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DEXiPM Grapevine® (version 1.0), a tool for analysing the sustainability of grapevine cropping systems. DEXiPM Grapevine® data input manual

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DEXiPM Grapevine®

Version 1.0

A tool for analysing the sustainability of grapevine cropping systems

DEXiPM Grapevine® data input manual

DEXiPM Grapevine® designers

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Introduction

The DEXiPM (standing for DEXi Pest Management) multi-criteria evaluation model for cropping systems was originally designed as part of the ENDURE European Network of Excellence[1] for evaluating the sustainability of innovative arable cropping systems. Its adaptation for grapevine was initiated by the work of Delmotte and *al.* (2008). Based on this prototype, the first version of DEXiPM Vine was completed and validated for Mediterranean cropping systems (Aouadi, 2010). The model was then expanded in order to incorporate soil and weather conditions beyond the Mediterranean and to meet the sustainability issues specific to other wine regions. As part of the PURE European project[2], the economic and environmental branches of the tree have been perfected through collaborative work involving various European researchers (from France, Germany and Italy). These improvements were discussed at length during the PURE WP6 workshops that were held in Florence (22-23 June 2011), Bordeaux (6 October 2011) and Montpellier (18-19 October 2012).

DEXiPM Vine has been used by project partner teams to evaluate different integrated protection solutions in Mediterranean, Atlantic and continental contexts. DEXiPM Vine has also been parameterised for Burgundy, complete with input and user manuals, and used by the Vinipôle Sud Bourgogne to evaluate the sustainability of 20 cropping systems in the DEPHY network in Saône and the Loire over a two-year study period (Dubuc, 2013). The trajectories of seven other DEPHY network cropping systems in the Loire, Savoie and Var have been evaluated by the INRA unit in Dijon. Comparative evaluations on the sustainability of PURE experimentation on trial stations (as part of the EXPE programme of the DEPHY Ecophyto network) and on the farm (as part of the FERME programme) have been conducted to test the efficacy, practicality and relevance of integrated crop protection solutions in the major study areas.

DEXiPM Vine is a MDSS[3] which evaluates the contribution of cropping systems to the sustainability of farms for three pillars: economic, social and environmental. It functions on the basis of a detailed and transparent tree that aggregates simple information (number of cultural interventions, TFI etc.) to estimate complex variables (resources used, biodiversity of fauna etc.). Entirely qualitative, the model takes expert judgements (its 65 entries are described by qualitative classes such as *low*, *medium*, *high*, for example) from data, numerical or otherwise, converted into qualitative classes. The evaluation of the inputs (or 'basic criteria') requires no particular techno-economic references and uses no external model.

In this manual we provide a detailed description of the model inputs (the criteria to be specified by the user), their modalities (or 'qualitative classes') and the suggested method for using this information. There is also a summary of criteria where the thresholds for qualitative classes can be tailored to local practices (number of interventions for tillage, TFI etc.) if the model is to be used in an advisory capacity.

According to the criterion in question, the thresholds should be defined according to (i) official survey data of cultural practices (subject to availability), or (ii) expert opinion (table 1). It is important to fix a unique parameterisation for each region under study. In addition, only cropping systems evaluated with this parameterisation of the model and with the same production context can be compared in terms of sustainability. For any other use of DEXiPM Vine (for example, to compare the sustainability of experimentation conducted on trial stations), it is imperative to keep the initial setting of the model or their is a risk of creating a bias in the sustainability analysis.

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1 European Network for the Durable Exploitation of crop protection strategies http://www.endurenetwork.eu/fr/

2 Pesticide Use-and-risk Reduction in European farming systems with Integrated Pest Management http://www.pure-ipm.eu/project

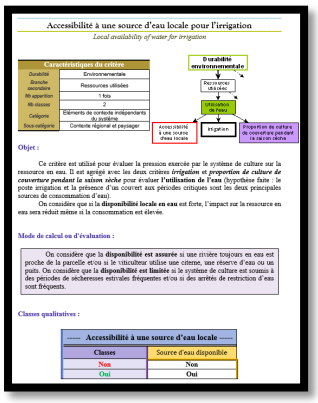
3 MDSS: Multicriteria Decision Support System

Table 1. Basic criteria for which thresholds could be tailored to local practices

Basic criterias	Qualitative classes	Burgundy thresholds
TFI of fungicides	high, medium, low, none	high : > 15, medium : [11-15], low :]0-11[, none
TFI of herbicides	high, medium, low, none	high : > or equal à 1,5, medium :]0.5-1,5], low :]0-0.5], none
TFI of insecticides	high, medium, low, none	high : > 3, medium :]1-3], low :]0-1], none
Total pesticide TFI	very high, high to medium, medium to low, low, none	very high : >20, high to medium :]15-20], medium to low:]12-15], low : =<12, none
Mineral K fertilizer applications	high, medium, low, none	high: >60 kg/ha K2O per year, medium: 30-60 kg/ha K2O per year, low: <30 kg/ha K2O per year, none
Mineral P fertilizer applications	high, medium, low, none	high: >=0,5 kg/ha P2O5 per year, medium:]0,2-0,5[kg/ha P2O5 per year, low:]0-0,2] kg/ha P2O5 per year, none
Mineral N fertilizer applications	high, medium, low, none	high: > 30 kg/ha, medium: 10-30 kg/ha, low: <10 kg/ha, none
Mowing	high, medium, low, none	number of mowing : high: =>3, medium >= 2, low :]2, 0[, none
Superficial tillage	high, medium, low, none	high >2, medium =2, low=1, none
Undervine tillage	high, medium, none	high: >1 medium =1, none
Pruning operations (with machinery)	high, medium, low, none	high : >=4 per year, medium : 3 per year, low : <3 per year; nonee taille mécanisée
Number of manual operations	high, medium, low, none	high : > 12 per year, medium : de 8 à 12 per year, low : < 8 per year, none
Number of mechanized operations	high, medium, low	high : > 20 per year, medium : 18-20 per year, low : < 18 per year
Total number of treatment operations (fertilizers and pesticides)	high, medium, low	high : >12 per year, medium : [10-12] per year, low : <10 per year
Evenness of workload distribution *"surface area/number of permanent employees" by specific group (ex : cooperative wineries group, private wineries group, ...)*	surface area/number of permanent employees = … for cooperative wineries's group, … for private wineries's group	surface area/number of permanent employees = 6,2 for cooperative wineries's grorp, 3,8 for private wineries's grorp
Physical difficulty and disturbance *Level of TFI fungicides under which one wine-grower/owner could be stressed du to the risk*	TFI fungicides hich one wine-grower/owner could be stressed du to the risk = …	TFI fungicides hich one wine-grower/owner corld be stressed du to the risk = 9
Access to inputs	average distance from wineries to distributors = … km	10-20 km

Presentation of criteria and indicator sheets

All the inputs specified by the user are successively described with the help of sheets which bring together the following information:


Accessibilité à une source d'eau locale pour l'irrigation

Local availability of water for irrigation

Caractéristiques du critère	
Durabilité	Environnementale
Branche secondaire	Ressources utilisées
Nb apparition	1 fois
Nb classes	2
Catégorie	Eléments de contexte indépendants du système
Sous-catégorie	Contexte régional et paysager

Objet :

Ce critère est utilisé pour évaluer la pression exercée par le système de culture sur la ressource en eau. Il est agrégé avec les deux critères ***irrigation*** et ***proportion de culture de couverture pendant la saison sèche*** pour évaluer **l'utilisation de l'eau** (hypothèse faite : le poste irrigation et la présence d'un couvert aux périodes critiques sont les deux principales sources de consommation d'eau).

On considère que si la **disponibilité locale en eau** est forte, l'impact sur la ressource en eau sera réduit même si la consommation est élevée.

Mode de calcul ou d'évaluation :

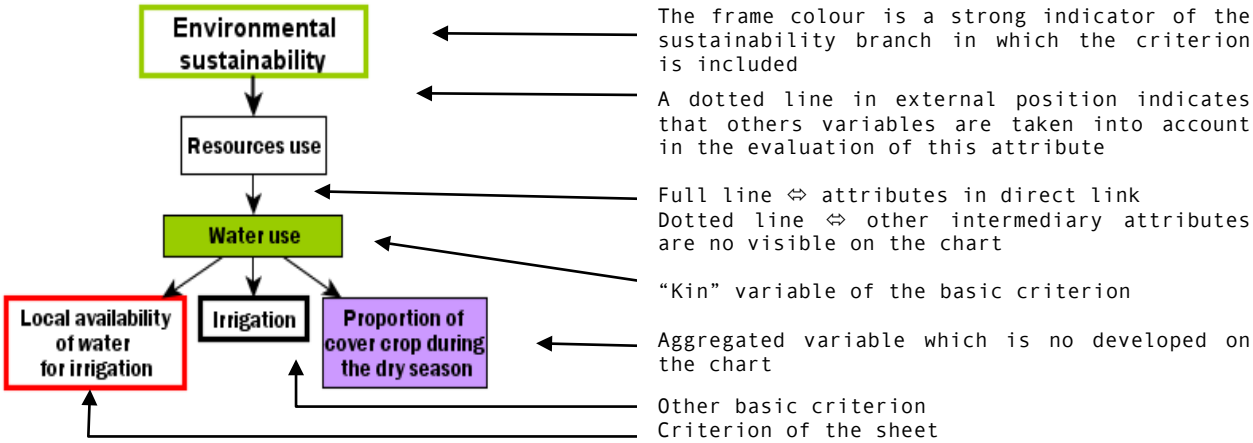
On considère que la **disponibilité est assurée** si une rivière toujours en eau est proche de la parcelle et/ou si le viticulteur utilise une citerne, une réserve d'eau ou un puits. On considère que la **disponibilité est limitée** si le système de culture est soumis à des périodes de sécheresses estivales fréquentes et/ou si des arrêtés de restriction d'eau sont fréquents.

Classes qualitatives :

------ Accessibilité à une source d'eau locale ------	
Classes	Source d'eau disponible
Non	Non
Oui	Oui

- Name of the criteria (or attribute)
- Criterion characteristics (main/sub-tree affiliation, number of appearances, number of qualitative classes, criterion category, sub-category)
- Objective of the criterion (what it is about)
- Calculation or evaluation method
- Qualitative classes (initial or calibrated)
- One or more comments (optional)
- One or more bibliographic references (when available).

A graph illustrate the place of the criterion in the tree view. The style of the chart is explained below.



The criteria are presented logically, in the order in which the user enters the information in an Excel file which serves as the interface for populating the system.

Basic criteria, DEXiPM Grapvine® V1.0

Classification of model inputs
Contextual factors independent of the system
Agro-climatic context
Regional and landscape context
Economic and social context of the farm
Cropping system factors
Crop protection
Fertilisation
Soil maintenance (tillage, weeding)
Other pratices
Variables describing the overall cropping system
End product
Contextual factors dependent on the system
Bio-climatic factors
Equipment
Access to knowledge
Subsidy (or subsidies)
Production and products
Societal evaluation of viticulture

➔ Contextual factors independent of the system

These inputs describe the context of the study and are independent of the cropping system. In the case of a comparison between systems or the evaluation of systems derived from databases, these criteria may be fixed to reference values.

➔ Cropping system factors

These criteria describe the agricultural practices and the desired end product. They provide information on the grower's production strategy.

➔ Contextual factors dependent on the system

These factors are used to evaluate the compatibility of the cropping system with its economic environment (ex: compatibility of production with certification requirements), social environment (ex: work-life balance, societal acceptance of the strategy) and environmental situation (ex: risk of soil compaction, risk of pesticide drift).

Summary of model inputs

Below is the list of 65 model inputs with:

- in red, *those which are classed by qualitative thresholds and can be adapted to local practices*;
- in green, those which are *evaluated through specific data for each production area (such as the number of labour units per hectare, for example).*

- Soil fragmentation risk due to context
- Run-off risk due to context
- Hydromorphic soil
- Leaching risk (soil and climate)
- Availability of uncropped land
- Local availability of water for irrigation
- Hedges
- Farmer and employees knowledge and skills
- Financial security of the farm
- (TFI of fungicides)
- TFI of herbicides
- Quantity of herbicide active ingredient applied
- (TFI of insectides)
- Total pesticide TFI
- Pesticide pollinators eco-toxicity
- Pesticide beneficials eco-toxicity
- Pesticide aquatic eco-toxicity
- Pesticide earthworms eco-toxicity
- Pesticide use risk
- Mating disruption
- Alternative plant protection products
- Mineral K fertiliser applications
- Mineral P fertiliser applications
- Organic amendments
- Mineral N fertiliser applications
- Coverage of crop nitrogen requirement
- % area covered
- Period covered
- Cover crop
- Flower strips
- Mowing
- Superficial tillage
- Undervine tillage
- Pruning operations (with machinery)
- Vine shoot management
- Irrigation
- Grape harvest
- Number of manual operations
- Number of mechanised operations
- Total number of treatment operations (fertilisers and pesticides)
- Evenness of workload distribution
- Physical difficulty and harshness of work
- System complexity
- Product quality
- Certification
- Marketing strategy
- Risk of mycotoxin contamination
- Risk of pesticide residues in product
- Expected yield
- Risk of losses due to biotic factors
- Risk of losses due to abiotic factors
- Requirement for agricultural equipment
- Compaction risk (pedoclimatic + operations)
- Risk of pesticide drift (spray machinery)
- Availability of relevant advice for the strategy from public or private consultants
- Availability of relevant information from other farmers
- Direct subsidies in support of the strategy
- Access to inputs
- Compatibility with quality requirements other than health
- Compatibility with certification requirements
- Access to output market
- Job satisfication
- Social accessibility of product for consumers
- Acceptability of the strategy by society
- Landscape quality

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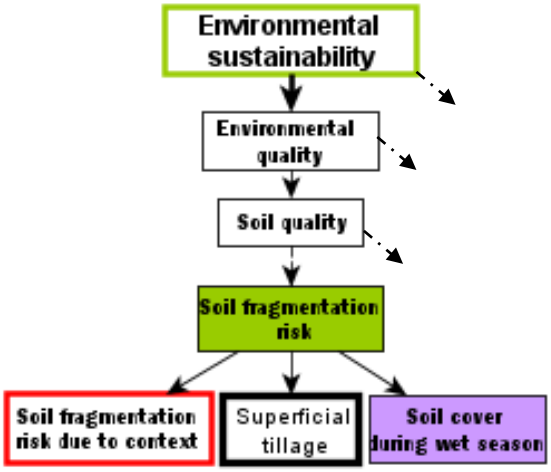
Soil fragmentation risk due to context

Criterion characteristics	
Sustainability	Environmental
Secondary branch	Environmental quality
No. appearances	Once
No. classes	3
Category	Contextual factors independent of the system
Sub-category	Agro-climatic context



Objective

This criterion is used to assess the sensitivity to soil erosion, which is dependent on both climatic and soil factors.
Soil erosion is a phenomenon which has worsened in recent decades due to changes in soil maintenance practices (weeding), the destruction of hedgerows and the lengthening of vine rows (Rochard, 2005). It corresponds to the detachment, transportation and deposition of soil particles under the usually combined action of wind, rain and run-off. In the long term, the loss of earth (mainly fine particles) can be highly detrimental because it leads to decreases in soil fertility and contributes to the transfer of pollutants into aquatic environments (pesticides, phosphorus, suspended particles, etc.). This is why it must be taken into account when considering practices.

