

Growing Camelina as Second Crop in Northern France to Supply a Local Biorefinery

Using a Participatory Design Approach to Produce Actionable Knowledge

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① BACKGROUND

Cropping systems with **diversification crops** are needed to meet the increasing demand of sustainable feedstock for food, feed, fibre, and fuel (Ghatak et al. 2011). **Lack of agronomic knowledge mobilised in/for action (i.e. actionable knowledge)** is one of the obstacles to develop these diversification crops (Meynard et al. 2013).

Camelina (*Camelina Sativa*) is a **promising little-known oilseed crop** adapted to European growing conditions and with **multiple potential food and non-food uses** because of its specific fatty acid profile (Berti et al. 2016; Zanetti et al. 2017). In northern France, **camelina** is one of the crops investigated to **sustainably supply** a local biorefinery.

According to the C-K theory (Hatchuel and Weil, 2003), a **design process** results in (i) exploring the space of concepts leading to **innovation** and (ii) **producing new knowledge** or at least **identifying the knowledge to be produced**.

How a design activity can support the production of actionable knowledge on a little-known diversification crop and on its introduction in cropping systems?



② GLOBAL APPROACH

Managing a design activity by combining a **multi-actors workshop** and **on-farm trials** to produce **actionable knowledge** and identify **knowledge gaps**

The multi-actors workshop

One day – 17 participants (farmers, advisors, researchers and transformers)

Step 1
Knowledge sharing

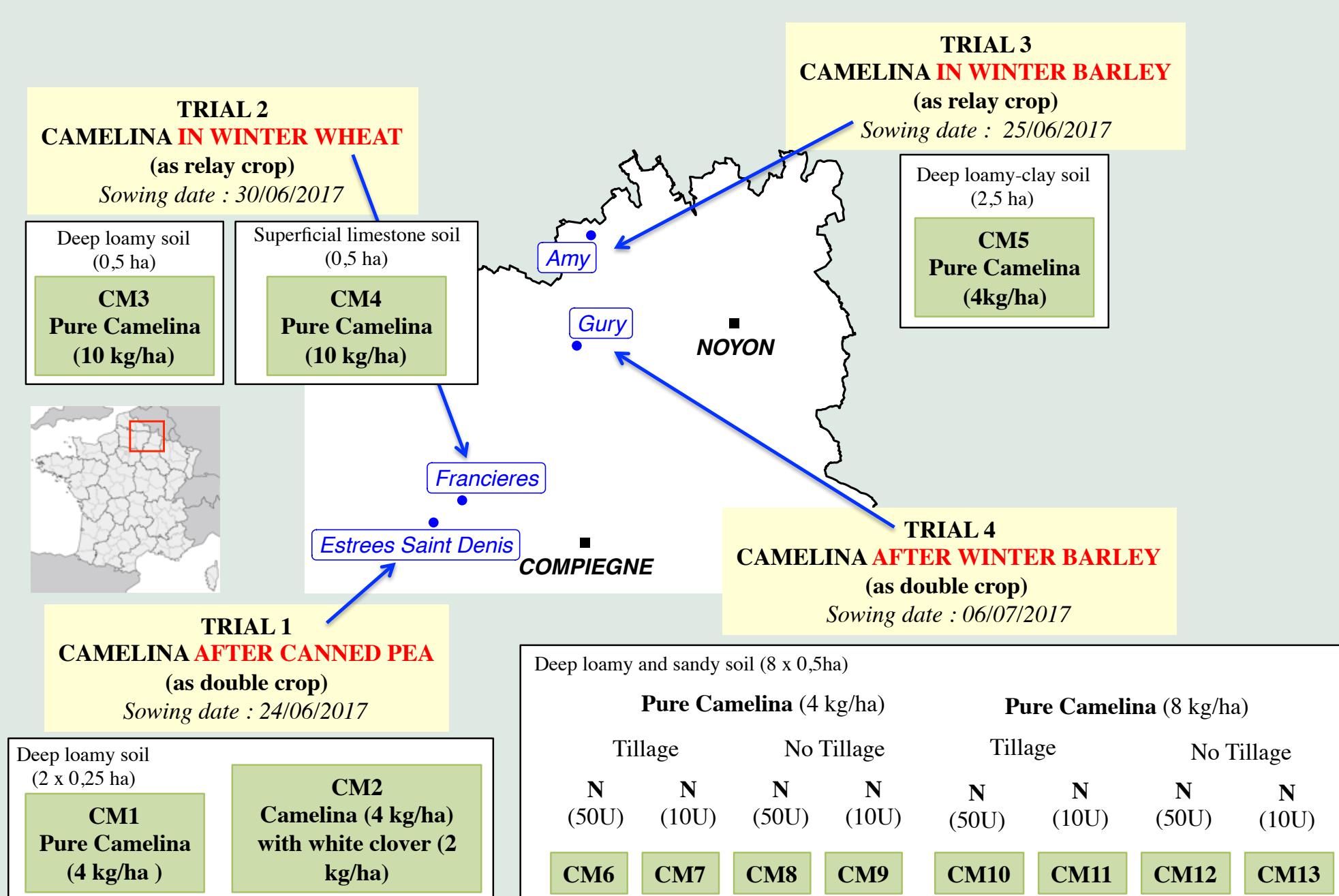
Step 2
Design of crop sequences
with camelina as second crop

