Practical guide

for the design of cropping systems less reliant on pesticides

Application in polyculture/mixed farming systems

Support sheets – Comprehensive programme

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE
MINISTÈRE DE L'AGRICULTURE DE L'AGROALIMENTAIRE ET DE LA FORÊT
Avec la contribution financière du compte d'affectation spéciale «développement agricole et rural»

Réseau Mixte Technologique Systèmes de Culture Innovants

endure® diversifying crop protection

ÉCOPHYTO
RÉDUIRE ET AMÉLIORER L'UTILISATION DES PHYTOS

Contents

List of abbreviations

The forms in this list are marked by the [a] sign in the text.

CMP	Crop management plan
COMIFER	Comité Français pour le développement de la Fertilisation Raisonnée (French committee for the development of rationalised fertilisation)
CS	Cropping system
CT	Conservation tillage
F	Farm
IC	Intercrop period
K	Potassium
N	Nitrogen
OM	Organic matter
P	Phosphorous
RSA	Revue Suisse Agricole (Swiss Journal of Agriculture)
TFI	Treatment Frequency Index

Programme summary

Step 1: Diagnosis of the initial situation
1.a. Overall performance of the farm
Objectives : → Understanding the overall objectives of the farmer for his farm → Understanding the farm's assets and constraints → Identifying the CS[a] of the farm and which should be improved first *Production of a diagnosis of the farm (Support sheet S1)*
1.b. Description of the cropping system to be improved
Objectives : → Characterise the CS[a] (crop sequence, CMPs[a]) and soil types → Become acquainted with the farmer's objectives and issues with the CS[a] *Description of the crop sequence* *Description of the CMPs[a] (Calculator - see Support sheet S2 for example)*
1.c. Evaluation of the initial cropping system
Objectives : → Evaluate the CS[a] , starting with predefined indicators to then be able to compare its performance with those of the proposed alternative systems *Multicriteria evaluation of the current CS (Calculator – see Support sheet S3 for example)*
Step 2: Co-design of alternative cropping systems
Objectives : → Identify with the farmer those agronomic levers already used in the current CS[a] at the rotation scale → Identify supplementary levers which could be interesting to use, according to the objectives
2.a. Considering the rotation
Identify those levers used at the rotation scale in the current CS[a] *Suggest supplementary levers for implementation (Support sheet S4)*
2.b. Considering the CMP
Identification of levers for implementation at the CMP scale in the current CS[a] *Suggest supplementary levers for implementation (Support sheet S5)* *Description of the CMP[a] for the CS[a] constructed (Calculator – see Support sheet S2 for example)*
Step 3: Evaluating alternative cropping systems compared with the initial cropping system
Objectives : → Evaluate the performances of alternative CS[a] compared with the initial CS[a] *Multicriteria and qualitative evaluation of the performances of the CS[a] constructed (Calculator – see Support sheet S6 for example)*
Step 4: Discussion of results
Objectives : → Discuss the introduction of alternative systems suggested for the farm

Support sheet S1 : Summary diagram for the diagnosis of the farm (Step 1a)

Date : **Farm :**

Priority tasks	Farmer's priorities	Milieu (soil/climate)

Workforce	Crop sequences		Local issues
	Crop sequence 1	**Crop sequence 2**	
	% on F: Crops: Most common planting method: ploughing/SCT/direct sowing	% on F: Crops: Most common planting method: ploughing/SCT/direct sowing	
Equipment/material	**Crop sequence 3**	**Crop sequence 4**	**Crop enemies**
	% on F: Crops: Most common planting method: ploughing/SCT/direct sowing	% on F: Crops: Most common planting method: ploughing/SCT/direct sowing	