The universal equation for soil loss combines the variables under six major factors (Wischmeier and Smith, 1965):

$$Xa = R\,K\,L\,S\,C\,P$$

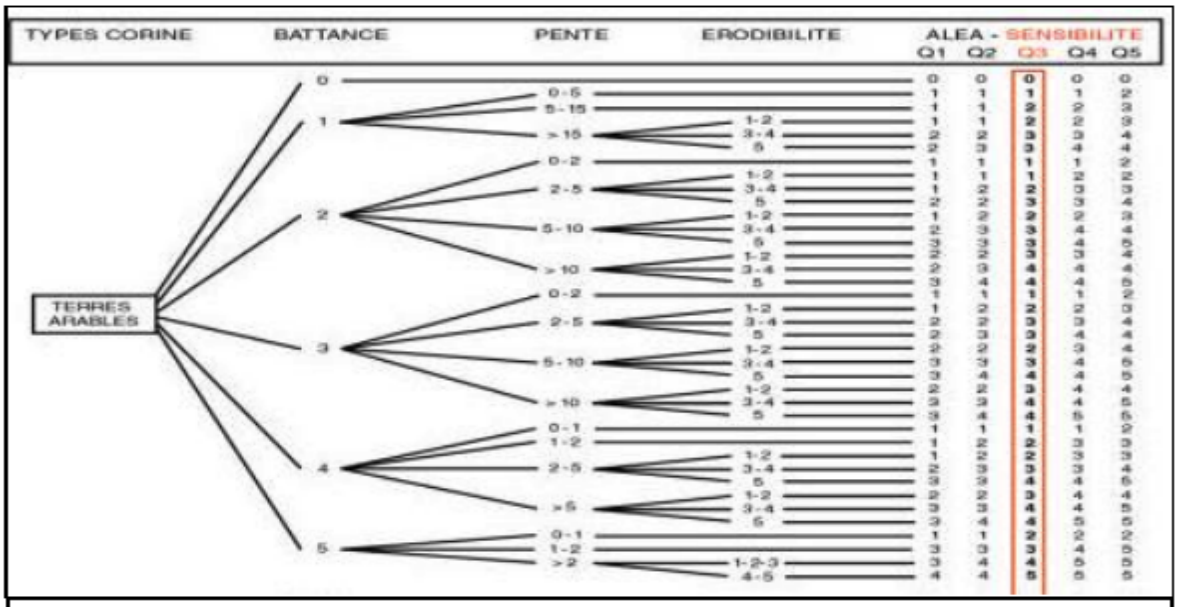
With:
Xa = average annual soil loss (t.ha-1.an-1)
R = rainfall erosivity factor (MJ.mm.ha-1.h-1.an-1), as a function of the intensity and frequence.
K = soil erodibility factor (t.ha-1.MJ-1.mm-1.ha.h), as a function in particular of the soil's texture and organic matter content.
LS = topographic factor depending on the slope and length.
C = cropping management factor, including cropping practices.
P = conservation and layout factor, for example, rows following contour lines (which reduces run-off).

Calculation or evaluation method:

Since the presence of plant cover on the soil during at-risk seasons (in other words, seasons with high rainfall) and that the practice of tilling the inter-row corresponding to other entries aggregated to this criterion, the risk assessment cannot use the universal soil loss equation.

It is possible to refer to the MESALES model to estimate water erosion of soils for arable land (Le Bissonnais *et al*, 1998; Le Bissonnais *et al*, 2002) (Figure 1). This model integrates the erosion parameters (soil erodibility, crusting, slope and rainfall erosivity) in a logical tree hierarchy and weights the classes of these parameters. The sensitivity of the environment to erosion is qualified by the value of a 'Hazard-Sensitivity' coefficient according to the following classes: (1-2 = low, 3 = average, 4 = < high).

The evaluation of this risk is based on data obtained through this model at the commune scale. In France, this data can be found on the site of the Géoïdd tool: (http://geoidd.developpement-durable.gouv.fr/geoclip_stats_o3/index.php?profil=FR#v=map1;l=fr), 'soil and sub-soil/erosion' section. However, due to the model's lack of precision at this scale, it is recommended that the risk assessment is supported by more accurate soil data (at least 1/250,000). Moreover, as the sustainability analysis is conducted at the scale of the farm and the plots are often highly fragmented, we will focus on the most representative plots of the cropping system. If they are located in different municipalities, the expert will have to decide on the risk which appears to him to be the most relevant to the system under test.



Légende :

- La battance et l'érodabilité sont estimées par une note de 1 à 5 (0 = sensibilité nulle et 5= sensibilité forte).
- La pente est estimée en %.
- L'intensité et la hauteur des précipitations sont estimées de Q1 à Q5 (Q1 : indice de précipitation faible et Q5 : indice de précipitation élevée)
- La sensibilité est estimée de 1 à 5 (1= très faible et 5 = très fort).

Figure 1: 'Arable land' module of the model for the evaluation of water erosion of soils in France (Le Bissonnais *et al*, 2002)

----- Soil fragmentation risk due to context -----	
Classes	'Hazard-Sensitivity' coefficient from the MESALES model
High	**>= 4**
Medium	**= 3**
Low	**= 1-2**

Source: V. Antoni, Ministry of Ecology, Sustainable Development and Energy

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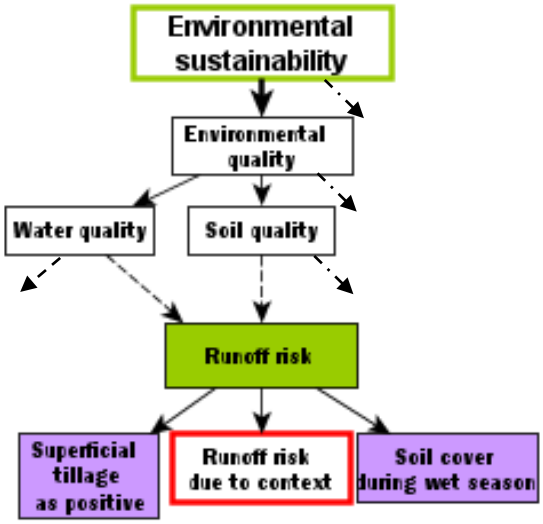
Run-off risk due to context

Criterion characteristics	
Sustainability	Environment
Secondary branch	Environmental quality
No. appearances	Twice
No. classes	3
Category	Contextual factors independent of the system
Sub-category	Agro-climatic context



Objective:

This criterion evaluates the run-off potential of plots in the system by considering their soil and topographic features. This potential is a function of (i) the slope, as we know that even a gentle slope can generate run-off; (ii) the state of the soil surface including the presence of crusting; (iii) infiltration problems due to hydromorphic soil at shallow depths. The existence of vegetative cover during high-risk seasons, tillage practices and methods used to prevent water from entering the plots are not taken into account in the assessment of this criterion since they come under production strategy.

It should be recalled that run-off drives water erosion of soils. It corresponds to the gravity flow of water to the soil surface due to precipitation (Le Bissonnais *et al*, 2002). The infiltrability of a soil is defined by its ability to be penetrated by water and convey that water into a pore space which initially contained no water (Hillel, 1974). This depends on its porosity and water content.

Two main types of run-off have been observed (Ambroise, 1999): Hortonian run-off, where the infiltration capacity of the soil has been exceeded, and run-off on a saturated surface, where soils are saturated before precipitation. The first type is particularly found in cases where the soil surface is sealed, notably when crusting has occured. The second, heavily influenced by the total rainfall, is found alongside water courses and in hydromorphic soil.

Calculation or evaluation method:

The evaluation is made according to the decision chart (
Table 2) offered in the manual for calculating viti-environmental indicators using the INDIGO® method (Thiollet-Scholtus & Bockstaller, 2015). The chart has been reworked so as not to take into account soil cover (C. Bockstaller, personal communication): only situations with a soil cover of 33% are retained (33 % signifies that only the vine provides soil cover)

Table 2: Construction of the variable for run-off potential as a function of slope and plot texture.

Slope	Soil cover*	Sandy [a]	Loam Crusting		Clay [b] Hydromorphic	
			No	Yes	No	Yes
<1 %	33%	0,07	0,07	0,07	0,07	0,23
1-5 %	33%	0,43	0,57	0,73	0,57	0,73
5-15 %	33%	0,73	0,83	1	0,83	1
> 15 %	33%	0,73	0,83	1	0,83	1

[a]= classes "sandy" and "sand/clay"

[b]= classes "heavy clay", "clay", "silty clay" and "sandy clay"

*33% soil cover signifies that only the vines in the rows provide soil cover. All inter-rows are weeded chemically or worked mechanically.

Source : Manual for calculating viti-environmental indicators using the INDIGO® method (Thiollet, 2003)

Qualitative classes

-----Risk of run-off due to context---	
Classes	Run-off potential
High	**>= 0,7**
Medium	**[0,3; 0,7[**
Low	**< 0,30**

Source: on the basis of distributed values

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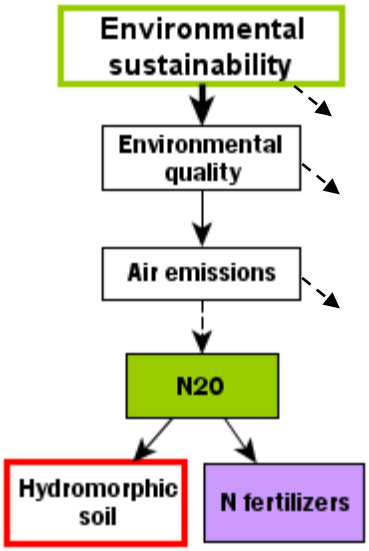
Hydromorphic soil

Criterion characteristics	
Sustainability	Environmental
Secondary branch	Environmental quality
No. appearances	Once
No. classes	2
Category	Contextual factors independent of the system
Sub-category	Agro-climatic context



Objective:

Hydromorphy is the morphological manifestation of waterlogging of the soil at a certain time of year (temporary engorgement) or permanently (plots near water courses). Water saturation at different depths makes soils asphysixiating and reductant. The oxidation-reduction reactions of iron are a consequence. As for soil biological activity, this is significantly modified and some processes, such as denitrification, are strongly amplified in such conditions (Fortino *et al*, 2007a). Investigating soil waterlogging allows us to indirectly estimate the nitrous oxide emission intensity (N_2O) whose main source is the activity of micro-organisms in the soil (Yulipriyanto, 2001).

Calculation or evaluation method:

No sufficient soil indicator exists to confirm whether a soil has hydromorphic traits. Therefore, only the expert will be able to judge this criterion according to his own diagnosis, based on practical experience.
However, some indicator plants and certain observable marks on soil profiles bear witness to more or less prolonged saturation with water. While it is clear they are in no case sufficient to confirm the presence of hydromorphic soil, they are useful in guiding our thinking.
These are:

- Rust marks (iron in its oxidised state Fe^{3+}) ⇔ unsaturated soil, water table which regularly rises.
- Blue/grey to green staining (iron in its reduced state Fe^{2+}) ⇔ anoxic soil conditions.
- Black concretions from ferromagnetic precipitation.

(*Delaunois et al., 2008)*

Indicator plants: horsetail, *Aristolochia* or round-leaved mint.

Note: Poorly drained soil (when pools of water can be observed) is considered hydromorphic.

Qualitative classes:

----- Hydromorphic soil -----	
Classes	**Hydromorphic traits**
Yes	**Presence**
No	**Absence**

Bibliography:

Bockstaller, C. et P. Girardin (2008a). Mode de calcul des indicateurs agri-environnementaux de la méthode INDIGO®. Colmar, UMR Nancy-Université-INRA Agronomie et Environnement Nancy-Colmar.

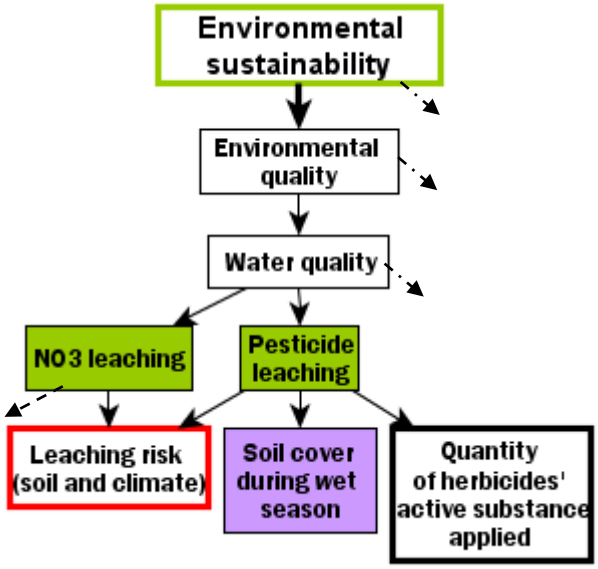
Delaunois, A., Y. Ferrie, *et al.* (2008). Guide pour la description et l'évaluation de la fertilité des sols, Chambre d'agriculture du Tarn.

Fortino, G., E. Lô-Pelzer, *et al.* (2007a). Presentation of the updated version of DEXiPM arable crops. A qualitative multi-criteria model for the assessment of the sustainability of pest management systems, INRA, Deliverable DR2.22a.

Yulipriyanto, H. (2001). Emission d'effluents gazeux lors du compostage de substrats organiques en relation avec l'activité microbiologique (nitrification/dénitrification), UMR 6553 "ECOBIO" CNRS - Université de Rennes1.

Leaching risk (soil and climate)

Criterion characteristics	
Sustainability	Environmental
Secondary branch	Environmental quality
No. appearances	Twice
No. classes	2
Category	Contextual factors independent of the system
Sub-category	Agro-climatic context



Objective:

This parameter evaluates the risk of leaching based on soil and climate characteristics. This depends on a combination of factors such as soil texture, depth, stoniness (which affects the soil's water storage capacity) and annual rainfall. The drainage indicator (DI) (Table 2) is relevant for estimating this risk. It corresponds to the ratio of winter rainfall to the soil's water storage capacity (Corpen, 2006). His equation is:
DI = winter rainfall (mm) / average soil water storage capacity (SC).
It therefore provides a basis for reflection on deciding whether or not there is a risk (for example, high rainfall and low water storage capacity).

Calculation or evaluation method:

The assessment takes into account those soil and climatic factors which favour the leaching of pesticides (the parameters for cover or crop, such as uptake of nitrogen by the vine or vegetative cover are considered in other criteria). We first estimate the soil's SC, then bring in winter rainfall to this figure to provide a soil drainage index.
The tables allow us to obtain (i) the value of DI (**Table 4**) and (ii) the orders of magnitude of soil SC (**Table 4**,

Table 5**)**. To refine the estimated SC, we must take into account the volume of soil occupied by stones and the depth of roots (Tableau 6). Note: in viticulture, the idea of crop rotation does not exist; to calculate the SC, we therefore use the root depth of the

Table 3 : Drainage index as a function of the soil's average water storage capacity and winter rainfall

	Dry winter (rainfall = 200 mm)	Wet winter (rainfall = 600 mm)
SC (50mm)	DI = 3.6 Medium	DI = 9 High
SC (150mm)	DI = 1.2 Low	DI = 3 Medium

Source: deliverable ENDURE_2.22.PDF

Table 4: Classification of soils as a function of their depth

Type of soil	Soil depth
Superficial	< 60cm
Average	60-90cm
Deep	90-120cm
Very deep	> 120cm

Source: Bockstaller and Girardin (2008),

Table 5 : Estimation of soil's water storage capacity as a function of its depth and texture

	Texture					
Depth of soil	**Sandy**	**Sand/clay**	**Loam**	**Clay/sand**	**Clay/loam**	**Clay**
Superficial	25	40	45	50	50	55
Average	50	80	90	95	100	105
Deep	75	120	135	145	150	155
Very deep	100	160	180	190	200	205
Drained	75	120	135	145	150	155

Source: Fortino et al, 2007

Tableau 6 : Estimation of soil's water storage capacity as a function of its texture, depth of crop's root system and volume of stones

	Depth of crop's root system								
	Low: 35cm			Average: 70cm			High: 100cm		
	Volume occupied by stones (%)			Volume occupied by stones (%)			Volume occupied by stones (%)		
Principal texture	**0**	**0-20**	**>20**	**0**	**0-20**	**>20**	**0**	**0-20**	**>20**
Sand	50	40	30	100	80	60	140	120	80
Loam	100	90	60	200	180	120	300	240	180
Clay	120	100	60	240	200	140	340	300	200

Source: COMIFER (2002).

Qualitative classes:

----- Leaching risk (soil and climate) -----	
Classes	Drainage index
High	>= 7
Medium to low	< 7

Source: document « DEXiPM_Grapevine_inputs_october2012 »

Bibliography:

Bockstaller C., Girardin P., 2008. Mode de calcul des indicateurs agri-environnementaux de la méthode INDIGO®, p. 115.

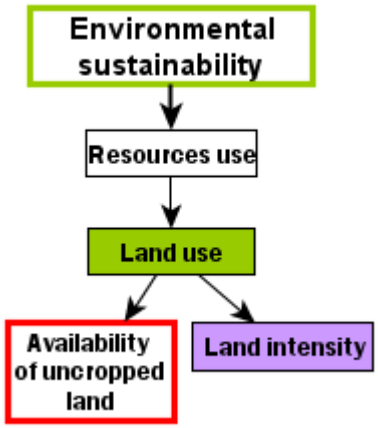
COMIFER (2002). Lessivage des nitrates en systèmes de cultures annuelles. Diagnostic du risque et propositions de gestion de l'interculture. Rapport COMIFER, Groupe Azote.

Corpen (2006). Des indicateurs Azote pour gérer des actions de maîtrise de pollutions à l'échelle de la parcelle, de l'exploitation et du territoire. Rapport du Comité d'Orientation pour des Pratiques Agricoles Respectueuses de l'Environnement.

