends in world population growth orient instead to foster more efficient use and management of the resources (Pisante et al. 2012). Various solutions are being developed in function of the local agropedoclimatic conditions. In this context, agronomists are questioning the soil tillage practices, eventually to reduce the tillage intensity. On the one hand, the goal is to reduce fuel use, time and labour. On the other hand, a lower tillage intensity might improve soil organic matter building and, in the end, soil health (DeJong-Hughes 2017). Rethinking soil tillage inevitably underpins and follows farming system design (Leclercq and Corfdir 2017; Yatskul and Ugarte 2018). Indeed, the evolution of agriculture is inherently systemic, thus requiring to address the production intensification across the various components of the agricultural system and beyond (Darnhofer et al. 2012). Altogether, this results in taking into greater account multiple stakeholders and embracing the complexity of the farmers' decision-making (Douthwaite and Hoffecker 2017). The sustainable intensification process has though two main barriers: the learning curve to master new techniques and the cost of equipment suited for the new practices. This communication aims to discuss a project of strip-till design following an innovation system approach. First, we present the agronomic challenge and our approach for a custom supply development. Then, we discuss the relevance of our some early outcomes for the wider goal of sustainable intensification of crop production.

The agronomic challenge: designing a strip-till for fine seedbed preparation

Sustainable intensification can be pursued (and evaluated) in different way according to the local farming system and agropedoclimatic condition. In this context, the European Regional Development Fund, the French State and the Hauts-de-France Regional Council invested about 2.7 million EUR in a project called "Demonstrating site network" ("Réseau de sites démonstrateur IAR" in French) for the period 2015-2020. This project aims to study and show the feasibility of the diversification of current cropping systems in the region by the introduction of food and non-food crops for feed, bio-based products and bioenergy (Lammerre et al. 2017). The project particularly addresses the production of knowledge to support farmers at embracing the innovation. Accordingly, it includes 4 demonstration sites and 3 areas to explore the organization of new supply chains. Three 4-year crop sequences, each replicated with or without soil tillage, are tested on each site. The crop sequences are designed on three scenarios: baseline, food-priority and biomass-priority. The baseline is the regional mixed farming system that includes canola, winter wheat and silage maize. We focus here on the biomass scenario, which fosters the intensification of fodder and energy crop production by introducing fodder beet and harvested catch crops (Fig. 1). Introducing these crops requires therefore to simplify the soil tillage.

The region shows a predominance of silt and silt loam soils (USDA). These soil types are characterized by a weak structural stability presenting a high risk of crusting and erosion. They thus benefit from simplified soil tillage, when operated shortly before the seeding, because reducing soil degradation. Amid the different approaches, strip-tillage appeared as the most promising because combining the reduction of labour time, and the preparation of fine seedbed, as required for maize and beet (Duval 2014; Laufer and Koch 2017). Though, available commercial strip-tillage tools, mostly passive, can achieve fine seedbed if operated months ahead, or at a speed of 10-12 km/h. So, they can be combined only with

L'Agronomia nelle nuove *Agriculturæ* (Biologica, Conservativa, Digitale, di Precisione)

recent planters or operated separately by using RTK-GPS. Altogether, these machines and technologies may require high investments by farmers, eventually hampering the whole farming system innovation.

A group of 6 students specializing in agricultural equipment at UniLaSalle (centre for higher education in Northern France) were challenged to prototype a strip-till fitting commonly available beet planters operating at low speed (3 km/h). This was achieved by an ad-hoc combination of tools, part of which power-operated (Fig. 2). The field tests realized at the end of the current academic year with the single-element prototype succeeded at preparing a fine seedbed 10 cm wide and 20-25 cm deep.