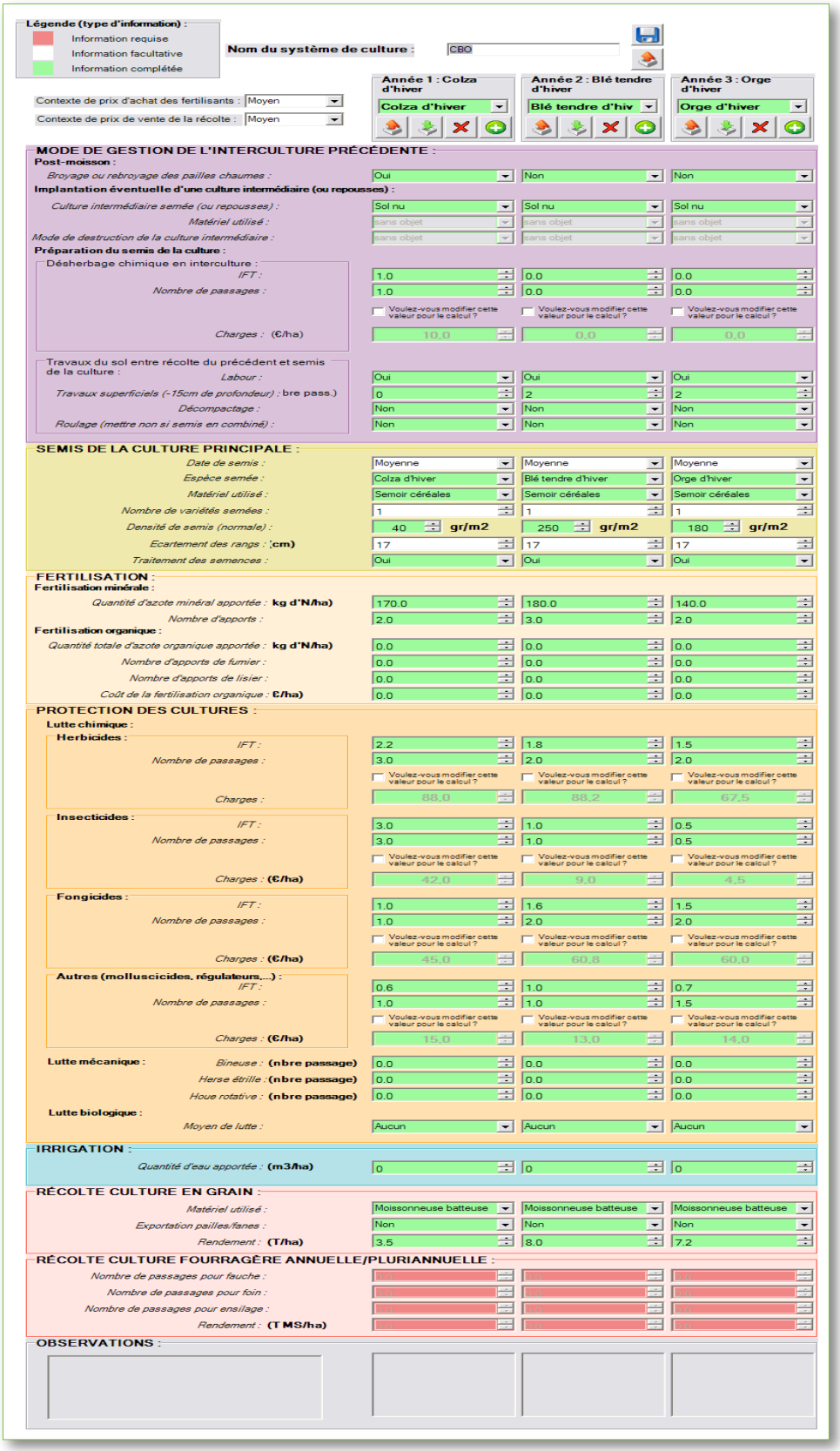
Location of fields	Production system	Technical-economic environment

(According to Capillon, Vogrincic et al.)
The diagram should be completed by highlighting the assets and constraints of the farm for each of the criteria above. A list of questions is supplied in Help sheet H1 for completing the table.

Support sheet S2 :

Description of the current CS (Step 1b)

For this programme the identification of practices is made directly in the calculator.
An example of the relevant sheet for practices is presented below, showing how it should be completed.



Support sheet S3 :
Evaluation of the current CS (Step 1c)

The evaluation for this programme is made with the help of the calculator. Below is an example of the results obtained.

Système de culture de référence :

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CBO	Oui	Colza d'hiver -> Blé tendre d'hiver -> Orge d'hiver

Systèmes de culture alternatifs : Ces flèches permettent de déplacer le système de culture sélectionné

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CBLBPB	Non	Colza d'hiver -> Blé tendre d'hiver -> Lin graine -> Blé tendr...