Fortino, G., E. Lô-Pelzer, *et al*. (2007a). Presentation of the updated version of DEXiPM arable crops. A qualitative multi-criteria model for the assessment of the sustainability of pest management systems INRA, Deliverable DR2.22a 111. http://www.endure-network.eu/endure_publications/deliverables

Availability of uncropped land

Criterion characteristics	
Sustainability	Environmental
Secondary branch	Resources used
No. appearances	Once
No. classes	2
Category	Contextual factors independent of the system
Sub-category	Regional and landscape context



Objective:

This criterion provides information on the possibility of using a greater production area (sometimes in a context where there is increasing urban pressure) to maintain the same harvest volume if the system introduced is likely to provide lower yields. But even though "the vine better resists urban pressure" compared to other agricultural products (Peres, 2007), it must nevertheless face land pressure (Bourdon, 2009).

In emerging wine-producing countries, land resources to increase the size of vineyards are not yet limited, but they have become very rare in the areas of Protected Designation of Origin and Protected Geographical Indication in European vineyards (P. Spiegel-Roy, 2000).

It is therefore essential to take this criterion into account in certain regions as it can be a major obstacle to the adoption of innovative cropping systems with low yields.

Calculation or evaluation method:

Consult with the wine-grower

Qualitative classes:

----- Availability of uncropped land -----	
Classes	Agricultural land available
No	**No**
Yes	**Yes**

Bibliography:

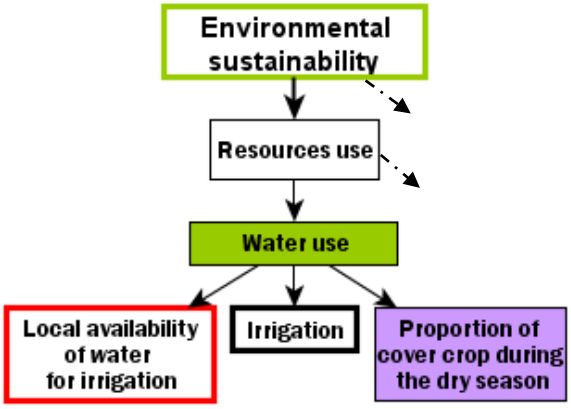
Bourdon, F. et M.-C. Pichery (2009). Du territoire géographique au territoire économique : la situation de la viticulture. Documents de travail, Laboratoire d'Economie et de Gestion, Université de Bourgogne & CNRS UMR 5118.

Péres, S. (2007). La Vigne et la Ville : Forme Urbaine et Usage des Sols. Bordeaux, Université Montesquieu - Bordeaux IV.

Spiegel-Roy P. (2000). Vineyards in the year 2000: ressource pressures. ISHS Acta Horticulturae 104: Symposium on Vineyards in the year 2000, XX IHC.

Local availability of water for irrigation

Criterion characteristics	
Sustainability	Environmental
Secondary branch	Resources used
No. appearances	Once
No. classes	2
Category	Contextual factors independent of the system
Sub-category	Regional and landscape context



Objective:

This criterion is used to assess the pressure of the cropping system on water resources. It is associated with the criteria ***irrigation*** and ***percentage of cover crop during the dry season*** to evaluate **water use** (the hypothesis is that irrigation facilities and the presence of a cover crop during critical periods are the two main sources of water consumption).

We consider that if **local water availability** is high, the impact on water resources will be reduced, even if actual consumption is high.

Calculation or evaluation method:

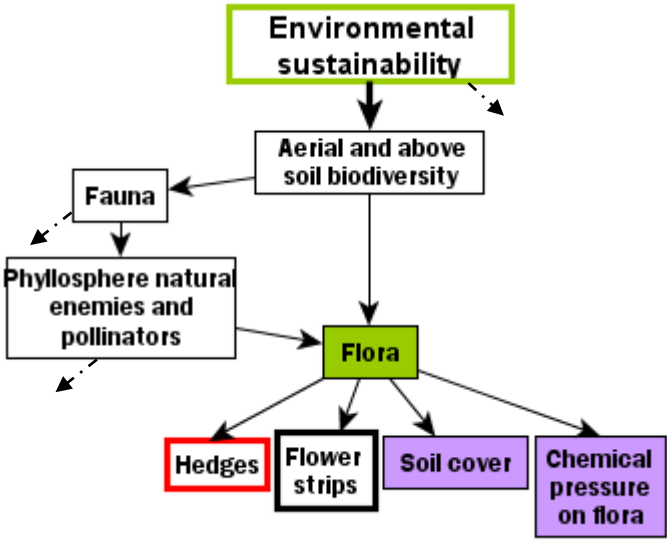
We consider that **availability is assured** if a river which never dries is close to the plot and/or the wine-grower uses a tank, reservoir or well. We consider that **availability is limited** if the cropping system is subject to frequent periods of summer drought and/or legal restrictions on water use are common.

Qualitative classes:

----- Local availability of water -----	
Classes	Water source available
No	**No**
Yes	**Yes**

Hedges

Criterion characteristics	
Sustainability	Environmental
Secondary branch	Ground and aerial biodiversity
No. appearances	Twice
No. classes	3
Category	Contextual factors independent of the system
Sub-category	Regional and landscape context



Objective:

This criterion concerns the density of hedges in plots and their connectivity with other landscape elements. Hedges, which host both aerial and ground fauna, are a key component in biodiversity (Altieri, 1991) and, in some cases, are an interesting lever for controlling vine pests (Ponti *et al*, 2005). The more they are composed of various species and are in contact with other landscape features (grass strips, embankments, ditches, walls, etc.), the more the biodiversity is likely to be significant in the plots concerned (the association of 'hedges + grass strips' appears to offer the most interesting habitat). In addition, hedges act as 'anti-drift' barriers to pesticides and have a windbreak effect, though these services will not be considered here.

Note: For our analysis, only hedges of more than 20m long/1m wide and close to the vineyard are considered (<5m) (Fortino *et al*, 2007). We also include wooded buffer strips if they meet the conditions described here.

Calculation or evaluation method:

We qualitatively estimate the density and degree of connection of hedges, modulated according to the species of which they are composed. You will find the decision rules in the tables of qualitative classes below.

Qualitative classes:

------ Hedges ------	
Classes	
None	**No existing hedge** and no additional planting
Medium density and connectivity	• **Several hedges** conserved in cropping system plots but **no additional planting** • **No existing hedges** but **significant hedge planting**
High density and connectivity	**Several hedges** conserved in cropping system plots and **significant hedge planting**
• **+ 1 class** if more than 12 different varieties (CA 84, 2013) and/or more than 50% of the varieties have a good capacity for hosting vine beneficials	

Bibliography:

Altieri M. A. (1991). How best can we use biodiversity in agroecosystems. Outlook on Agriculture, 20: 15-23

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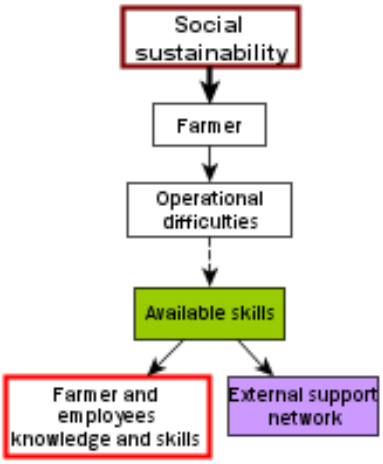
Ponti L, Ricci C, Veronest F and Torricelli R (2005). Natural hedges as an element of functional biodiversity in agroecosystems: the case of a Central Italy vineyard. Bulletin of Insectology 58: 19-23.

Sanson, K. (2012a). Diagnostic Bocager du site Natura 2000-Grosne-Clunisois. Synthèse et analyses des résultats, Direction Départementale des Territoires de Saône-et-Loire: 6p.

Sanson, K. (2012b). Caractérisation et numérisation du bocage sur des communes échantillons du site Natura 2000 du Clunisois - Description du protocole : méthodes et matériel, Direction Départementale des Territoires de Saône-et-Loire.: 6p.

Farmer and employees knowledge and skills

Criterion characteristics	
Sustainability	Social
Secondary branch	Farmer
No. appearances	Once
No. classes	3
Category	Contextual factors independent of the system
Sub-category	Farm context



Objective:

This criterion is based on the hypothesis that a grower with a high level of technical and managerial skills is more likely to adopt a new strategy than a grower with less knowledge or ability to manage staff (Fortino *et al*., 2007a). Indeed, the advice provided by the grower to employees will be more relevant and their interest increased, facilitating the adoption of an innovative system on the farm. A study supports this hypothesis, demonstrating that the level of education of the farmer as well as age, sex and farm size significantly influence the adoption of new measures (Anjichi *et al*, 2007).
This criterion therefore evaluates the predisposition of the wine-grower and employees to adopt a new cropping system according to the managerial ability of the manager and the levels of education, technical skills and experience of the entire team.

Calculation or evaluation method:

The estimation of this criterion depends on the extent of the changes to be made between the current cropping system and the innovative one. The more the new system involves **different** strategies, the more the grower and his employees will need to **adapt** and **learn**.
The evaluation should be done by an expert: the importance of the knowledge to be acquired should be estimated in terms of the strategic changes required for the adoption of the innovative cropping system. The expert should first evaluate the knowledge and skills of the wine-grower in terms of:

- Their discussions about the strategy or strategies to be adopted
- The grower's experience
- The grower's involvement in regional networks (France's BSV, for example) or projects such as France's national project to create references for biodiversity in agricultural environments
- The grower's career path
- The grower's participation in training (the more a grower is willing to be educated in different subjects, the more he would appear to be open to change and therefore to the adoption of new strategies).

Qualitative classes:

------ Farmer and employees knowledge and skills ------	
Classes	Expert opinion
Low	**Little or no** skill/experience in the strategy to be implemented - **difficulty acquiring** these new skills - difficulties in managing
Medium	**Average skills and experience** of the system - **some difficulties in acquiring** information required
High	**Good skills** and experience - good learning capacity, ability to receive information and implement advice given

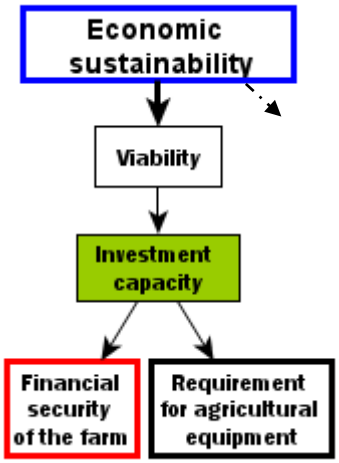
Bibliography:

Fortino, G., E. Lô-Pelzer, *et al*. (2007a). Presentation of the updated version of DEXiPM arable crops. A qualitative multi-criteria model for the assessment of the sustainability of pest management systems INRA, Deliverable DR2.22a, p. 41.

Anjichi, V. E., L. W. Mauyo, *et al*. (2007). The Effect of Socio-Economic Factors on a Farmer's Decision to Adopt Farm Soil Conservation Measures. An Application of Multivariate Logistic Analysis in Butere/Mumias District, Kenya. Advances in Integrated Soil Fertility Management in sub-Saharan Africa: Challenges and Opportunities 2007, pp 915-920 Springer, Netherlands.

Financial security of the farm

Criterion characteristics	
Sustainability	Social
Secondary branch	Farmer
No. appearances	Once
No. classes	3
Category	Contextual factors independent of the system
Sub-category	Farm context



Objective:

This criterion considers the availability and adequacy of financial resources to invest in new equipment for developing the system. It reflects the financial position of the farm before investment in the equipment required by the innovative cropping system.

Calculation or evaluation method:

A relevant indicator for this criterion is the **economic and financial capacity of the farm**, as it is largely upon this that its ability to invest is based upon (investment is also based on a grower's willingness to take risks, but that is not considered here).

The economic and financial capacity of the farm is based upon respect for the equilibrium of the balance sheet (cash, debt, working capital). Then it rests on its ability to provide resources measured by the gross operating profit (EBITDA) and the items this sum is used for: EBITDA must provide remuneration for the farmer, reimbursement of borrowings, financial reserves, cash flow, and even inventory financing if required (H. Brivet, 2013). We consider that there must be a minimum monthly salary of €2,000 per family Annual Work Unit (AWU).

We arrive at the following equation:

Financial and econmic capacity = (EBITDA - (Annuities + Short-term financial costs) - 2000*12*AWU)

Qualitative classes:

The proposed qualitative classes have been based on the premise that a minimum of 10% of EBITDA should be reserved to maintain sufficient financial capacity for cash flow, the ideal would be 25% (Hubert Brivet, 2013).

------ Financial security of the farm ------	
Classes	Financial and economic capacity
Low	(EBITDA - (Annuities + Short-term financial costs) - 2000*12*AWU) **<10 %**
Medium	**10%<** (EBITDA - (Annuities + Short-term financial costs) - 2000*12*AWU) **<25 %**
High	**25%<** (EBITDA - (Annuities + Short-term financial costs) - 2000*12*AWU)

Source: Hubert Brivet, 2013 (head of agricultural and legal advice, accounting company)

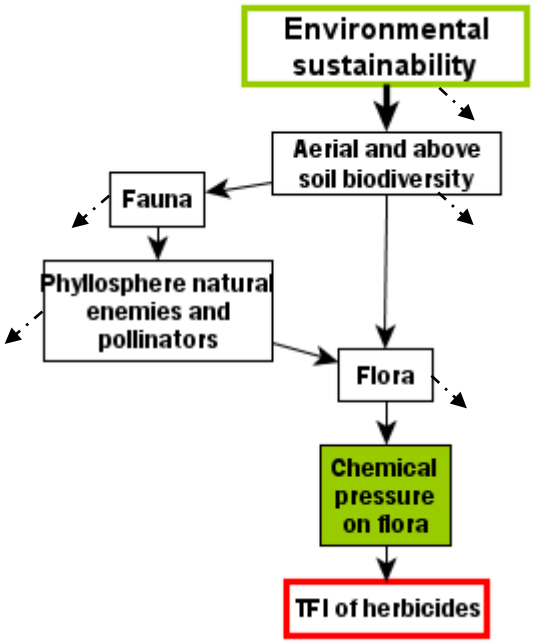
Bibliography:

Brivet, H. (2013). Capacité des exploitations à investir [courriel envoyé par hbrivet@71.cerfrance.fr]. Envoyé le 25 juin 2013 [consulté le 26 juin 2013].

CER France, Ed. (2012). Fermoscopie 2012, Analyse économique de l'Agriculture en Saône et Loire.

TFI of herbicides

Criterion characteristics	
Sustainability	Environmental
Secondary branch	Ground and aerial biodiversity
No. appearances	Twice
No. classes	4
Category	Cropping system factors
Sub-category	Crop protection



Objective:

This criterion makes it possible to estimate the impact of herbicides applied to flora.

Calculation or evaluation method:

Evaluation is from the treatment calendar, taking into account the ratio between treated area / total surface area.

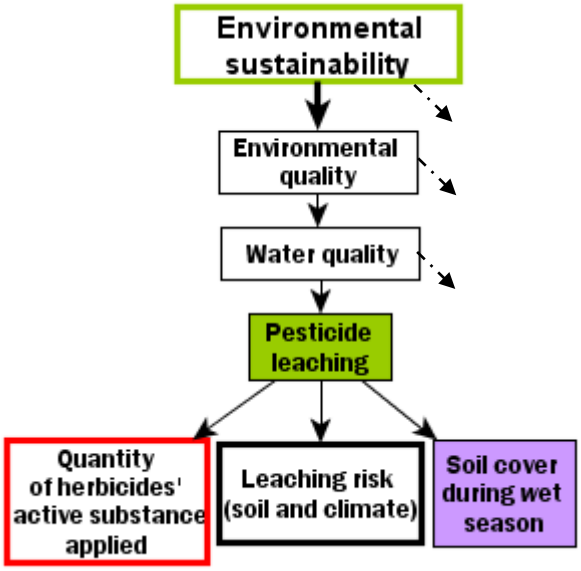
Qualitative classes:

------ TFI of herbicides ------	
Classes	TFI herbicides
High	**> 1**
Medium	**] 0.5 - 1]**
Low	**] 0 - 0.5]**
None	**None**

Source: document 'DEXiPM_Grapevine_inputs_october2012'

Quantity of herbicide active ingredient applied

Criterion characteristics	
Sustainability	Environmental
Secondary branch	Environmental quality
No. appearances	Once
No. classes	4
Category	Cropping system factors
Sub-category	Crop protection



Objective:

This criterion is based on the fact that only herbicides are found in significant quantities in groundwater (N. Domange, 2005; A. Huber *et al*, 2000). While other pesticides seep into the ground, they are not taken into account in this criterion because of their lower concentration.

