Robotic Weeding

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This educational presentation covers some product features and factors to consider when introducing robotic weeding into a farming operation. The landscape is changing rapidly, so before applying the material, ensure that the information is still current/correct and that it fits the context of the use-case.

Refer to "Robotic Weeding: Concepts and Options" material, presented at the Central Dakota Ag Day on Dec 19, 2026, for information on frames, powertrains, and electronic subsystems (User interface, navigation, communications, safeguarding, machine health monitoring). Watch upcoming information from Grand Farm, NDSU, and ARS-Fargo.

What role(s) will the robot be playing? What problem is being addressed?

- Traditional sprayer replacement, supplement, or experiment
- Use for operations besides weed control (multipurpose)
- Special considerations such as specialty crops, organic crops, herbicide resistant weeds, spot treatment

Weeding mechanisms

- Chemical spray (continuous or weed-activated)
- Mechanical
    - Inter-row
    - Inter-plant
- Light: Spectrum and mode (microwave – gamma ray), laser vs other
- Heat
    - Fire
    - Liquid/steam
    - Electrical
    - Plasma

- Example products
    - Guss ag (Deere) blast and weed-activated sprayer for orchards
    - Carbon Robotics G2 laser weeder
    - FD20 from FarmDroid
    - Aigen
    - W4 from Farming Revolution
    - Kult iVision

Business model factors

- Coastal specialty vs Midwest commodity crop weed control
    - Higher vs lower crop value
    - Higher cost manual weeding vs lower cost chemical weed control
    - Dry, drip irrigated land vs potentially wet and windy fields
    - Crops are shorter vs crops and weeds than can outgrow equipment

Mis-treatment	Cost

Crop damage
    Mobility
    Treatment
 	
Weed escapes
    Not treated
    Insufficient treatment
    Missed window (weather)
    Surviving seeds etc
	Yield
	Quality
	Cleanliness
	Re-treatment

Actions	Costs	Multipliers
Pre-season maintenance and set-up To-field transport In-field set-up In-field attention Off-field attention In-field tear-down	Labor Cost of capital Depreciation Wear items Consumables Note: If the robot is used for more than weeding, costs may be split over more operations.	Rows Machines Road miles Fields Acres Hours Years

UIUC model: Yu, Chengzheng et al, "Herbicide-resistant weed management with robots: A weed ecological-economic model", *IAAE Agricultural Economics*, Oct 2, 2024.
https://onlinelibrary.wiley.com/share/R3R4DYUCZADREGYBAU97?target=10.1111/agec.12856

European sugar beet study data

Gerhards, R., Risser, P., Spaeth, M., Saile, M. & Peteinatos, G. (2024) A comparison of seven innovative robotic weeding systems and reference herbicide strategies in sugar beet (*Beta vulgaris subsp. Vulgaris* L.) and rapeseed (*Brassica napus* L.). *Weed Research*, 64(1), 42–53. Available from: **https://doi.org/10.1111/wre.12603**

Treatment	Herb. Savings (%) (mean/min/max)	Weed Control Eff. (%) (mean/min/max)	Crop Loss (%) (mean/min/max)
Herbicide broadcast	0	82.7 (61.5–98.9)	2.2 (0–8.8)
Conventional hoeing + harrowing	100	74.0	21.4
Band spraying + inter-row hoeing (offline)	75	95.3 (93–97.6)	4.7 (2.0–7.4)
FD20®-band spraying + inter-row hoeing (online)	83.1	66.5	1.8
FR-W4® inter-row + in-row hoeing	100	93.0	39.5
FD20® inter-row + in-row hoeing	100	92.0 (89.7–94.2)	20.7 (0.9–40.4)
FD20® inter-row+ in-row hoeing + Amazone spot spraying®	92.2	94.2	2.3
KULT-Vision Control® inter-row hoe	100	80.2 (69.9–90.5)	2.5 (0–7.4)
KULT-Vision Control® inter-row hoe + finger weeding	100	92.9	0
KULT-iSelect® with Hohenheim camera	100	93.5	0

Table 5

Treatment	Working width (m)	Speed (km h⁻¹)	Working rate (ha h⁻¹)[a]	Treatment costs (min/max) (€ ha⁻¹)[b]
Herbicide broadcast application	18	8	6.2	308.6 (oil-seed rape), 307.4 (sugar beet Ihinger Hof), 383.4 (sugar beet Kirschgartshausen)
Conventional hoeing + harrowing	5.4 (12)	4 (8)	1.0	230.6
Band spraying + inter-row hoeing (offline)	12 (5.4)	8 (4)	1.0	298.7
FD20®-band spraying + inter-row hoeing (online)	2.7	(2.5)[c] 5	0.95	804.2
FR-W4® inter-row + in-row hoeing	2.7	1	0.42	804.2[d]
FD20® inter-row + in-row hoeing	2.7	1	0.42	733.4
FD20® inter-row and in-row hoeing + Amazone spot spraying®	2.7	1	0.42	804.2
KULT-Vision Control® inter-row hoe	3	(3)[c] 8	1.3	102.5 (sugar beet) 205 (oil-seed rape)
KULT-Vision Control® inter-row hoe + finger weeding	3	(2.5)[c] 5	1.0	220.8
KULT-iSelect® with Hohenheim camera	3	1	0.4	554.7

Table 6