Résultats de l'évaluation : Evaluer les systèmes de culture

Pour les indicateurs surlignés en rouge :
Des paramètres rentrés par l'utilisateur ont été utilisés,
Le résultat obtenu n'est pas garanti

Comparaisons des systèmes de culture | CBO(Moyen/Moyen) | CBLBPB(Moyen/Moyen)

Indicateurs	unité	CBO (réf.)	CBLBPB (% à la réf.)
Traitement des semences	%	**100**	**100 (+ 0 %)**
IFT total		**5,8**	**3,8 (- 34,8 %)**
IFT herbicides		2,2	1,2 (- 43,8 %)
IFT insecticides		1,5	0,8 (- 44,4 %)
IFT fongicides		1,4	1,1 (- 18,3 %)
IFT autres		0,8	0,6 (- 19,6 %)
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Charges engrais	€/ha	190	155 (- 19 %)
Charges semences	€/ha	60	76 (+ 27 %)
Charges de mécanisation et de ...	€/ha	**274**	**292 (+ 7 %)**
Marge directe	€/ha	**181**	**285 (+ 57 %)**
Nombre de passages		**14,7**	**13 (- 11 %)**
Nombre de passages : Pulvérisation		7	4,7 (- 33 %)
Nombre de passages : travaux méca...		2,3	3,3 (+ 43 %)
Temps de passage	h/ha	**4,8**	**5,3 (+ 10,2 %)**
Temps de passage : Pulvérisation	h/ha	0,9	0,6 (- 33,3 %)
Temps de passage : travaux mécani...	h/ha	2,2	2,6 (+ 19,7 %)

Support sheet S4 :

Introduction of alternative solutions available for integrated crop management at the rotation scale (Step 2a)

To complete this table, refer to help sheet H3 for the characteristics of arable crops.

The objective of this table is to make it possible to rapidly see which practices have already been implemented by the farmer and those which could be used in alternative CS[a]. In no case is the objective to introduce all these levers in the CS[a]: according to the objectives and the constraints of the farmer, the task is to find a combination of practices to limit the pest pressure he is faced with.

Date : **Farm :**

			Implementation by the farmer					
Targets in the pest cycle	**Technical solutions available**	**Indicators**	**Implementation in current CS**		**Implementation in alternative CS 1**		**Implementation in alternative CS 2**	
			Rotation :		**Rotation :**		**Rotation :**	
			Probably yes	**Probably no**	**Probably yes**	**Probably no**	**Probably yes**	**Probably no**
Limit the presence of pests in general in the crops	Diversify families and species in the rotation to break the pest cycle, taking into account the time period before the return of crops and the possible precedents	Absence of precedents to be avoided						
Limit the presence of diseases in the crops	Diversify families and species in the rotation to break the pest cycle, taking into account the time period before the return of crops and the possible precedents	At least two different families						
		At least three different species cultivated						
		Respect for time period between same crop						
Limit the specialisation of weed flora and reduce the seed bank	Diversify families and species in the rotation for 'despecialising' weed flora	At least three sowing periods in four						
		Ratio of autumn crops to spring crops close to 2/3						
Reduce the population of animal pests in the field	Introduce a long fallow period one year in three to allow tillage	At least one long fallow period every three years						
Add nitrogen to the system	Introduce at least one leguminous crop into the rotation	At least ¼ of leguminous crop in the rotation						
Maintain level of OM in the soil	Sowing a grain crop returning straw at least one year in three	At least one grain crop returning straw every three years						
Trap nitrogen in the soil in winter period	Follow a leguminous crop by a winter crop with high N demand or, as a default, a cover crop	A leguminous crop followed by a winter crop with high N demand						
Maintain chemical fertility of soil	Alternate crops with high PK demand with less demanding crops	Less than 30% of crops with high P demand						
		Less than 30% of crops with high K demand						

Strategies concerned with crop protection

Support sheet S4 :
Introduction of alternative solutions available for integrated crop management at the rotation scale (Step 2a)

Remark :
The interactions which would take place during the introduction of these practices are not taken into account here. The effects of implementing these strategies on a given system depend on the soil and weather conditions in which the system is situated. Thus, the contribution of straw to the level of organic matter in the soil depends on the climate; in hot and wet climates, mineralisation of organic matter occurs faster.
Finally, it is important to consider tillage at the same time as the crop sequence. Indeed, the interaction between these two elements has an important role in the management of pests.