Calculation or evaluation method:

The calculation is made using the doses of applied products, the ratio of the treated area/total surface area and the concentration of each active ingredient in the commercial product.

Qualitative classes:

------ Quantity of herbicide a.i. applied ------	
Classes	Quantity in g (a.i.)/ha
High	**> 500**
Medium	**]50 - 500]**
Low	**< 50**
None	**None**

Source: document 'DEXiPM_Grapevine_inputs_october2012'

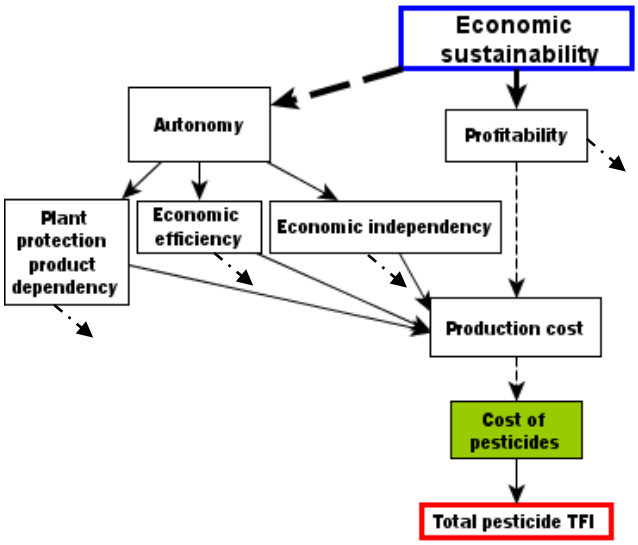
Bibliography:

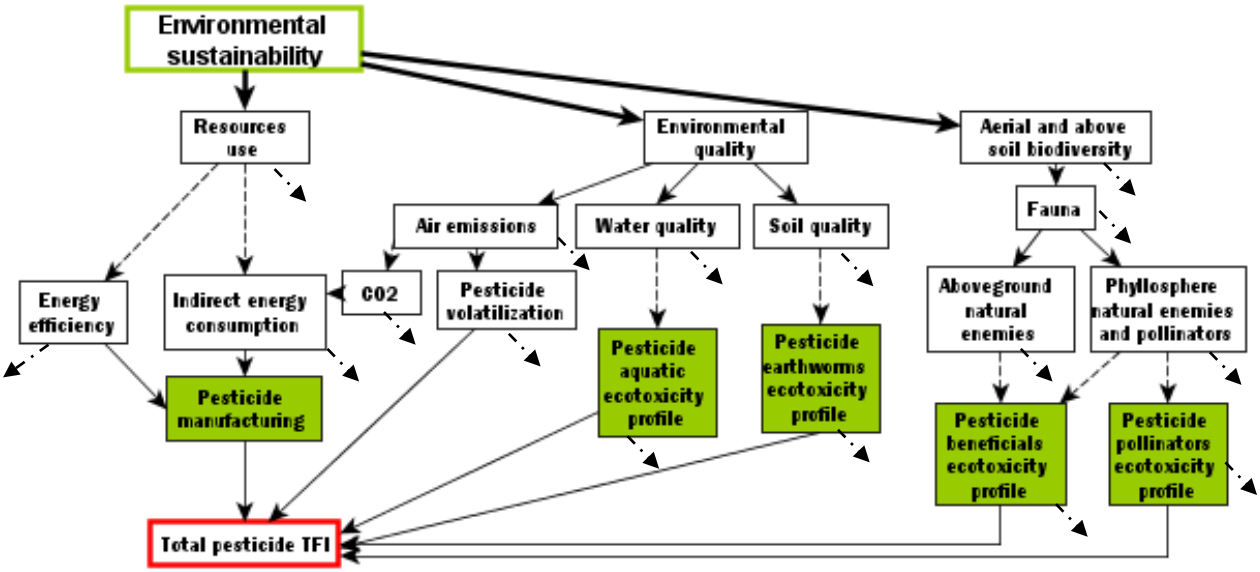
Domange N (2005). Etude des transferts de produits phytosanitaires à l'échelle de la parcelle et du bassin versant viticole (Rouffach, Haut-Rhin) Strasbourg: Université Louis Pasteur Strasbourg I

Huber A, Bach M and Frede HG (2000). Pollution of surface waters with pesticides in Germany: modeling non-point source inputs. Agriculture, Ecosystems & Environment, 80, 191-204..

Total pesticide TFI (Treatment Frequency Index)

Criterion characteristics	
Sustainability	Economic Environmental
Secondary branch	Profitability Viability Resources used Environmental quality Ground and aerial biodiversity
No. appearances	13 times
No. classes	5
Category	Cropping system factors





Objective:

This criterion evaluates the intensity of the use of all pesticides in the cropping system, through the number of homologated doses applied during a crop cycle.
Note: The total TFI does not take into account treatments outside the field (seed treatments)

Qualitative classes:

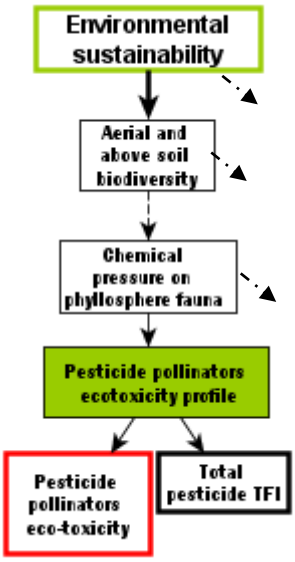
------ Total pesticide TFI ------	
Classes	
Very high	> 21
High to medium	] 13 - 21]
Medium to low	] 9 - 13]
Low	=< 9
None	None

Defined thresholds for some French wine-producing departments				
Classes	Saône-et-Loire	Savoie	Var	Maine-et-Loire
Very high	> 20	> 20	> 14	> 15
High to medium	]15 - 20]	]16 - 20[	]11 - 14]	[13 - 15]
Medium to low	]12 - 15]	]11 - 16]	[8 - 11]	[10 - 13[
Low	=< 12	=< 11	< 8	< 10
Source	Experts Vinipôle & CA de Saône et Loire	Experts CA Savoie	Experts CA Var	Experts CA Maine-et-Loire

Source: document 'DEXiPM_Grapevine_inputs_october2012'

Pesticide pollinators eco-toxicity

Criterion characteristics	
Sustainability	Environmental
Secondary branch	Ground and aerial biodiversity
No. appearances	Once
No. classes	4
Category	Cropping system factors



Objective:

This criterion allows us to understand the impact of pesticides on pollinators, which are protected by law. With a view to protecting pollinators, treatments conducted with insecticides and acaricides are prohibited during the flowering and exudate periods, no matter which product is used nor the application apparatus used. Insecticides and acaricides marked 'bees' may, however, be applied during the periods concerned.

Calculation or evaluation method:

According to EPPO recommendations (European and Mediterranean Plant Protection Organization) (EPPO, 1993; EPPO, 2010), the `Hazard Quotient' (HQ) is useful for calculating this toxicity. It is defined as the ratio between the quantity of active ingredient (a.i.) applied (Application Rate [AR]) and the LD 50 (Lethal Dose) which corresponds to the dose of a.i. causing the death of 50% of a given population (in this case bees).
Initially we calculate an HQ for each a.i. applied. The HQ (a.i.) are then added to produce a 'product' eco-toxicity.

$$\mathbf{HQ}\ (\textit{product}) = \sum\ (\mathbf{Quantity\ of\ a.i.\ applied\ (g.ha^{-1})\ /\ LD\ 50\ (\mu g\ a.i.\ x\ bee^{-1})})$$

HQ < 50 → Product eco-toxicity ➔ **Low**
50 < HQ < 400 → Product eco-toxicity ➔ **Medium**
HQ > 400 → Product eco-toxicity ➔ **High**

Source: Mineau et al. (2008)

Ultimately, the TFI of products with high toxicity will be recorded to set an eco-toxicity level at the treatment programme scale.

Qualitative classes:

------ Pesticide pollinators eco-toxicity ------	
Classes	∑ TFI (high toxicity products [**HQ > 400**])
Very high	**TFI (high toxicity products) > 3**
High	**TFI (high toxicity products) = [2 – 3[**
Medium	**TFI (high toxicity products) = [1 – 2[**
None	**TFI (high toxicity products) = [0 – 1[**

Source: document 'DEXiPM_Grapevine_inputs_october2012'

Bibliography:

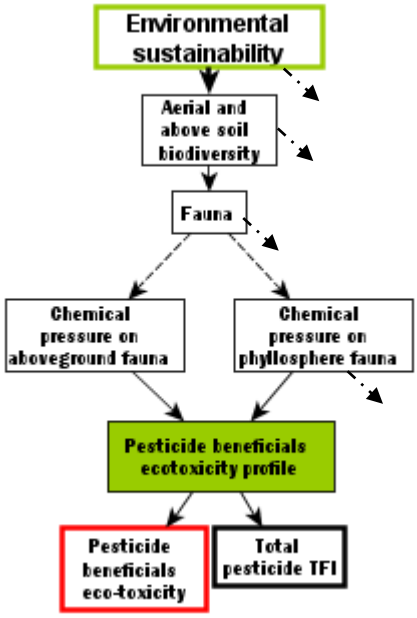
OEPP/EPPO (1993) Système pour l'évaluation des effets non intentionnels des produits phytosanitaires sur l'environnement. Chapitres 1–6, 8 & 10. Bulletin OEPP/EPPO Bulletin 23, 1–165.

OEPP/EPPO (2010) Environmental risk assessment scheme for plant protection products. Bulletin OEPP/EPPO Bulletin 40, 1–9.

Mineau P., Harding KM, Whiteside M, Fletcher MR, Garthwaite D, Knopper LD, 2008. Using reports of honey bee mortality in the field to calibrate laboratory derived pesticide risk indices. *Environ. Entomol.* 37, 546-554.

Pesticide beneficials eco-toxicity

Criterion characteristics	
Sustainability	Environmental
Secondary branch	Ground and aerial biodiversity
No. appearances	Twice
No. classes	4
Category	Cropping system factors



Objective:

This criterion allows us to evaluate the unintentional effects of pesticides on beneficials (Aversenq, 2005).
It is difficult to accurately estimate the impact of each commercial product on all populations of vine beneficials. This is why we have chosen a risk assessment method focusing on a typhlodromus population - *Typhlodromus pyri*. Indeed, they are the only beneficial dependent on vines whose population is naturally large and readily observable in the vineyard. In addition, rearing them in laboratory conditions is easy which means experiments can easily be reproduced. Hence the many studies conducted to assess unintentional effects of products on these beneficials.

Calculation or evaluation method:

Because of the lack of data on the possible protection of typhlodromus species in the vineyard through the habitat structure, we pose the hypothesis that **they are affected when a product is applied to the vine. Neither is possible resistance of populations taken into account.**

* Data is available on the toxicity of active ingredients vis-à-vis vine beneficials (NT: neutral to weak toxicity, MT: average toxicity, T: Toxic). The eco-toxicity attributed is a function of the doses of ingredients applied. Without access to the latter, it is difficult to consider the application doses in the evaluation method and the level of toxicity of each a.i. will be equal to the one defined in the database, regardless of the application dose.

⇨ At the product scale:
Eco-toxicity (*product*) = Maximum eco-toxicity value of the a.i. contained

⇨ At the treatment programme scale:
Eco-toxicity (*treatment programme*) = TFI (products with high toxicity)

* *I-phy database (Christian Bockstaller)*

Qualitative classes

------ Pesticide beneficials eco-toxicity ------	
Classes	∑ TFI (high toxicity products [T])
Very high	**TFI (high toxicity products) > 3**
High	**TFI (high toxicity products) = [2 – 3[**
Medium	**TFI (high toxicity products) = [1 – 2[**
None	**TFI (high toxicity products) = [0 – 1[**

Source: document « DEXiPM_Grapevine_inputs_october2012 »

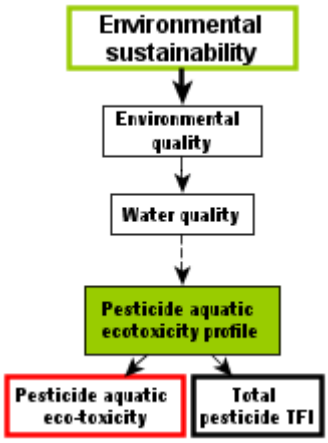
Bibliography:

Toxicity classes per product are available on the e-phy site of France's Ministry of Agriculture (http://e-phy.agriculture.gouv.fr/).

Aversenq, S. (2005). Les effets non intentionnels des acaricides. Acte du 2ème colloque international sur les acariens des cultures de l'AFPP. Montpellier, 24 -25 October 2005.

Pesticide aquatic eco-toxicity

Criterion characteristics	
Sustainability	Environmental
Secondary branch	Environmental quality
No. appearances	Once
No. classes	4
Category	Cropping system factors



Objective:

This criterion addresses the impact of pesticides on aquatic organisms. This unintentional effect can be understood by combining the amount of each active ingredient applied to its level of aquatic ecotoxicity (Aquatox), in other words, the potential exposure and possible effects (risk = exposure/effects) (Knauer *et al*. 2010).
The Aquatox value corresponds to the highest toxicity (equivalent to the lowest median effective concentration (CE50)) vis-à-vis aquatic organisms, including fish, crustaceans of the *Daphnia* genus, and algae. It is inversely proportional to the CE50 since it corresponds to the concentration of active ingredient per litre of water which causes a binary biological response (for example, mobile, immobile) in 50% of exposed organisms in a given time period (SAgE pesticides). The lower the CE50 is, the more the product is considered toxic to the organisms under consideration.

Calculation or evaluation method:

Studies on the evaluation of risks associated with the use of pesticides usually use indicators such as Exposure-Toxicity Ratio (ETR). This is the standard indicator recognised by the EPPO (European and Mediterranean Plant Protection Organization) to evaluate the potential risks to aquatic organisms (OEPP/EPPO, 2003).

We therefore use this indicator to estimate the eco-toxicity of each a.i. applied, though only the largest value will be retained.

ETR = Quantity of a.i. applied ($kg.ha^{-1}$) / Aquatox ($mg.l^{-1}$)

ETR < 0.1 → Eco-toxicity ➔ **Low**
0.1 < ETR < 1 → Eco-toxicity ➔ **Medium**
ETR > 1 → Eco-toxicity ➔ **High**

⇨ At the product scale:
Eco-toxicity (*product*) = Maximum eco-toxicity value of the a.i. contained

⇨ At the treatment programme scale:
Eco-toxicity (*treatment programme*) = TFI (products with high toxicity)

Qualitative classes:

------ Pesticide aquatic eco-toxicity ------	
Classes	∑ TFI (high toxicity products [**ETR > 1**])
Very high	**TFI (high toxicity products) > 3**
High	**TFI (high toxicity products) = [2 – 3[**
Medium	**TFI (high toxicity products) = [1 – 2[**
None	**TFI (high toxicity products) = [0 – 1[**

Source: document 'DEXiPM_Grapevine_inputs_october2012'

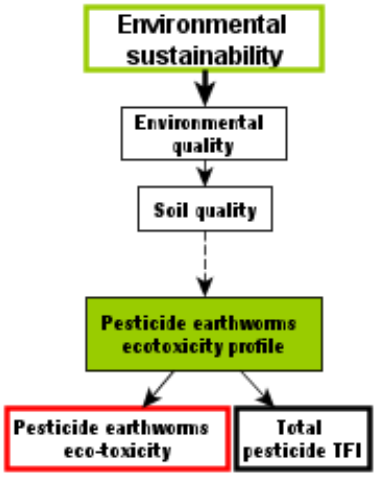
Bibliography:

Knauer K., Knauert S., Félix O and Reinhard E (2010). Evaluation du risque des produits phytosanitaires pour l'écosystème aquatique. Recherche Agronomique Suisse 1, 372–377.

European and Mediterranean Plant Protection Organization (2003). EPPO Standards. Environmental risk assessment scheme for plant protection products EPPO Bulletin. pp. 147-149.

Pesticide earthworms eco-toxicity

Criterion characteristics	
Sustainability	Environmental
Secondary branch	Environmental quality
No. appearances	Once
No. classes	4
Category	Cropping system factors



Objective:

This criterion estimates the unintentional effects of pesticides on soil organisms, especially earthworms. A decrease in earthworm activity in soils may result in serious disruption of the structural condition of the soil and the recycling of organic matter (Cluzeau *et al*, 1987; Cluzeau *et al*, 1990).

