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Executive Summary

This is a short report of the first work on developing the list of tools for implementation in WP3-7. The work commenced shortly after the start of IWMPRAISE in early June 2017. The list was revised and extended substantially during summer 2018, and the latest version was finished in early October 2018. At present, the list contains 30 strategies and tactics that are implementable - or close of being so - in WP3-7. These methods are mostly simple technologies accessible to most growers. Some of the suggested solutions still require further development. The list of tools is organised in two Excel sheets that provide information such as descriptions, expected effects, application, applicability, contact persons and links to websites with further information and demonstrations of the tool. In addition to the strategies and tactics mostly ready for use, the other Excel-sheet is for more innovative methods. Private partners in IWMPRAISE as well as other stakeholders and manufactures are currently developing these methods, some of which may become implementable in WP3-7 during the lifetime of IWMPRAISE.

Abbreviations

D	Deliverable
EC	European Commission
WP	Work Package
WT	Work Task
TRL	Technology Readiness Level

Contents

1 List of tools for implementation in WP3-7

The first version of the list of tools for inspiration and eventual implementation in WP3-7 was made in January 2018 (milestone 4). The list was then revised and extended in the period from January 2018 to October 2018 (milestone 5). CNR (Italy), SSSA (Italy), WUR (the Netherlands), RRES (UK), INRA (FR) & AU (DK) provided inputs to the list with the names of the specific contributors mentioned in a column named 'Contacts'. The list is organised in two Excel-sheets: one containing solutions for immediate or close to immediate implementation and one for more innovative technologies that still require development and testing before they can be implemented in practise. The methods and strategies listed are organised in columns with the titles: 1) Crop, 2) Crop specific, 3) WP relevance, 4) Strategy and implementation, 5) Short description, 6) Application (how and when to apply), 7) Expected effect on weeds, 8) Applicability, 9) TRL code, 10) Contact persons, 11) Links. Searches and sorting for solutions can be made from these columns. The lists are available for all partners on the internal collaborative workspace.

1.1 Methods and strategies for immediate implementation

For cereals more classic methods, such as stale seedbed, delayed sowing, manipulated seed rates, herbicide strategies with reduced inputs and mechanical weed control, have been proposed and are being implemented in WP3. Relay sowing of annual or perennial legumes as living mulches is particularly practised in durum wheat in Italy. For field vegetables, flame weeding and inter-row cultivation are easily implemented. In maize, band-spraying technology and herbicide strategies are applicable and a number of mechanical intra-row tools are suggested in the list, such as finger weeding, torsion weeding and ridging. For sugar beets, inter-row hoeing and flame weeding are applicable methods.

In addition to the directly implementable methods, there are a number of methods and strategies mentioned which requires moderate changes and investments to become applicable. For example, inter-row hoeing in cereals requires hoes capable of operating shares in narrow inter-row spaces including reliable steering technology to avoid severe crop injuries. The technology is purchasable, but probably not present as standard machinery on most farms.

1.2 Innovative solutions

The list contains several innovative methods under development by the private partners in IWMPRAISE including other stakeholders interacting with the project consortium of IWMPRAISE. Especially, the work on inter-row cultivation and band-spraying in maize in Italy by CNR and Maschio Gaspardo has already made significant progress. The prototype combining inter-row cultivation with band-spraying technology provided effective weed control (90%) in maize spraying only 10 cm wide bands. With further modifications, it seems that this technology can be introduced for practical use during the lifetime of IWMPRAISE.

Inter-row hoeing in narrow row crops can be implemented with current technologies, but the method is also listed in the folder with innovative tools. Shanks and shares can be improved to ease operation and intra-row weed growth remains a challenge because these weeds are not affected directly by the hoe. Different tactics and strategies are thus studied in WP2 to minimise the impact of intra-row weed growth on crop performance. A new shank and share design is part of the work on inter-row hoeing; a greater shank stiffness helps ensuring a correct position of the share and the share design minimises undesired sideward soil movement that may cause excessive soil covering of crop leaves (Fig. 1).

Robotic intra-row weeding in sugar beets is still in its infancy in many respects but progress is made in deep learning of sugar beet detection (Fig. 2) under various growing conditions. The first robotic intra-row weeding using a mechanical devise showed an encouraging performance (Fig. 2).

Work on cover crops and their termination is progressing in Italy, Denmark and Slovenia. Studies using roller crimpers (Fig. 3) for mechanical cover crop termination has shown promising results but further studies are needed before practical recommendations can be made. Especially more stability in effectiveness despite variability in soil type and weather conditions is needed.