Support sheet S5 :

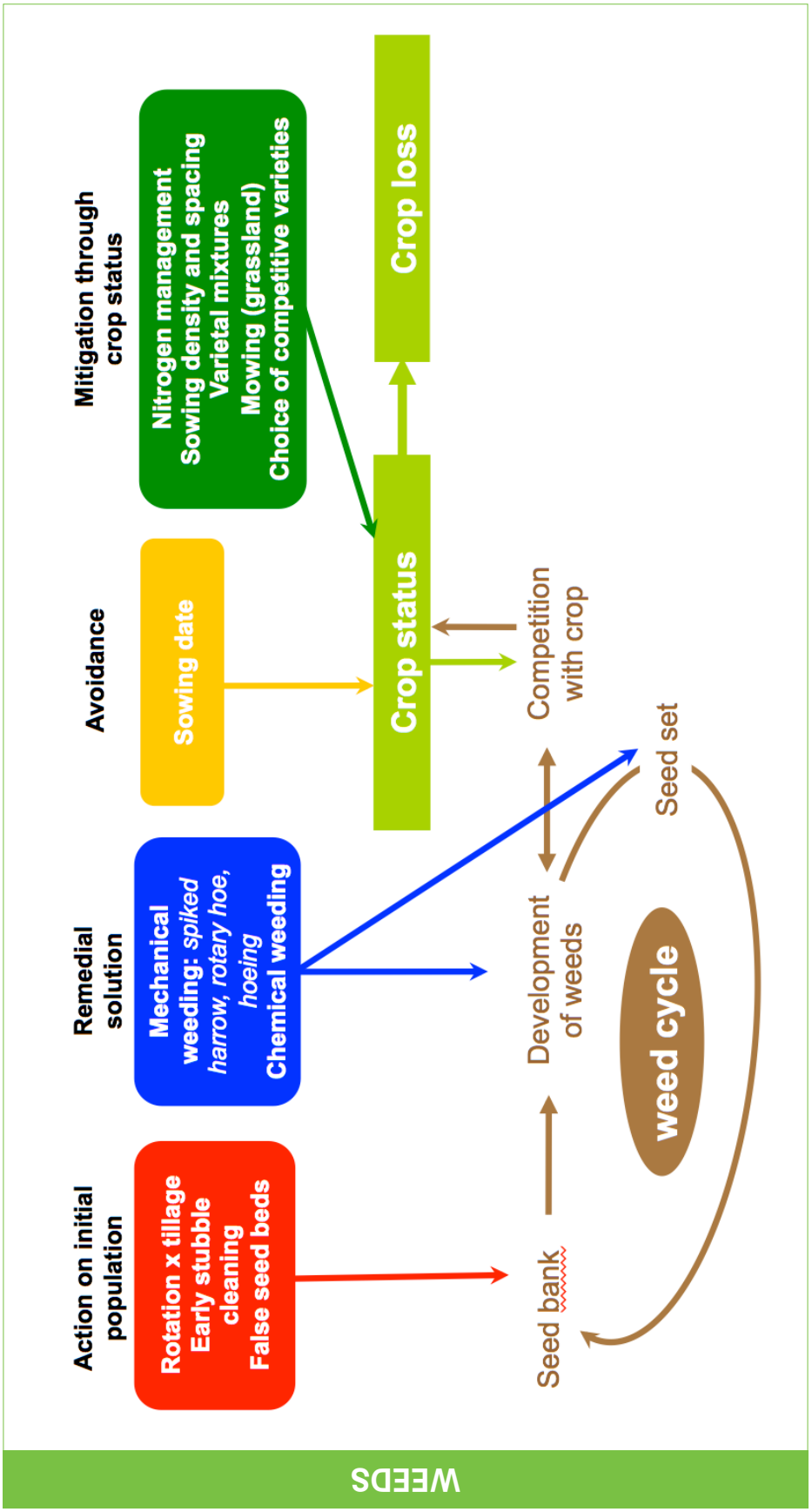
Mechanisms and introduction of alternative technical solutions available for crop protection at the CMP scale (Step 2b)

Farm :

Date :

The objective of this table is to make it possible to rapidly see which practices have already been implemented by the farmer and those which could be used in alternative CS[a]. In no case is the objective to introduce all these levers in the CS[a]: according to the objectives and the constraints of the farmer, the task is to find a combination of practices to limit the pest pressure he is faced with.