Step 3
Design of camelina management options



On-farm trials

Four farmers – 13 crops managements (CM) options designed, tested and assessed by farmers – a monitoring by researchers through semi-directive interviews, field tours with farmers and yield measurements



③ RESULTS

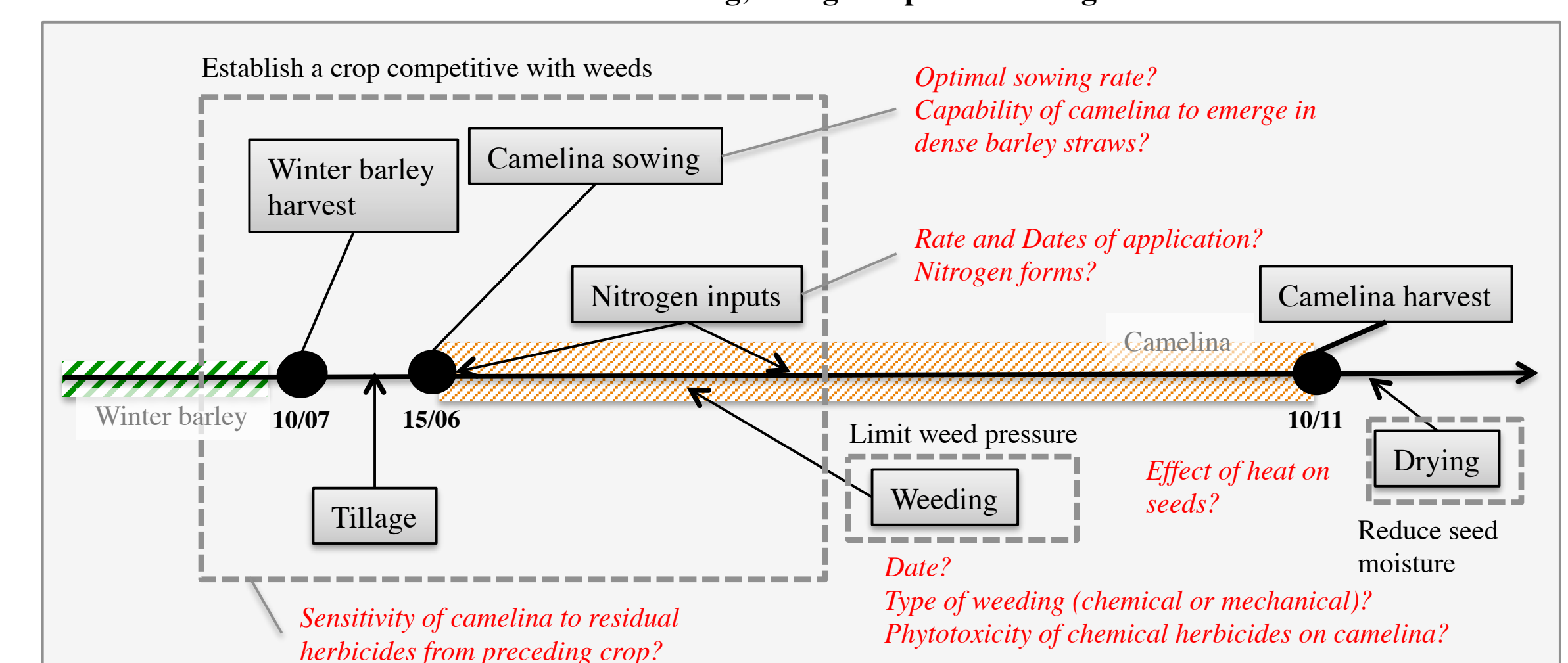
a) During the **workshop**, **agronomic, economic, environmental and quality criteria** for camelina production and camelina-based cropping systems were defined from the expected services mentioned by actors regarding eight designed crop sequences.