Calculation of evaluation method:

As in the evaluation of pesticide eco-toxicity vis-à-vis pollinators, the LC 50 (Lethal Concentration [$mg.kg^{-1}$]) is available for the majority of active ingredients (a.i.) used in viticulture. Thresholds of eco-toxicity* have also been defined under which an a.i. is considered low/medium/highly toxic vis-à-vis earthworms. Without access to thresholds which take into account the concentrations of each a.i. in the product (as in the case of the ratio of 'dose [function of concentration]/Eco-toxicity (a.i.)), the weighted sum of LC 50 (a.i.) depending on the concentration of each a.i. is used to its obtain an indicator at the product scale. The same toxicity thresholds can thus be used to define the eco-toxicity of the product.

⇨ At the product scale:

Eco-toxicity (*product*) = ∑weighted (LC 50 (*a.i. contained in the product*))

∑weighted (LC 50 [a.i.]) > 1000 → Eco-toxicity ➔ **Low**
10 < ∑weighted (LC 50 [a.i.]) < 1000 → Eco-toxicity ➔ **Medium**
∑weighted (LC 50 [a.i.]) < 10 → Eco-toxicity ➔ **High**

⇨ At the treatment programme scale:

Eco-toxicity (*treatment programme*) = TFI (products with high toxicity)

*Base Footprint (PPDB: Pesticide Properties DataBase), University of Hertfordshire.

Qualitative classes:

------ Pesticide earthworms eco-toxicity ------	
Classes	∑ TFI (high toxicity products [∑**weight (LC 50 < 10]**)
Very high	**TFI (high toxicity products) > 3**
High	**TFI (high toxicity products) = [2 – 3[**
Medium	**TFI (high toxicity products) = [1 – 2[**
None	**TFI (high toxicity products) = [0 – 1[**

Source: document 'DEXiPM_Grapevine_inputs_october2012'

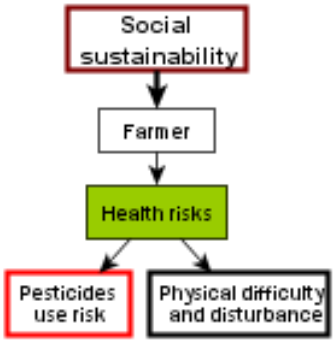
Bibliography:

Cluzeau, D., M. Lebouvier, *et al*. (1987). Relations beetween earthworms and agricultural practices in the vineyards of Champagne. Preliminary results. In: Bonvicini Pagliai A.M., Omoedo P. (Eds.). On earthworms. Selected Symposia and Monographs U.Z.I, 2, Mucchi, Modena, p.465-484.

Cluzeau, D., Z. T. Guo, *et al*. (1990). Etats structuraux et biologiques des sols du vignoble de Champagne. Rapport scientifique, vol. 1/2 (in French). Conseil Régional Champagne-Ardennes, SUAD Marne. Université de Rennes I.

Pesticide use risk

Criterion characteristics	
Sustainability	Social
Secondary branch	Farmer
No. appearances	Once
No. classes	4
Category	Cropping system factors
Sub-category	Crop protection



Objective:

This criterion evaluates the risk of workers being harmed while handling the pesticides being used. Contamination can be presented as immediate health hazards (headache, irritation, digestive and respiratory problems etc.) and occur in the longer term (reproductive disorders, neurological diseases, even cancers). The risk can be reduced by (i) reducing the use of pesticides, (ii) using application equipment which meets all standards and is well maintained, (iii) the use of personal protective equipment (PPE), (iv) the substitution of hazardous products (products classed as harmful, toxic or very toxic) with less hazardous products of the same efficacy.

Calculation or evaluation method:

The evaluation method chosen is the TFI of pesticides classified as harmful (Xn), toxic (T) and very toxic (T+). In the new European regulations, these classes correspond to risk phrases H 350, H 340 and H 360 for products formerly classified as CMR 1 and 2, and risk phrases H 351, H 341 and H 361 for products formerly classified as CMR 3.
The failure to use protective equipment when preparing mixtures and during the maintenance and cleaning of sprayers (the most risky moments of exposure for growers) leads to an increased risk of one class. This is also the case for the use of knapsack sprayers or the absence of an enclosed tractor cab (MSA, 2010).

Qualitative classes:

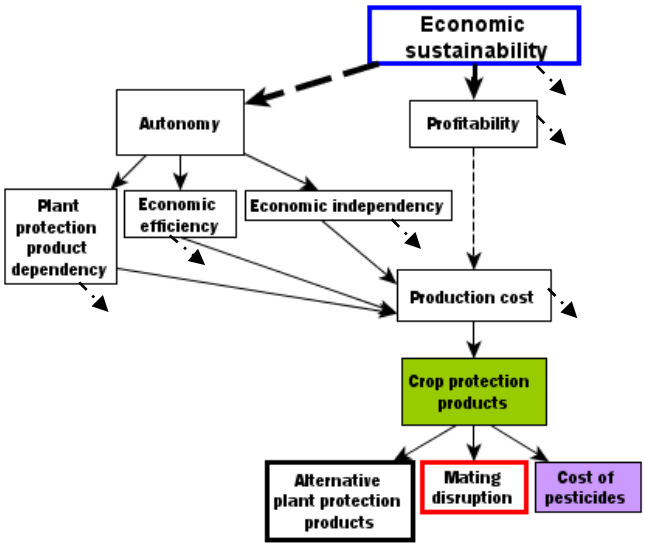
------ Pesticide use risk ------	
Classes	TFI products 'harmful [Xn]', 'toxic [T]', 'very toxic [T+]'
High	**> 14**
Medium	**[7 - 14]**
Low	**] 0 - 7 [**
None	**none**
+ 1 class if	• **Protection equipment is not used** during the preparation of mixtures or during the maintenance and cleaning of sprayers • The use of **knapsack sprayers** or the **absence of an enclosed tractor cab**

Bibliography:

MSA (2010). Phytosanitaires et pratiques agricoles: Phyt'attitude au cœur de la prévention 1997-2007 | 10 années de bilans, Caisse centrale de la MSA, 28p.

Mating disruption

Criterion characteristics	
Sustainability	Economic
Secondary branch	Profitability Viability
No. appearances	Four times
No. classes	2
Category	Cropping system factors
Sub-category	Crop protection



Objective:

This data provides information on the use of mating disruption. Widely used in recent years in numerous vineyards, this protection technique is now less widely used because of obligatory treatments against the leafhopper vector of flavescence dorée, *Scaphoïdeus titanus*.

Calculation or evaluation method:

A binary criterion which requires no quantitative assessment. To be completed by the user based on the protection methods used.

Qualitative classes:

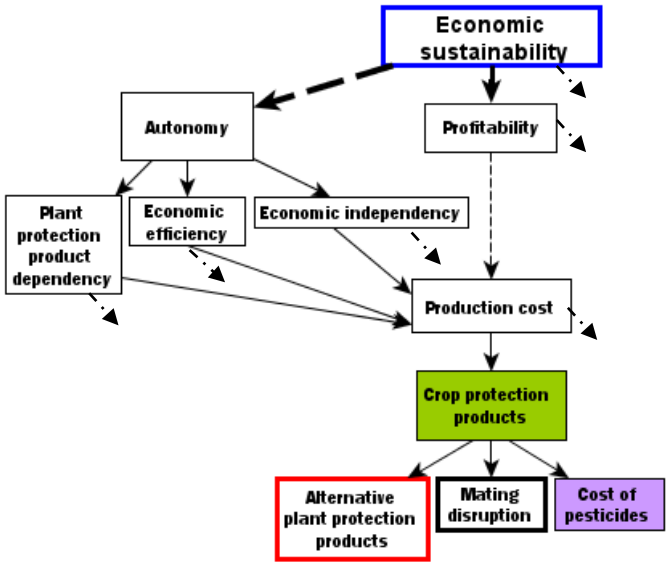
----- Mating disruption -----	
Classes	Use of this protection method
Yes	• **On more** than half of the system's total area
No	• **On less** than half of the system's total area

Bibliography:

Weintraub PG. (2007) Insect vectors of phytoplasmas and their control-an update. Bulletin of Insectology 60: 169-173.

Alternative plant protection products

Criterion characteristics	
Sustainability	Economic
Secondary branch	Profitability Viability
No. appearances	Four times
No. classes	3
Category	Cropping system factors
Sub-category	Crop protection



Objective:

This criterion assesses the intensity of the use of alternative protection products (pest predators, pathogens, products for stimulating the immune systems of plants, etc.). These products are qualified as 'biocontrols'. A TFI specific to this type of product is calculated independent of the TFI for total pesticides.

Calculation or evaluation method:

$$\frac{\text{TFI alternative products (list of products authorised in the NODU Vert calculation)}}{\text{TFI total pesticides + TFI NODU vert}}$$

Qualitative classes:

----- Alternative protection products -----	
Classes	Intensity of use of biocontrol products
None	**None**
Moderate use	**< 25%**
Intensive use	**>= 25%**

Source: expert opinion, validated by two expert groups

Bibliography:

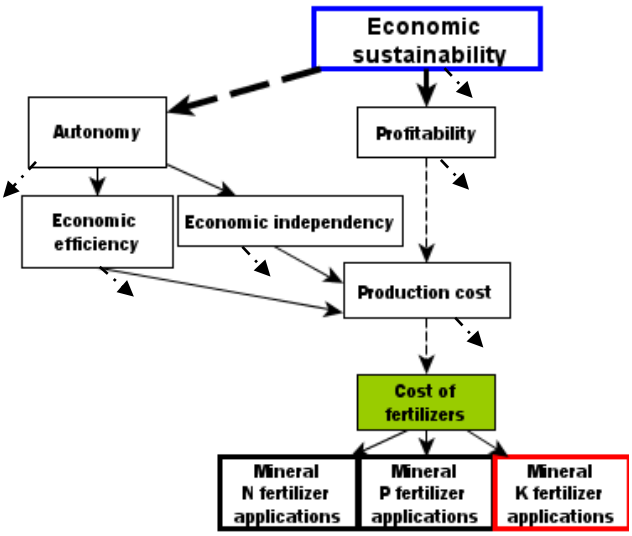
Direction générale de l'alimentation (2012a). Liste des produits entrant dans le calcul du NODU "vert" Biocontrôle au titre de l'année 2012 - validée par le groupe Indicateurs du plan Ecophyto: 2p.

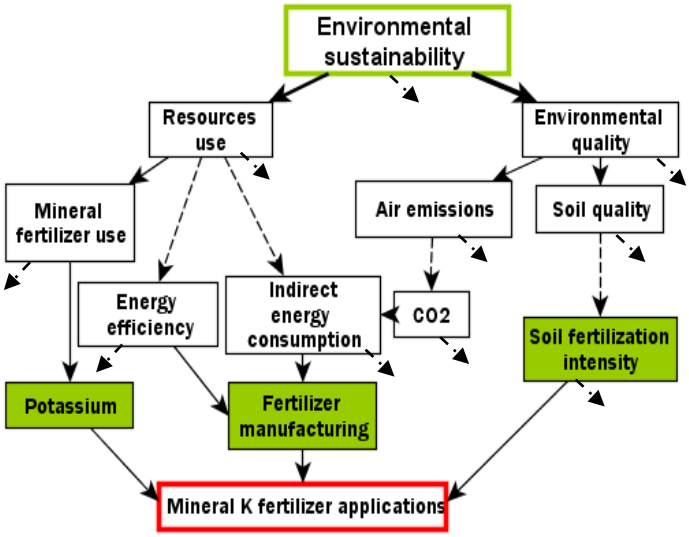
Direction générale de l'alimentation (2012b). Le Nombre de doses unités (NODU) Vert Biocontrôle - Ecophyto 2018. Fiche méthodologique, Ministère de l'Agriculture: 3p. Disponible sur : http://agriculture.gouv.fr/ecophyto-2018.

Mineral K fertiliser applications

Criterion characteristics	
Sustainability	Economic Environmental
Secondary branch	Profitability Viability Resources used Environmental quality
No. appearances	Eight times
No. classes	4
Category	Cropping system factors

Objective:
This criterion provides information on the average amount of mineral potassium applied during the season (kg of K_2O/ha/year).





Calculation or evaluation method:

The quantitative estimate is based on the doses of K applied.

Qualitative classes:

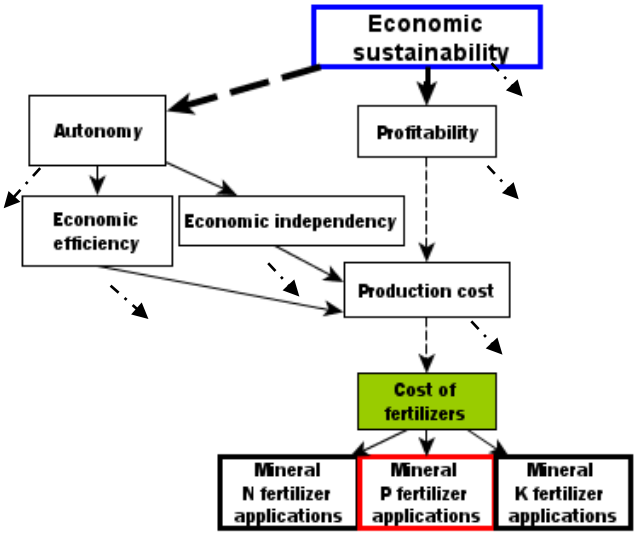
------ Mineral K fertiliser ------	
Classes	Annual input
High	**> 30kg/ha K2O**
Medium	**15-30kg/ha K2O**
Low	**0-15kg/ha K2O**
None	**None**

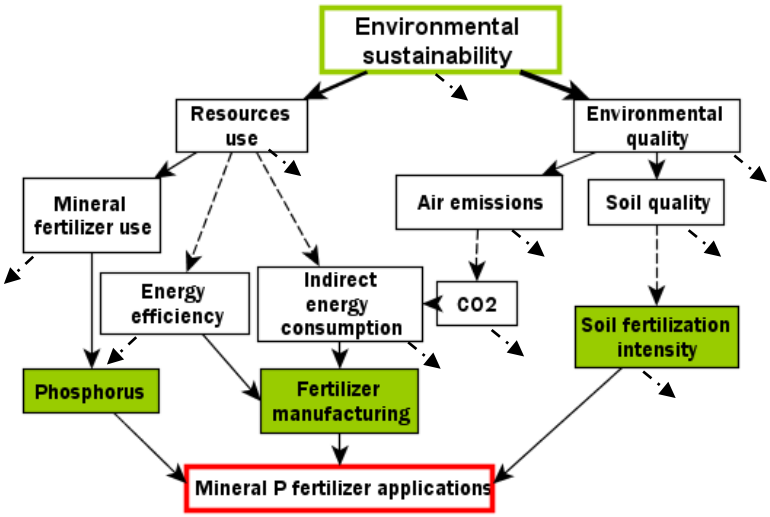
Source: document 'DEXiPM_Grapevine_inputs_october2012'

Mineral P fertiliser applications

Criterion characteristics	
Sustainability	Economic Environmental
Secondary branch	Profitability Viability Resources used Environmental quality
No. appearances	Eight times
No. classes	4
Category	Cropping system factors

Objective:
This criterion provides information on the average amount of mineral phosphorus applied during the season
(kg of P2O5/ha/year).





Calculation or evaluation method:

The quantitative estimate is based on the doses of P applied.

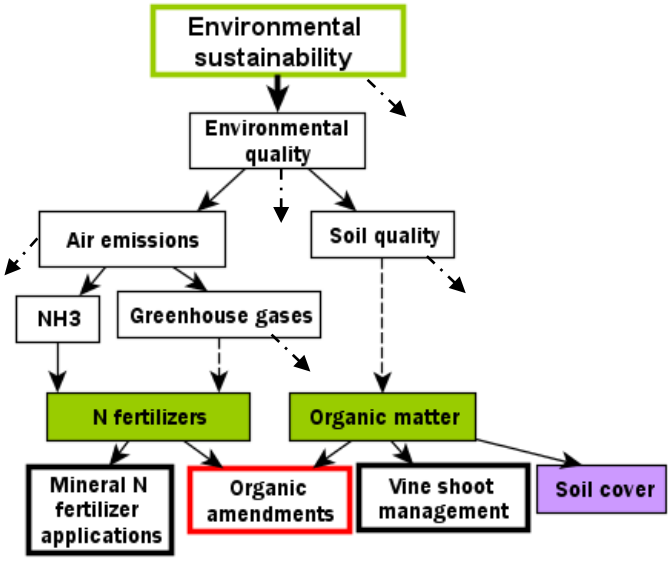
Qualitative classes:

------ Mineral P fertiliser ------	
Classes	Annual input
High	**> 20kg/ha P2O5**
Medium	**10-20kg/ha P2O5**
Low	**< 10kg/ha P2O5**
None	**None**

Source: document 'DEXiPM_Grapevine_inputs_october2012'

Organic amendments

Criterion characteristics	
Sustainability	Environmental
Secondary branch	Environmental quality
No. appearances	Three times
No. classes	6
Category	Cropping system factors



Objective:

This criterion evaluates the impact of the cropping system on soil organic matter. Maintaining this in soils provides multiple agronomic and environmental services: carbon storage, chemical soil quality (ex: increased CEC), physical quality (ex: increased structural stability) and biological quality (ex: increased biomass and soil biodiversity).