Interactions between practices, crop status and pest cycle for weeds



TO BE COPIED SEVERAL TIMES FOR USE IN THE IMPLEMENTATION OF THE PROGRAMME

Support sheet S5 : Mechanisms and introduction of alternative technical solutions available for crop protection at the CMP scale (Step 2b)

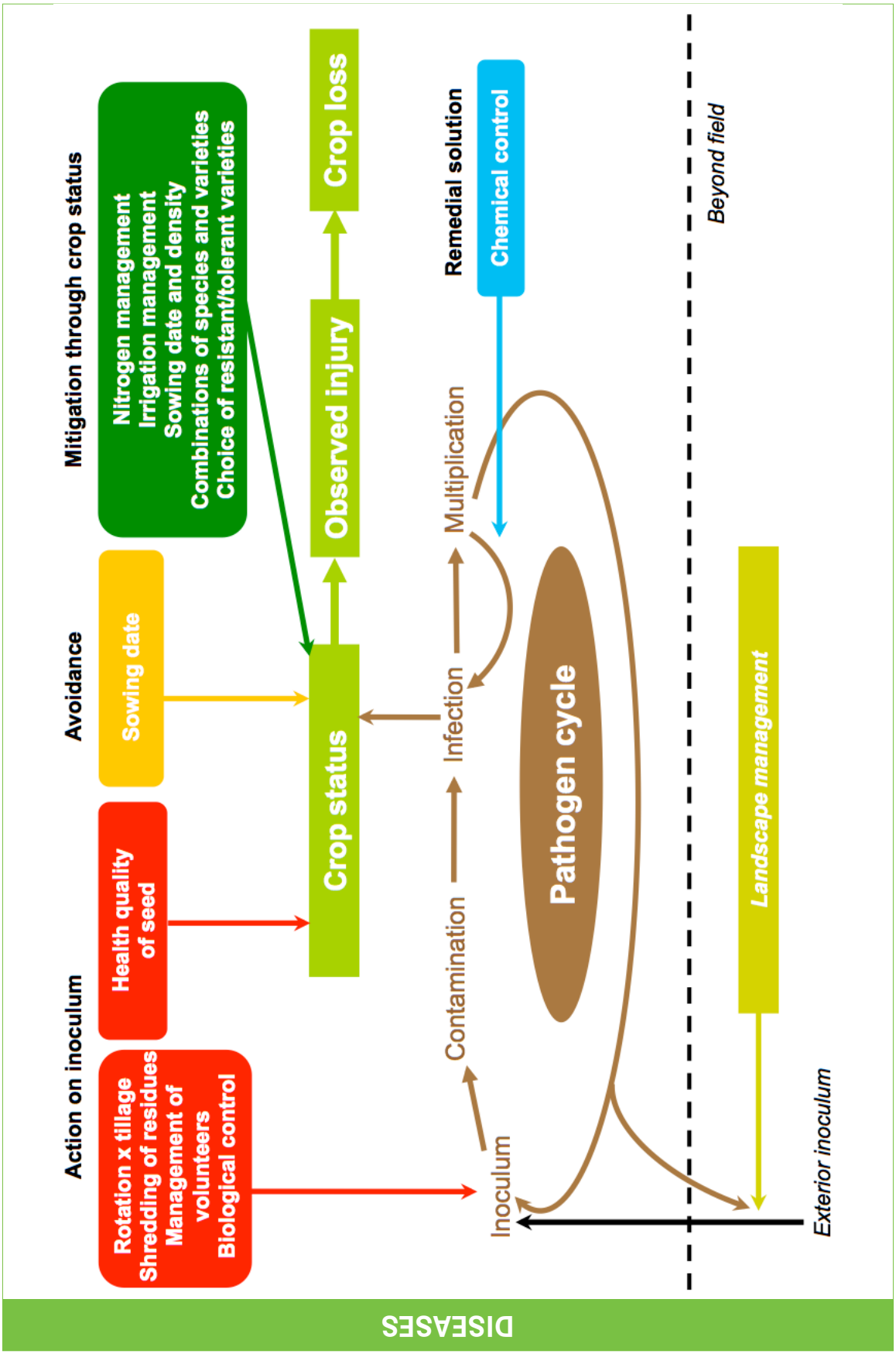
A. WEEDS

	Objectives	Technical solutions available	Implementation in current CS		Implementation in alternative CS1		Implementation in alternative CS2	
			Probably yes	Probably no	Probably yes	Probably no	Probably yes	Probably no
Limit observed injury	Reduce seed bank – break weed cycle	Diversification of the **crop rotation** (alternating sowing periods and growing methods, introduction of cover crops)						
		Tillage (stubble cleaning, ploughing etc.) – in conjunction with the crop rotation – to bury seeds						
		Stale seed beds: to germinate weeds						
	Destroy weeds	**Tillage** (stubble-cleaning, ploughing etc.)						
		Stale seed beds						
		Mechanical weeding						
		Use of cover crops						
	Avoiding external contamination	**Limiting contamination by equipment**						
Limit crop loss	Limit the periods when the plant is in competition with the weed	**Shifting sowing date**						
	Make the crop canopy competitive with weeds	**Adjustment of nitrogen inputs** to the production needs of the crop to encourage its development						
		Shifting sowing date						
		Increase sowing density, reduce spacing between rows						
		Combination of species and varieties						
		Choice of competitive varieties (according to their phenological characteristics)						

Support sheet S5 :

Mechanisms and introduction of alternative technical solutions available for crop protection at the CMP scale (Step 2b)

Interactions between practices, crop status and pest cycle for pathogens responsible for diseases



Support sheet S5 : Mechanisms and introduction of alternative technical solutions available for crop protection at the CMP scale (Step 2b)