Table 1: Example of assessment criteria defined from expected services formulated by various actors of the value chain during the design of two categories of crop sequences

Camelina introduction into crop sequences (Example of crop sequence designed)	Expected services	Assessment criteria derived from expected services
Introducing pure camelina as second crop after a winter cereal Ex : Rapeseed – Wheat – Barley – Camelina – Sugarbeet – Wheat Ex: Wheat- Camelina – Maize- Maize	A: Increase profitability B: Reduce GHG emission, Store carbon in the soil C: Reach low levels of impurities and erucic acids but high protein or oil contents	A → Profitability ; Yield B → GHG emission; Carbon storage C → Oil and protein content; Fatty acid profile; Dockage (level of impurities)
Introducing camelina as second crop after early harvest legume Ex : Wheat- Winter or Canned Pea – Camelina – Sugarbeet	A+ B + C + D: Limit mineral nitrogen inputs E : Harvest camelina at the right seed moisture for commercialisation	D → Nitrogen fertiliser rate of camelina E → Seed moisture content at harvest

b) During the **workshop**, the design of camelina management options raised **questions about camelina sowing, fertilisation, and weeding management and camelina crop functioning**. Some farmers mobilised these knowledge gaps to design their own **on-farm trials**.

Figure 1: Example of one of the crop management options designed during the workshop, “camelina as double crop after winter barley” (in red : knowledge gaps). Trial 4 of the on-farm trials was designed to address the uncertainties related to camelina sowing, nitrogen inputs and tillage.



c) During the **on-farm trials**, **monitoring indicators** were identified from the qualitative assessment of camelina crop management options by farmers. **Decisions rules** for camelina management were formulated. **Farmers learned about camelina crop functioning**.

Figure 2: Qualitative appraisal of the on-farm trials by farmers (Green = satisfactory, Orange = satisfactory but with some concerns, Red: unsatisfactory, NA: Non-assessed) and farmers' learning and decision rules associated

CRITERIA ASSESSED	INDICATORS USED BY FARMERS	Crop Management options													Farmers learning and decision rules
		CM1	CM2	CM3	CM4	CM5	CM6	CM7	CM8	CM9	CM10	CM11	CM12	CM13	
Camelina establishment	Emergence rate		NA												Camelina has a good germination capacity
	Soil cover		NA		NA										
Sensitivity to herbicides residuals	Plant vigour and density		NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Camelina seems to be no sensitive to herbicides residuals from the preceding crop
Nitrogen status	Plant vigour and height; leaves colour and size		NA		NA										
Date of maturity	Grain ripening, change in plant color		NA		NA										Camelina is sensitive to day length and cold temperature after flowering. If the growing season is too cold after flowering, camelina did not reach full maturity before the sowing of the following crop
Annual weeds	Abundance and species		NA		NA										
Perennial weeds															Some annual and perennial weeds can be very competitive with camelina. A good weed management in the preceding crop and soil tillage before sowing could be used to limit weed pressure
Volunteers of the previous crop	Abundance	NA	NA		NA										
Diseases	Presence/ Absence	NA	NA		NA										Camelina is sensitive to downy mildew, that can impacts camelina yield
Pests		NA	NA		NA										
Yield	Yield value (≥ 1.5 t ha ⁻¹)		NA		NA	NA									Camelina yield are satisfying regarding the threshold of 1.5 t ha ⁻¹
FARMER APPRAISAL															

④ CONCLUSION

- Several crop management options of camelina as second crop have been identified as **promising by farmers** thanks to on-farm trials.
- Some **knowledge gaps** identified during the approach and still unaddressed, such as camelina capacity to reach full maturity when grown as second crop, should be a **priority for future action-oriented and local research programs**.
- **Combining a multi-actors workshop and on-farm trials managed by farmers** is a promising participatory design approach to support the production of actionable knowledge and to pursue the identification of research priorities for little-known diversification crops.