Calculation or evaluation method:

The quantitative estimate is based on the cropping system's treatment schedule. Inputs are recorded as an annual input per hectare. If this is done every x number of years, then we need to divide the annual input so as not to disadvantage the system concerned (divide the input quantity by x number of years).

Input typology:

Suggested groups		Examples	Inputs
Type I:	• High soluble fraction (>30 % DM) • Very little cellulose/lignin • Very low C/N (=<8) • IBS (Index of Biological Stability) < 0.15	*Droppings, manure, horn, other animal waste…*	**Average annual input = around 1000kg of humus per hectare.** To be calculated (i) according to soil analysis and (ii) with K1, dry matter content and IBS
Type II:	• Average C/N (8 - 20) • Little cellulose/lignin • IBS: 0.1 – 0.3	*Well-rotted cattle manure, ready-to-use inputs or fertilisers*	
Type III:	• Average to high C/N (20-25) • IBS: 0.1 – 0.8	*Composted grape marc, fresh manure…*	
Type IV:	• High humus products, C/N > 30 • IBS: 0.5 - 1	*Straw, bark, vine shoots, brush, cake…*	

Qualitative classes:

------ Organic amendments ------	
Classes	Annual input
None	-
TYPE IV	-
TYPE I: low/medium input	**Average annual input: around 1000kg of humus/ha.** This may vary according to (i) soil analysis and (ii) with the K1, dry matter content and IBS
TYPE I: high input	
TYPE II: low/medium input	
TYPE II: high input	
TYPE III: low/medium input	
TYPE III: high input	

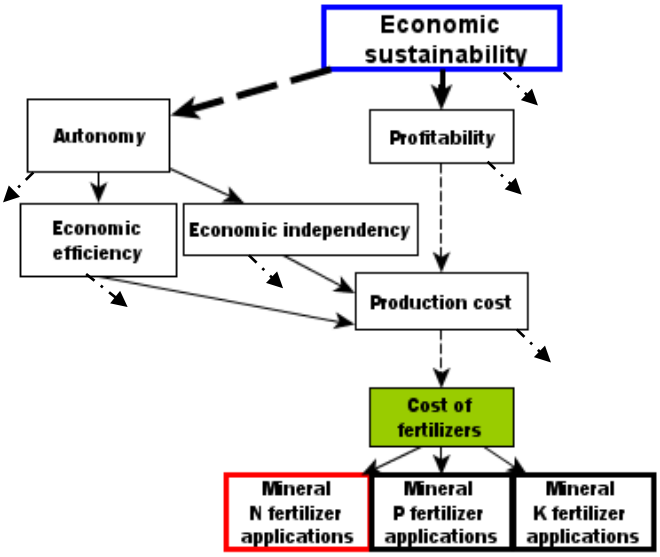
Bibliography:

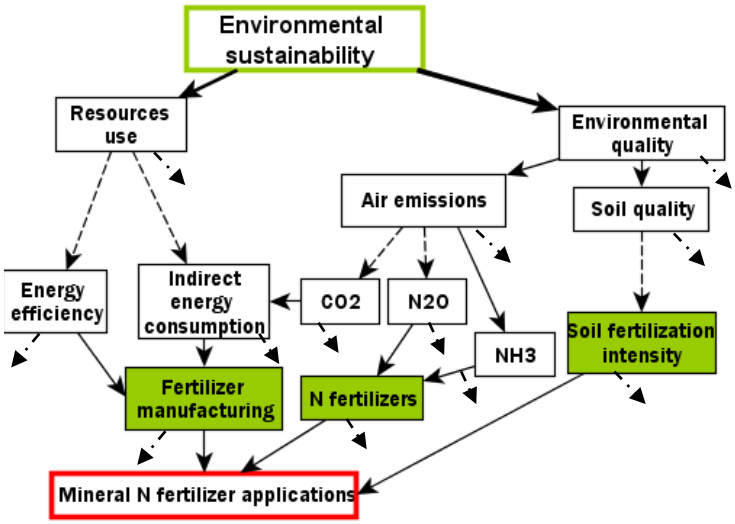
Chambre d'agriculture de Saône et Loire (2010-2012). Base de données Protection des cultures pérennes.

Mineral N fertiliser applications

Criterion characteristics	
Sustainability	Economic Environmental
Secondary branch	Profitability Viability Resources used Environmental quality
No. appearances	Nine times
No. classes	4
Category	Cropping system factors

Objective:
This criterion estimates the average quantity of mineral nitrogen applied during the season (kg N/ha/year).





Calculation or evaluation method:

The quantitative estimate is based on the doses of N applied.

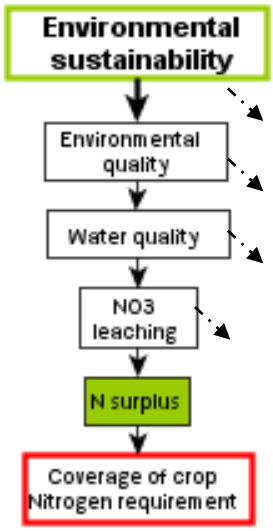
Qualitative classes:

------ Mineral N fertiliser ------	
Classes	**Annual input**
High	**> 40kg/ha N**
Medium	**20 - 40kg/ha N**
Low	**0 - 20kg/ha N**
None	**None**

Source: document 'DEXiPM_Grapevine_inputs_october2012'

Coverage of crop nitrogen requirement

Criterion characteristics	
Sustainability	Environmental
Secondary branch	Environmental quality
No. appearances	Once
No. classes	3
Category	Cropping system factors



Objective:

Excessive nitrogen inputs in vineyards have a considerable effect on aquatic ecosystems (Schaller, 1991; Ziegler, 1999). To assess the risk of NO_3 leaching, it is necessary to assess whether the nitrogen coverage for vines is excessive, inadequate or balanced.

Calculation or evaluation method:

Because of the data available and methodological constraints, the choice has been made to estimate vine nitrogen need according to yield objectives. In comparison with the majority of crops, vine nitrogen requirements can be considered as moderate, even for high-yielding vines (Wermelinger and Baumgärtner, 1991; Nendel and Kersebaum, 2004). They range from 20 to 60kg N/ha for yields of 40hL/ha to 120-130hL/ha. Thus, the needs for a vine of moderate production (40hL/ha) is estimated at 20kg/ha of nitrogen, and a higher yielding vine (80hl/ha) is estimated at 40kg/ha of nitrogen.

Equation used to estimate coverage of nitrogen needs:

(FERTILISATION + MINÉRALISATION) − (GRAPEVINE NITROGEN REQUIREMENTS*)

* Based on yield, see above.

Qualitative classes:

------ Coverage of vine nitrogen requirement ------	
Classes	**N balance**
Excessive	**+25kg N**
Balanced	**- 25kg to +25kg N**
Deficient	**-25kg N**

Source: document 'DEXiPM_Grapevine_inputs_october2012'

Complementary information:

Annual N mineralisation rate		
	Saône-et-Loire (North-East France) (**Table 7**)	Sud de la France
Annual N mineralisation rate	• **25kg N.ha^{-1}** sandy soils Beaujolais • **30kg N.ha^{-1}** limestone and clay soils Mâconnais	**40kg N.ha^{-1}**
Source	B. Dury, CA de Saône et Loire	DEXiPM_Grapevine_inputs_october2012

Table 7: Departmental references for vineyard soil mineralisation

Soil		CEC	Soil PF71	Vine mineralisation
SANDY SOILS	Sand on ancient uplands	CEC < 100	Sand	25 U
		100 <= CEC < 120	Silt	
		120 <= CEC < 200	Deep silt	
		CEC >= 200	Clay	
	Sandy alluvium	CEC < 100	Sands	25 U
		100 <= CEC < 120	Silt	
		120 <= CEC < 200	Deep silt	
		CEC >= 200	Clay	
CLAY SOILS	Shallow stony clay and limestone	CEC < 180	Deep silt	30 U
		CEC >= 180	Clay	
	Shallow/deep clay-limestone with low pH	CEC < 180	Deep silt	30 U
		CEC >= 180	Clay	
	Deep clay-limestone	CEC < 180	Deep silt	30 U
		CEC >= 180	Clay	

Source: B. Dury, Chambre d'agriculture de Saône et Loire

Bibliography:

Dury, B (2005-2006). Références départementales de minéralisation des sols viticoles, Chambre d'agriculture de Saône et Loire.

Nendel C, Kersebaum K (2004). A simple model approach to simulate nitrogen dynamics in vineyard soils. *Ecological Modelling* **177**, 1–15.

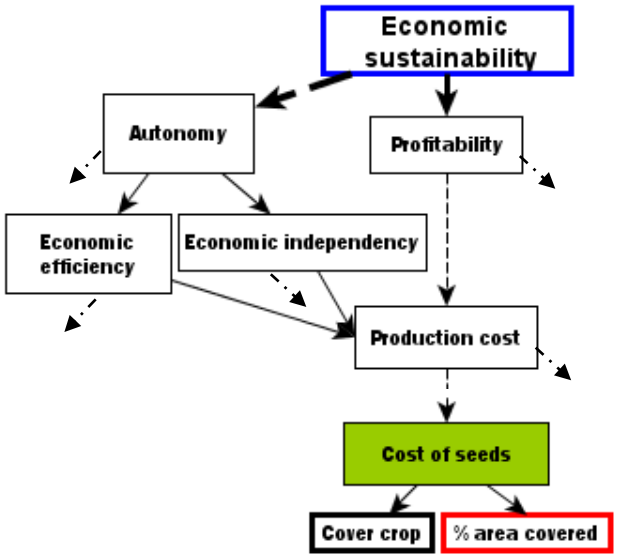
Schaller, K., 1991. Ground water pollution by nitrate in viticultural areas. In: Proceedings of the International Symposium on nitrogen in Grapes and Wine, 18-19 June 1991, Seattle, pp. 12-22.

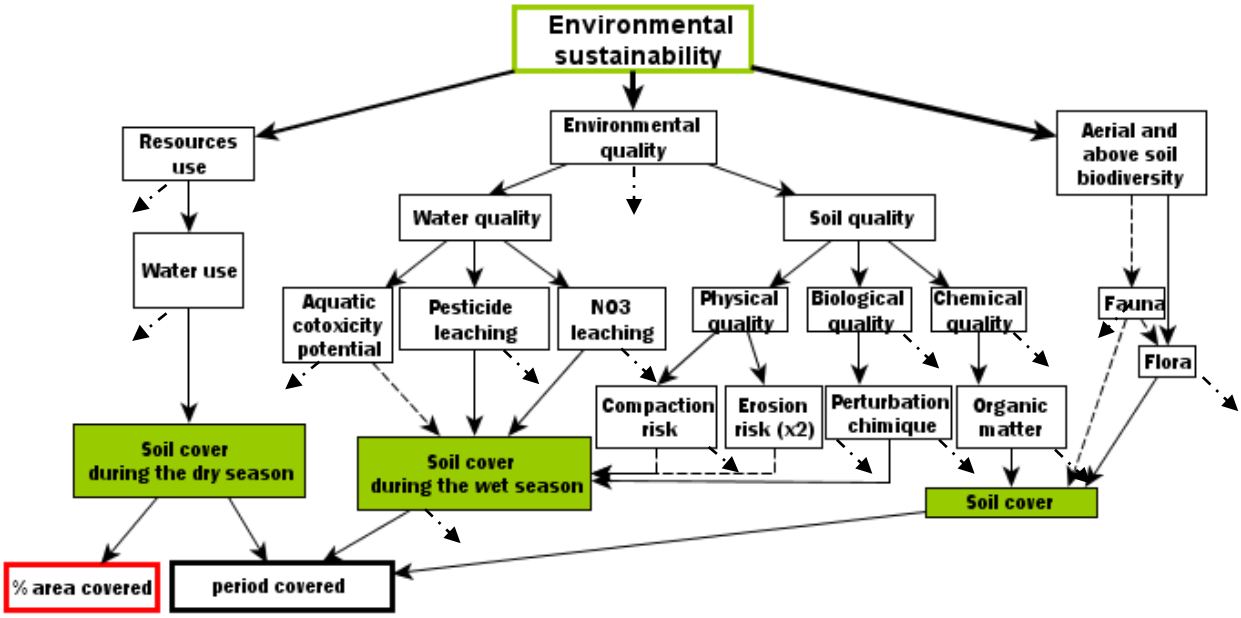
Wermelinger B, Baumgärtner J (1991). A demographic model of assimilation and allocation of carbon and nitrogen in grapevines. *Ecological Modelling* **53**, 1–26.

Ziegler, B., 1999. Rebendüngung unter Beachtung der Düngeverordnung. Staatliche Lehr- und Forschungsanstalt, Neustadt an der WeinstraBe, 24 pp.

% area covered

Criterion characteristics	
Sustainability	Economic Environmental
Secondary branch	Profitability Viability Resources used Environmental quality Ground and aerial biodiversity
No. appearances	Fifteen times
No. classes	4
Category	Cropping system factors





Objective:

This criterion evaluates the average density of vegetative cover in the plots (in %), whether this be spontaneous or sown. In the case of temporary ground cover, the relative surface may be revised as a function of the duration of the presence of ground cover which is recorded in the criterion addressing coverage period (see **Period covered**). Whenever this criterion is considered in the environmental tree, it will be aggregated with the criterion *Period covered*.

Calculation or evaluation method / Qualitative classes:

------ % area covered ------	
Classes	Description of cases
< 20 %	**No / very little** cover
20-50%	Cover **1 inter-row/2**
50-80%	Cover **in all inter-rows (large weeded band in the row** compared to the width of the inter-rows)
> 80%	Cover is **total / all inter-rows (narrow weeded band in the row)**

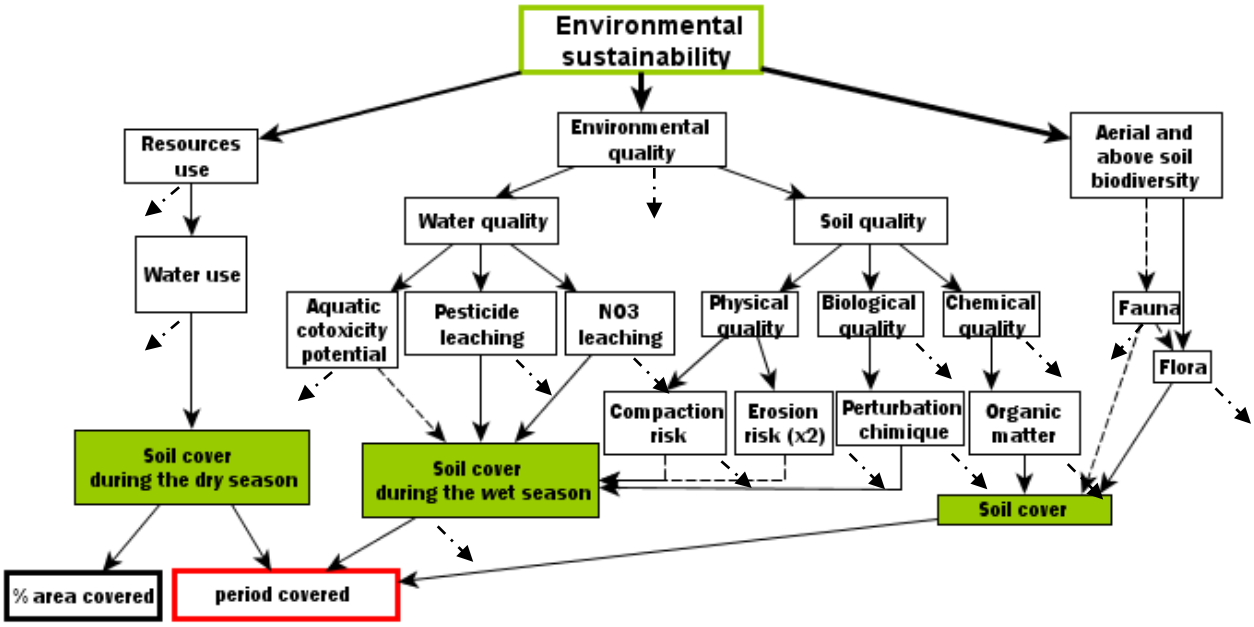
Source: document 'DEXiPM_Grapevine_inputs_october2012'

Period covered

Criterion characteristics	
Sustainability	Environmental
Secondary branch	Resources used Environmental quality Ground and aerial biodiversity
No. appearances	Twelve times
No. classes	3
Category	Cropping system factors

Objective:

This information allows us to take into account the period in which the cover (either sown or spontaneous) is present, thus influencing the risks of run-off, erosion, leaching.