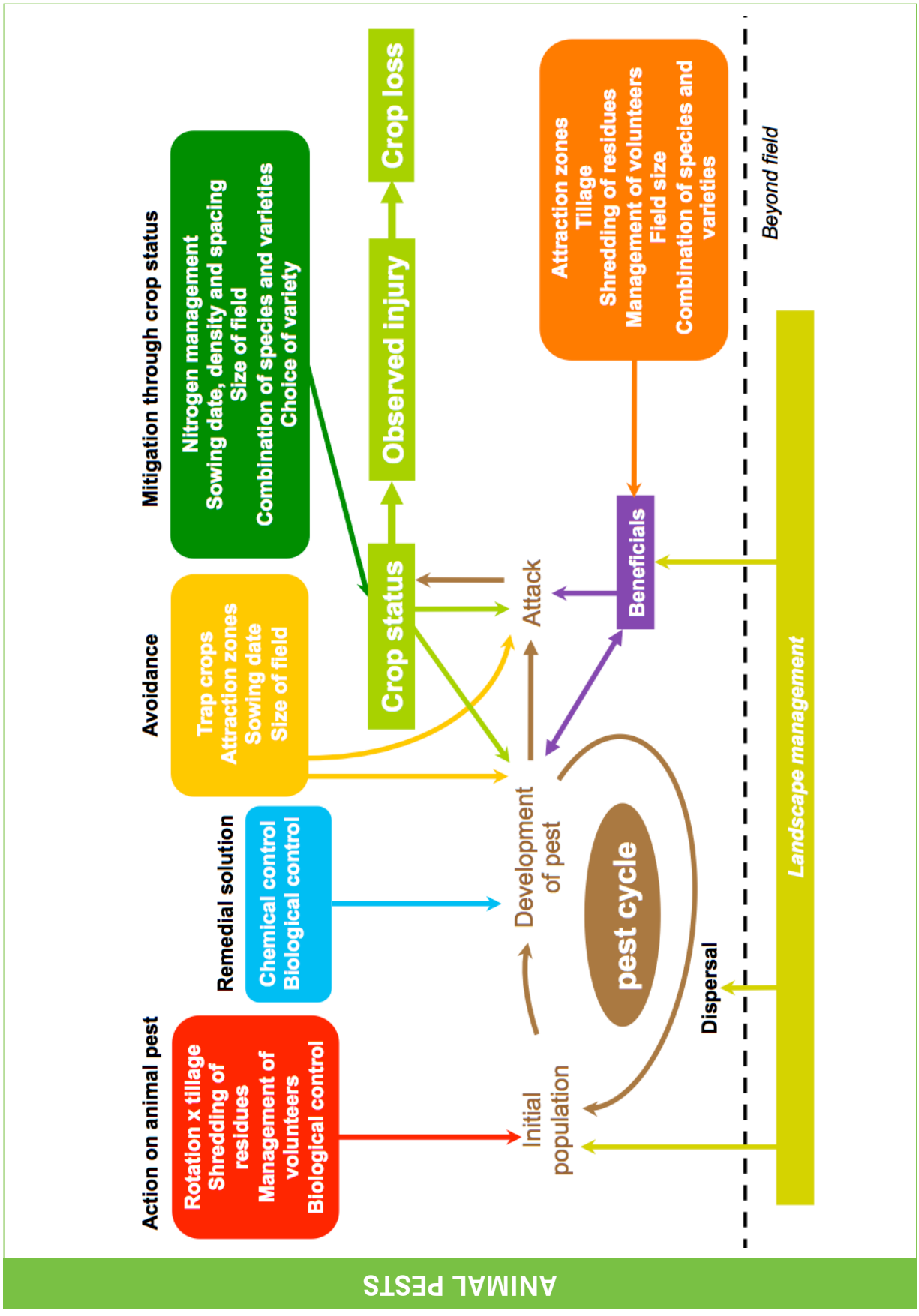
A. DISEASES

	Objectives	Technical solutions available	Implementation in current CS		Implementation in alternative CS1		Implementation in alternative CS2	
			Probably yes	Probably no	Probably yes	Probably no	Probably yes	Probably no
Limit observed injury	Reduce source of inoculum – break the disease cycle	Diversification of the **rotation** (diversification of crops, respect for recommended times before return of crop) => for soil-borne diseases						
		Tillage to bury crop residues – in conjunction with rotation => for diseases which can survive on residues						
		Shredding of crop residues => for diseases which can survive on residues						
		Destruction of volunteers and host weeds => for diseases which can survive only on living plants						
		Biological control						
	Avoiding external contamination	Choice of **uncontaminated seed**						
		Limiting contamination by equipment						
		Limiting dispersion between fields through **landscape management**						
	Limit contact surfaces between target crop and pest	**Adjustment of nitrogen inputs** to the production needs of the crop to limit over-development of foliar surfaces						
	Limit dispersion of the disease within the field	**Reduction of sowing density**						
		Combination of species and varieties						
	Create a microclimate unfavourable for disease development	**Reduction of sowing density**						
	Boost resistance of canopy to diseases	**Choice of resistant varieties**						
		Combination of varieties						
	Ensure the durability of resistance	**Combination of species and varieties**						
Limit crop loss	Increase the tolerance of the canopy to diseases	**Choice of resistant varieties**						
	Limit periods when plant is in contact with pest in contamination phase and thus vulnerable	**Shifting sowing date**						

Support sheet S5 :

Mechanisms and introduction of alternative technical solutions available for crop protection at the CMP scale (Step 2b)