Weed monitoring using sensors and aerial images are rather new technologies that may become implementable during IWMPRAISE. The first investigations were commenced recently, meaning that no results are available yet.

Herbicide resistance is an increasing problem and early detection of the problem is essential for minimising yield losses. A new kit for detecting non-target site resistance (NTSR) is available and its effectiveness for revealing NTSR in blackgrass populations is studied in Denmark, Italy and the Netherlands. Still, it is not ready for practice.

Figure 4. shows the IWM framework developed in WP1 (also presented in deliverable D1.1). The different methods listed in the list of tools are marked in red in the framework to illustrate the interaction between WP1 and WP2.

Fig. 1. A new shank and share for inter-row hoeing

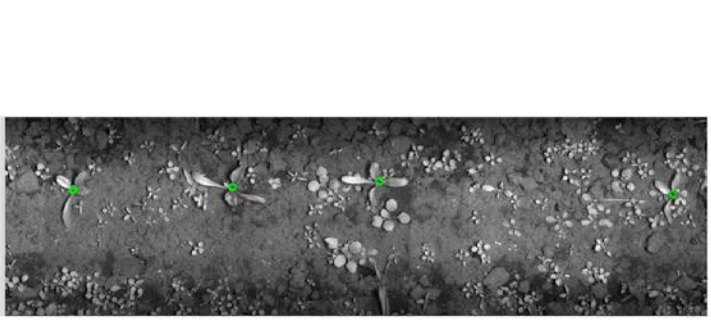

Fig. 2. Left: machine learning for the detection of sugar beet plants. Right: two rows of sugar beets recently weeded with the robotic intra-row weeder.

Fig. 3. A roller crimper with blades that can be adapted based on cover crop typology and biomass.

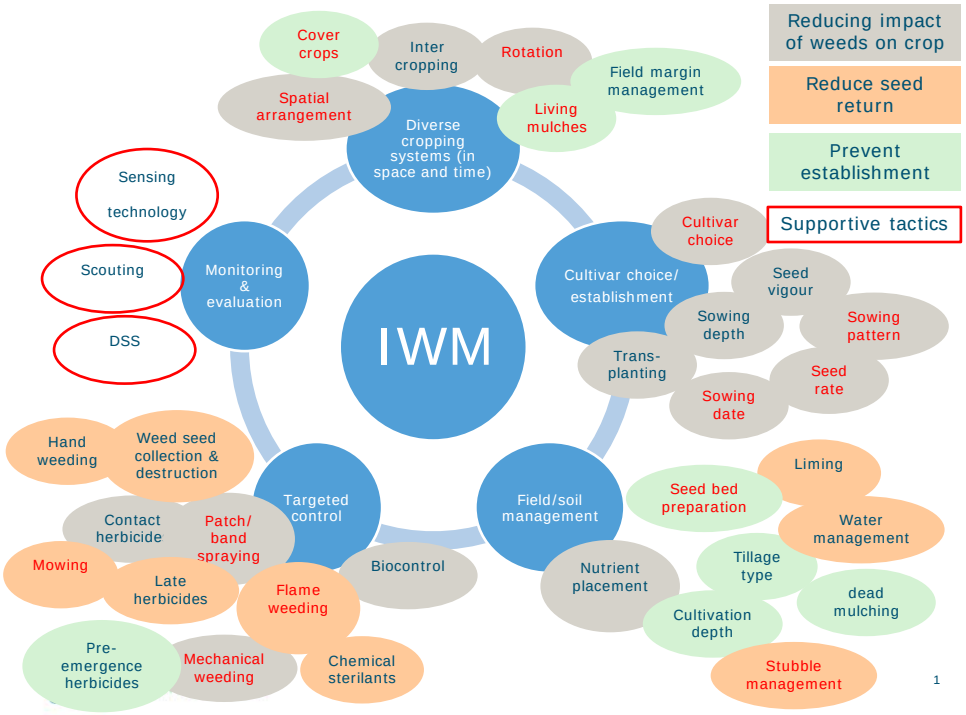

Fig. 4. Bubble-diagram from D1.1 (WP1) showing five pillars of Integrated Weed Management (blue) with examples of weed management tactics that can contribute to the reduction of weed pressure in a crop. Tactics marked in red have been added to the list of tools in WP2.