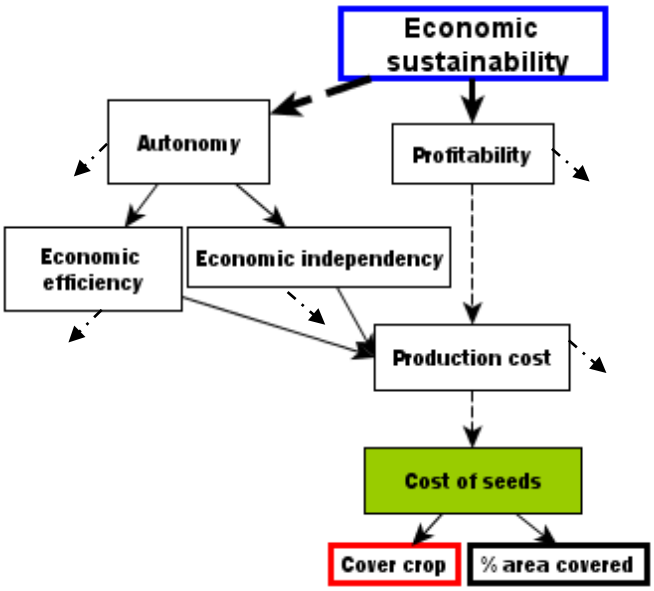


Qualitative classes:

------ Period covered ------	
Classes	
During the dry season	The length of each 'season' will depend on the region being studied. Sometimes the cover is destroyed during the 'season'. To take this into account in the evaluation of environmental risks, we must **revise the information on the surface pro-rata, taking the presence of the cover over the time period of the cover's presence.** *Example :* Total winter cover present from October to February. Rain period = 7 months. So, surface covered => 100% * 5/7 mois = **50-80 %**
During the rainy season	
All year round	

Type of cover crop

Criterion characteristics	
Sustainability	Economic
Secondary branch	Profitability Viability
No. appearances	Three times
No. classes	3
Category	Cropping system factors



Objetctive:

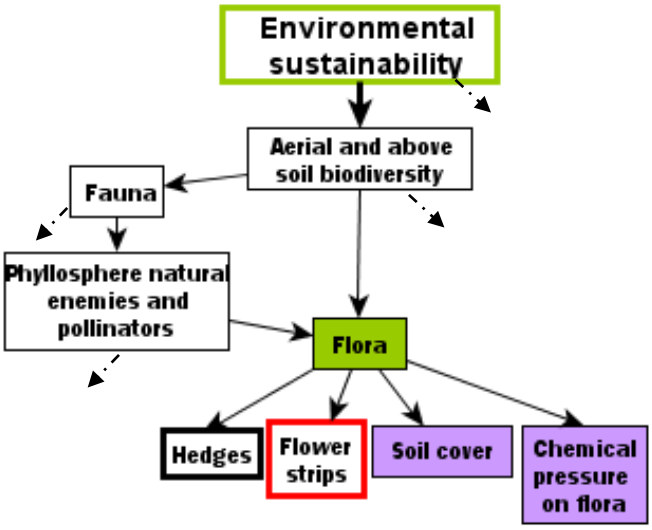
This parameter estimates the frequency of the renewal of a sown cover crop. In cases where this cover is spontaneous, we mark this criterion 'None'.

Qualitative classes:

------ Type of sown cover crop ------	
Classes	Class description
None	**Spontaneous and unsown** cover
Temporary	Cover **resown frequently** (every year or every two years)
Permanent	**Established sown cover** (regenerated every 3 to 4 years)

Flower strips

Criterion characteristics	
Sustainability	Environmental
Secondary branch	Ground and aerial biodiversity
No. appearances	Twice
No. classes	3
Category	Cropping system factors



Objective:

This criterion refers to the ability of the species present to host predators of vine pests and to attract pollinators. It depends on the species and the duration of their flowering period. For example, if the attractiveness of the species vis-à-vis pollinators is strong and the flowering extends over an entire growing season, then the environmental value of the flower strip is high.

Calculation or evaluation method:

In this study, no simple evaluation method has been found. This criterion has been completed as 'low to medium', regardless of the system.
A means of improving this has been sought in the number of mono- and dicotyledonous species present in the cover strip. When this exceeds 10 distinct species, it seems that the strip has a high environmental value. To further this work, it would be interesting to contact environmental consultancies which have developed simple evaluation methods, without recourse to complete floristic inventories.

Qualitative classes:

------ Flower strips ------	
Classes	...
None	
Low to medium	
High	

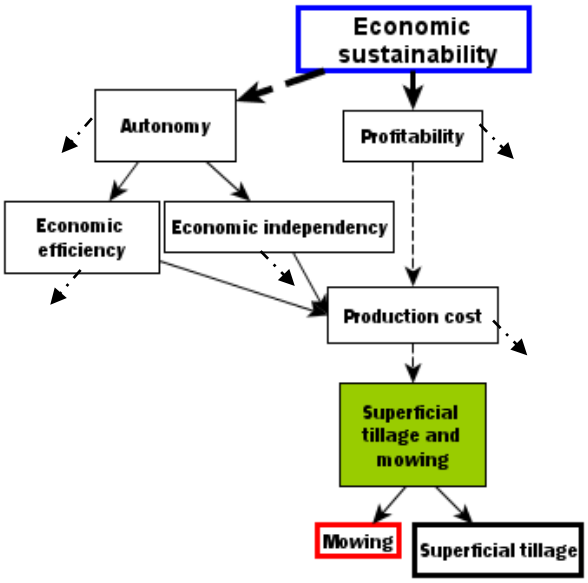
Source: document 'DEXiPM_Grapevine_inputs_october2012'

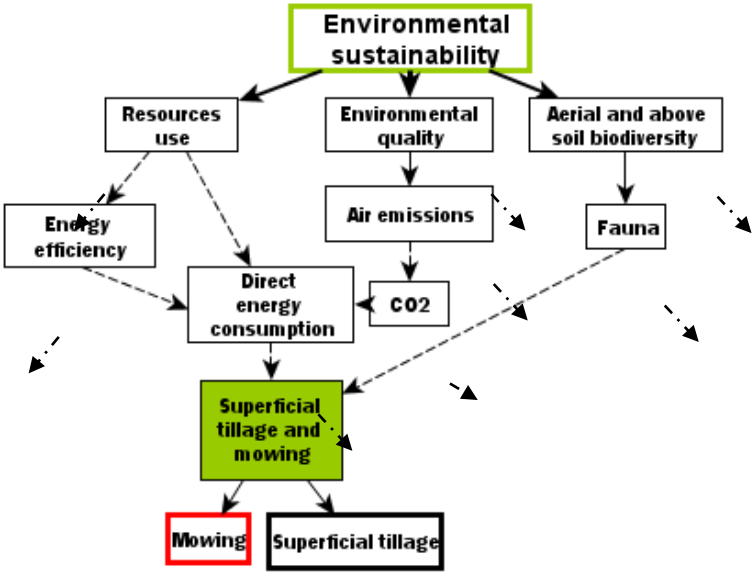
Mowing

Criterion characteristics	
Sustainability	Economic Environmental
Secondary branch	Profitability Viability Resources used Environmental quality Ground and aerial biodiversity
No. appearances	Seven times
No. classes	4
Category	Cropping system factors

Objective:

Like tillage, the number of times the cover is mowed affects production costs, direct energy consumption and populations of vine beneficials.





Calculation or evaluation method:

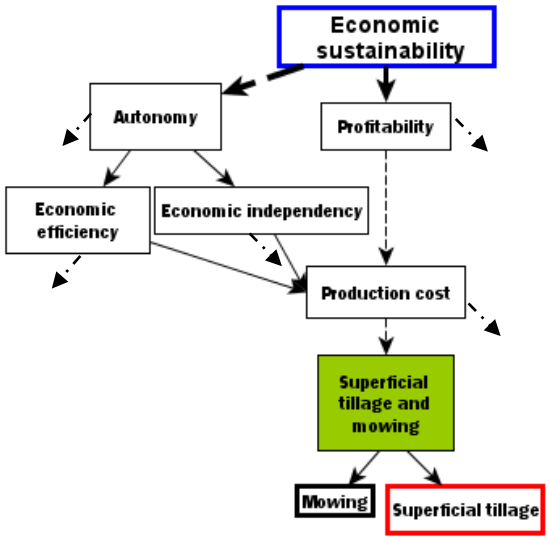
This quantitative estimate is based on the cultivation operations schedule of the cropping system in question. If the cover does not extend over the entire surface, we must then enter a number of passes in proportion to the covered area.
Example : *2 mowings of cover and weeds 1 row in 2 ⇔ so note as 1 mow*

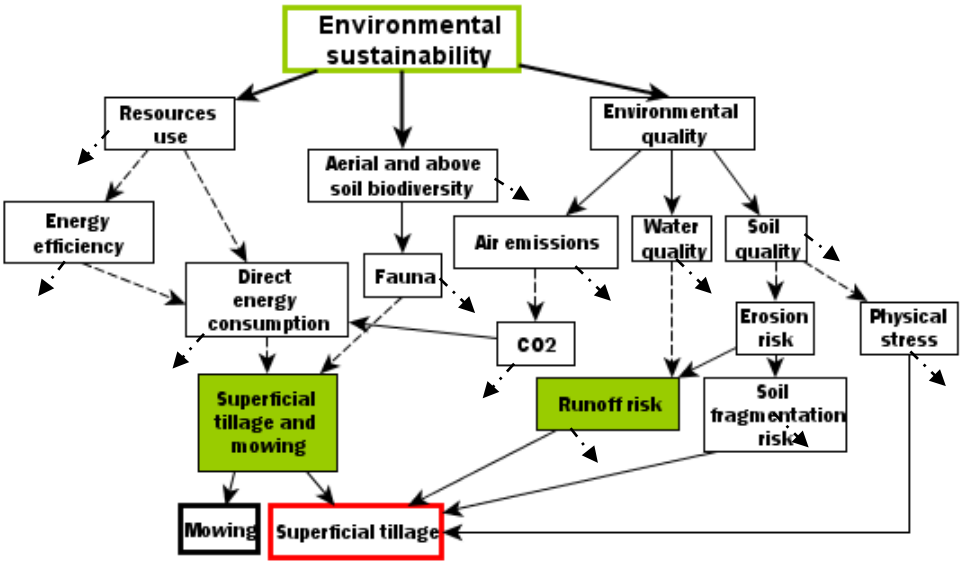
Qualitative classes:

------ Mowing ------	
Classes	No. of mowings conducted
High	>= 3
Medium	>= 2
Low	]0 - 2[
None	0

Superficial tillage

Criterion characteristics	
Sustainability	Economic Environmental
Secondary branch	Profitability Viability Resources used Environmental quality Ground and aerial biodiversity
No. appearances	Eleven times
No. classes	4
Category	Cropping system factors





Objective:

This criterion considers the average number of times superficial tillage is conducted in the inter-row.
It is taken into account in the calculation of production costs and direct energy consumption (it is an operation with high energy consumption (Gaviglio, 2010)). In addition, inter-row tillage, even if it is superficial, has a significant influence on erosion risk (Andrieux, 2006) and is therefore considered in the assessment of this risk. Here only the 'physical stress' effect for microorganism populations is considered. Finally, the last criterion in which it is aggregated concerns vine beneficials because tillage leads to the destruction of superficial cover which hosts some pest predators.

Calculation or evaluation method:

If tillage is only partial, we must enter a number of passes in proportion to the area worked.
Example: *2 tillages 1 inter-row in 2 ⇔ so 1 tillage recorded*

Qualitative classes:

---- Superficial inter-row tillage ----	
Classes	No. of passes conducted
High	**>= 3**
Medium	**>= 2**
Low	**]0 - 2[**
None	**0**

Source: document 'DEXiPM_Grapevine_inputs_october2012'

Bibliography:

Gaviglio, C. (2010). Etude des performances énergétiques des matériels viticoles. IFV station régionale Midi-Pyrénées. Matévi, lettre actualité n°45, 1-8.

Andrieux, P. (2006). "Effet des pratiques culturales sur le ruissellement et l'érosion. Vigne, sol et environnement : une rencontre profession-recherche en Languedoc Roussillon." 4p.

Chambre d'Agriculture du Bas-Rhin (2007). "Travail du sol : prudence!" Fiche Agri-mieux, disponible sur : http://www.bas-rhin.chambagri.fr/fileadmin/documents/Environnement-Innovation/agri-mieux_2007/FT_Travail_du_sol_prudence_VITI-avril2007.pdf

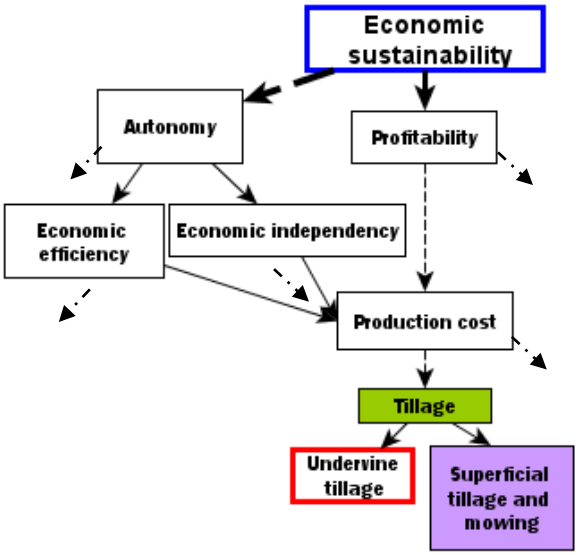
Chaussod R (1996) La qualité biologique des sols : Évaluation et implications. Forum « Le sol, un patrimoine menacé ? » Paris.

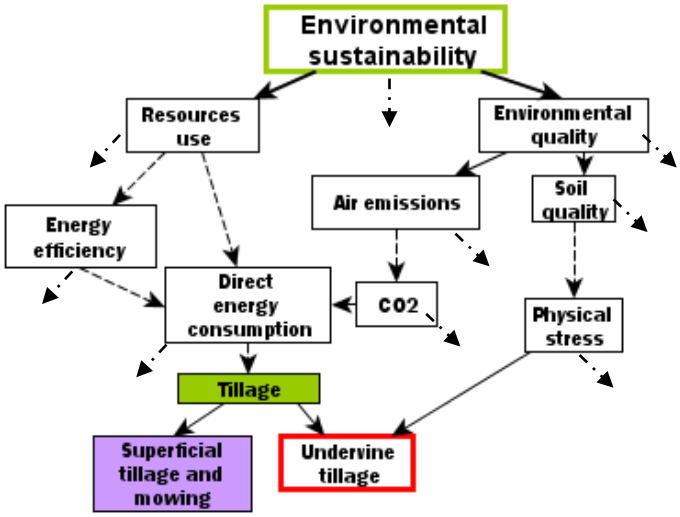
Undervine tillage

Criterion characteristics	
Sustainability	Economic Environmental
Secondary branch	Profitability Viability Resources used Environmental quality
No. appearances	Seven times
No. classes	3
Category	Cropping system factors

Objective:

This criterion considers the average number of times undervine tillage is conducted.
It has an impact on production costs, direct energy consumption and biological soil quality (see *Superficial tillage*). However, it does not affect biodiversity, as the area worked is too small to have a real impact.