Interactions between practices, crop status and pest cycle for animal pests



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A. ANIMAL PESTS

	Objectives	Technical solutions available	Implementation in current CS		Implementation in alternative CS 1		Implementation in alternative CS2	
			Probably yes	Probably no	Probably yes	Probably no	Probably yes	Probably no
Limit observed injury	Break the cycle of soil-borne pests (for example, nematodes)	Diversification of the **rotation** (alternating host and non-host crops)						
		Shredding of crop residues						
		Tillage in conjunction with rotation						
		Destruction of volunteers and weed hosts						
	Reduce pest populations	**Biological control**						
		Encourage beneficials through **landscape management** and by **limiting the use of pesticides**, through the **combination of species/varieties and through limiting field size**						
	Limit pest dispersal between fields	***Landscape management*** *(hedges, grass strips etc.)*						
		Creation of push/pull zones						
		Creation of trap crops						
	Limit periods when plant is in contact with pest	**Shifting sowing date**						
	Limit contact surface between target crop and pest	**Adjustment of nitrogen inputs** to the production needs of the crop to limit over-development of foliar surfaces						
		Reduction of sowing density						
		Combination of species and varieties						
	Boost resistance of canopy to pests	**Choice of resistant varieties**						
Limit crop loss	Boost tolerance of canopy to pests	**Choice of tolerant varieties**						
	Have a crop with low susceptibility to pests	**Assure a good level of nitrogen nutrition** so the plant is more vigorous						
	Limit periods when plant is in contact with pest in contamination phase and thus vulnerable	**Shifting sowing date**						

In italics, protection methods working at scales other than the field scale.

Support sheet S6 :

Evaluation of alternative CS (Step 3)

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