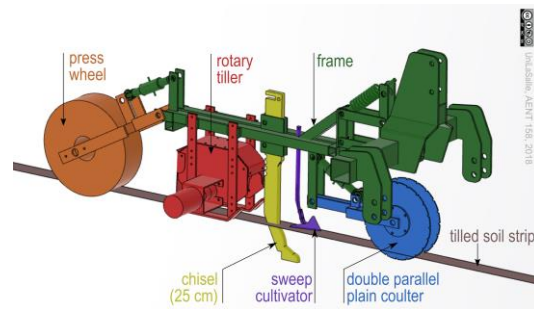
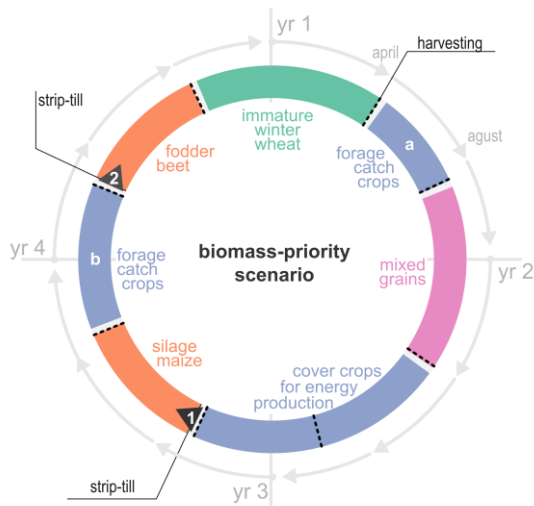


Fig 1 (left). Crop sequence of the biomass priority scenario. **Forage catch crops:** (a) forage canola and Italian ryegrass; (b) triticale 50%, forage pea 30% and fava beans (*Vicia faba* L. var. *minor*) 20%. **Mixed grains:** bere 50%, forage pea 25% and common vetch 25%. **Strip-tillage** (1 and 2) is planned before the seeding of silage maize and fodder beet.

Fig 2 (above). Schematic representation of the prototype strip-till (adapted from F. Pastol, CC BY-NC-SA 4.0 UniLaSalle, AENT 158, 2018).

Conclusions and perspectives

Reducing the width and frequency of soil tillage appeared as a lever to deploy the sustainable intensification of crop production in a mixed farming system on silt soil. Though, cost and customization of tillage equipment emerged as a major barrier for desired innovation. By adopting a systemic approach, we involved a group of agronomy students to design a fully adapted strip-tillage tool, thus based on farmers' and agronomic constraints. In conclusion, we widen the farming system innovation to include a farmer-centred perspective, with the final goal to operationalize the design and adoption of sustainable production practices.

References

- Darnhofer I, Gibbon D, Dedieu B (2012) Farming system research: an approach to inquiry. In: Farming Systems Research into the 21st Century: The New Dynamic. Springer, pp 3–31
- DeJong-Hughes J (2017) Upper Midwest Tillage Guide-Reducing tillage intensity : Soil management and health : Agriculture : University of Minnesota Extension. In: Soil Manag. Health. <https://www.extension.umn.edu/agriculture/soils/tillage/tillage-guide-intensity/>. Accessed 11 Jun 2018
- Douthwaite B, Hoffecker E (2017) Towards a complexity-aware theory of change for participatory research programs working within agricultural innovation systems. *Agric Syst* 155:88–102. doi: 10.1016/j.agsy.2017.04.002
- Duval R (2014) Le strip-till en betteraves sucrières : résultats ITB
- Lamerre J, Godard C, Boissy J (2017) Assessing environmental impacts of bioeconomy. Oriented cropping systems using Life Cycle Assessment approach. In: International LCA Conference, congrès Av'nir. Lille, FRA
- Laufer D, Koch H-J (2017) Growth and yield formation of sugar beet (*Beta vulgaris* L.) under strip tillage compared to full width tillage on silt loam soil in Central Europe. *Eur J Agron* 82:182–189. doi: 10.1016/j.eja.2016.10.017
- Leclercq C, Corfdir V (2017) Evolution des techniques d'implantation. *Agron Environ Sociétés* 7:63–73
- Pisante M, Stagnari F, Grant CA (2012) Agricultural innovations for sustainable crop production intensification. *Ital J Agron* e40–e40. doi: 10.4081/ija.2012.e40
- Yatskul A, Ugarte C (2018) Soil-tool interaction for an agro-ecological performance of the tillage implements. In: *Agriculture durable : une opportunité pour l'innovation des machines et des systèmes*. Beauvais, FRA, pp 101–113