Calculation or evaluation method:

See Superficial tillage

Qualitative classes:

------ Undervine tillage ------	
Classes	**No. of passes conducted**
High	**>= 3**
Medium	**]0 - 3[**
None	**0**

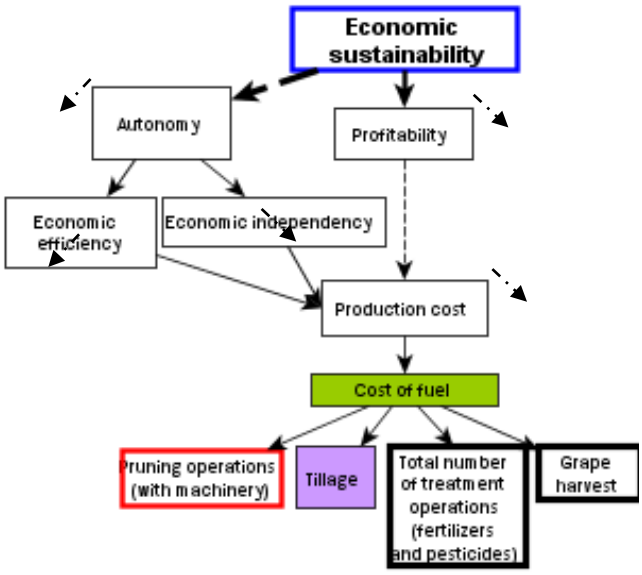
Source: document 'DEXiPM_Grapevine_inputs_october2012'

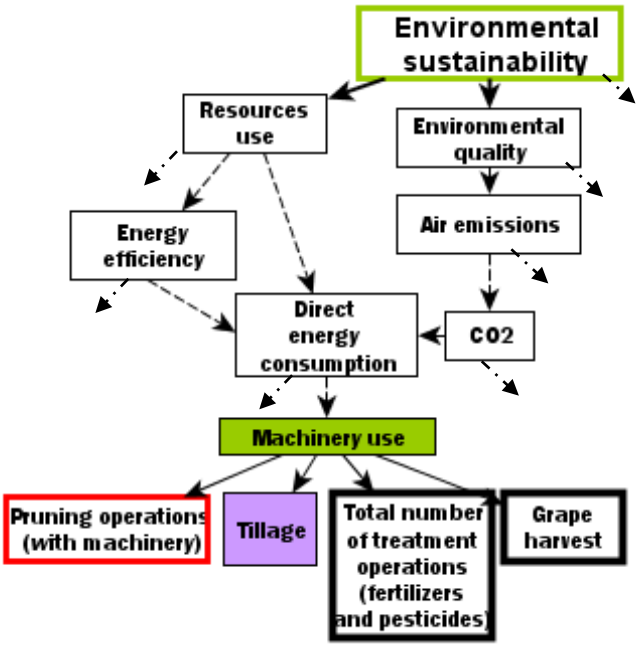
Pruning operations (with machinery)

Criterion characteristics	
Sustainability	Economic Environmental
Secondary branch	Profitability Viability Resources used Environmental quality
No. appearances	Six times
No. classes	4
Category	Cropping system factors

Objective:

This criterion concerns the number of mechanical pruning operations conducted, whether it be green pruning or 'dry' pruning (winter trimming of vine shoots). The use of electric secateurs is not included because this is a manual operation. We therefore count mechanical trimming, mechanical prepruning.





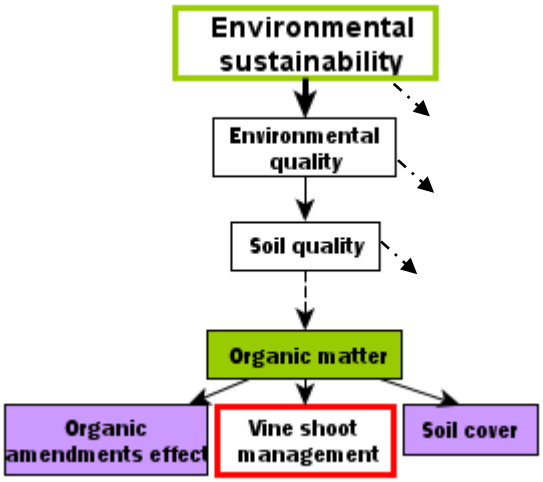
Qualitative classes:

------ Mechanical pruning operations ------	
Classes	No. of passes conducted
High	>= 3
Medium	]1 - 3[
Low	=< 1
None	0

Source: document 'DEXiPM_Grapevine_inputs_october2012'

Grapevine shoot management

Criterion characteristics	
Sustainability	Environmental
Secondary branch	Environmental quality
No. appearances	Once
No. classes	3
Category	Cropping system factors



Objective:

Prunings are an interesting source of humus in the long-term because their C/N ratio is very high (>80) (ITAB). If they are finely crushed and superficially buried in the soil, their decomposition is substantially accelerated. This practice thus increases the structural stability of the soil while significantly increasing soil biomass (Christen, 2008).

Qualitative classes:

------ Vine shoot management ------	
Classes	
Exported	Prunings **burned** or **removed from the plot**
Spread on soil surface	Prunings **left on soil, crushed or otherwise**
Crushed and buried	Prunings **crushed and buried**

Bibliography:

Christen, M. (2008). Valorisation des sous-produits de la vigne : Restitution au sol des sarments, par broyage ou après compostage. Brèves MATEVI, Chambre d'Agriculture de Gironde, Service Vigne&Vin: 5.

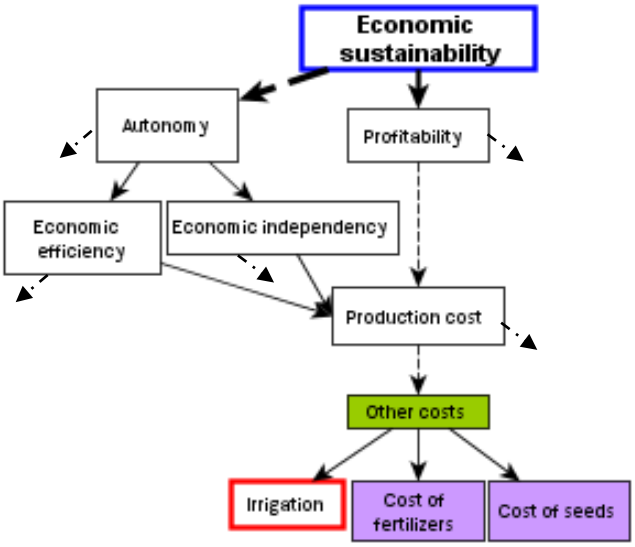
ITAB, Choix des amendements organiques en viticulture. TECHN'ITAB viticulture

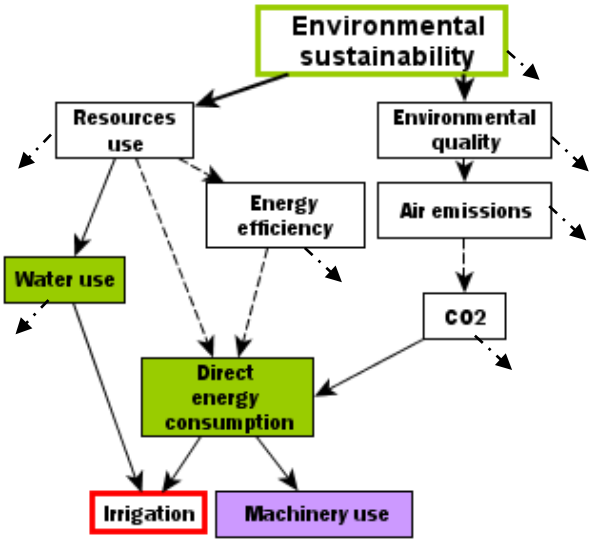
Irrigation

Criterion characteristics	
Sustainability	Economic Environmental
Secondary branch	Profitability Viability Resources used Environmental quality
No. appearances	Seven times
No. classes	2
Category	Cropping system factors

Objective:

This parameter allows us to estimate the intensity of water use. In some areas where vines are irrigated, water consumption has a cost and so is entered in the system's operational charges. This practice may also call into question the environmental sustainability of a system if it is implemented in areas where this resource is scarce and crops have large water requirements.



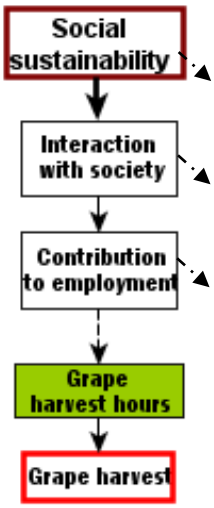


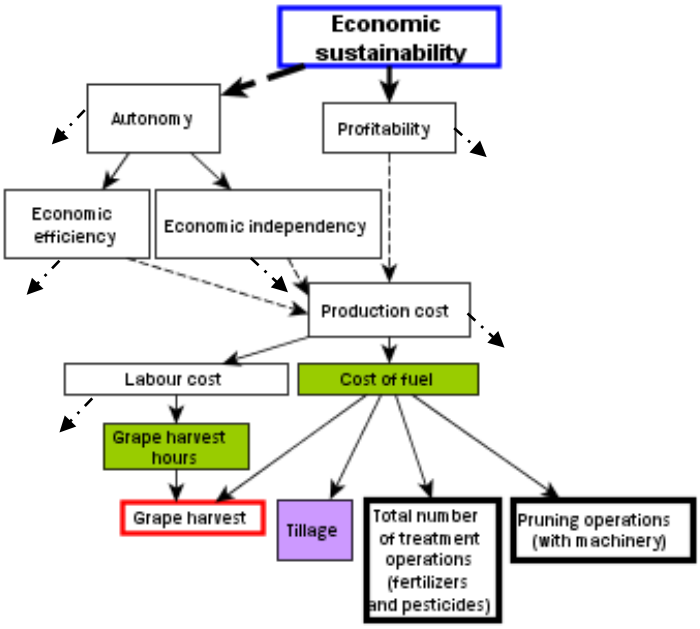
Qualitative classes:

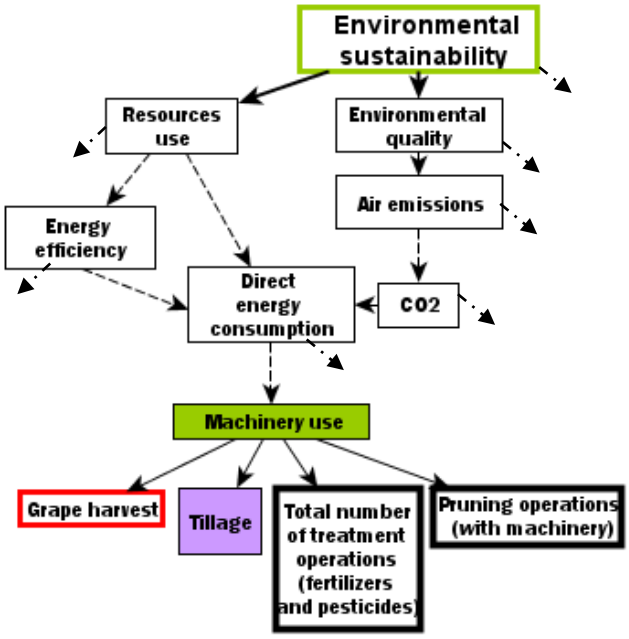
------ Irrigation ------	
Classes	
Yes	**Majority** of plots are **irrigated**
No	**Less than half** of plots are irrigated **- None**

Grape harvest

Criterion characteristics	
Sustainability	Economic Environmental
Secondary branch	Profitability Viability Interaction with society Resources used Environmental quality
No. appearances	Ten times
No. classes	2
Category	Cropping system factors







Objective:

Whether grape harvesting is conducted manually or mechanically has an impact on the cost of production, the contribution to employment, and also to direct energy consumption.

Qualitative classes:

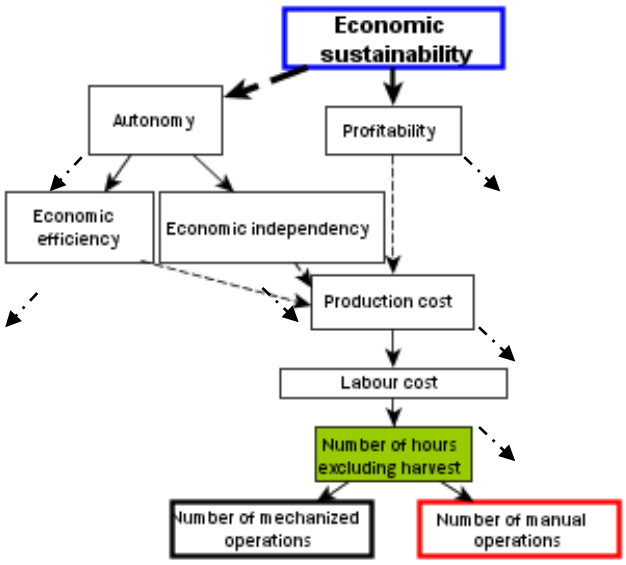
------ Grape harvest ------	
Classes	
Mechanical	Majority of plots are **harvested by machine**
Manual	Majority of plots are **harvested by hand**

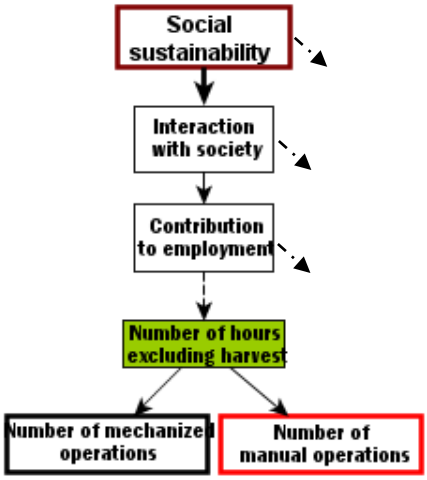
.

Number of manual operations

Criterion characteristics	
Sustainability	Economic Social
Secondary branch	Profitability Viability Interaction with society
No. appearances	Four times
No. classes	4
Category	Cropping system factors

Objective:
This criterion considers the number of manual operations with the aim of estimating the number of working hours.





Calculation or evaluation method:

→ If two operations are linked, then count it as only one operation.
→ If an operation is conducted on only a part of the plot, then it should be counted pro-rata to the surface concerned (so 0.5 for an operation carried out every second row).

Qualitative classes:

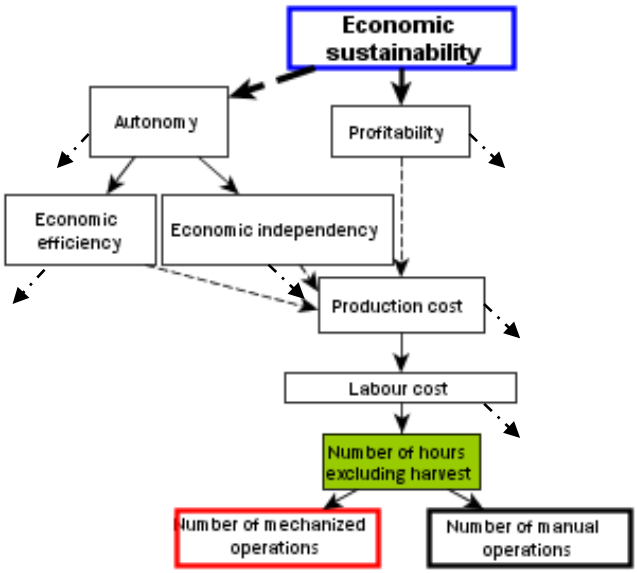
------ Number of manual operations ------	
Classes	No. of operations conducted
High	> 5
Medium	2 - 5
Low	< 2
None	0

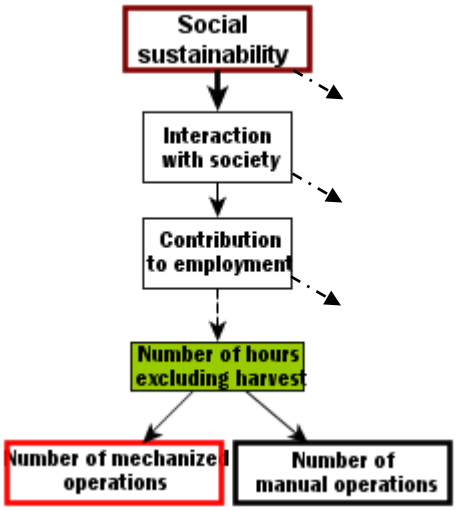
Source: document 'DEXiPM_Grapevine_inputs_october2012'

Number of mechanised operations

Criterion characteristics	
Sustainability	Economic Social
Secondary branch	Profitability Viability Interaction with society
No. appearances	Four times
No. classes	3
Category	Cropping system factors

Objective:
This criterion considers the number of mechanised operations with the aim of estimating the number of working hours.





Calculation or evaluation method:

→ If two operations are linked, then count it as only one operation.
→ If an operation is conducted on only a part of the plot, then it should be counted pro-rata to the surface concerned (so 0.5 for an operation carried out every second row).

Qualitative classes:

------ Number of mechanised operations ------	
Classes	**No. of operations conducted**
High	**> 18**
Medium	**15 - 18**
Low	**< 15**

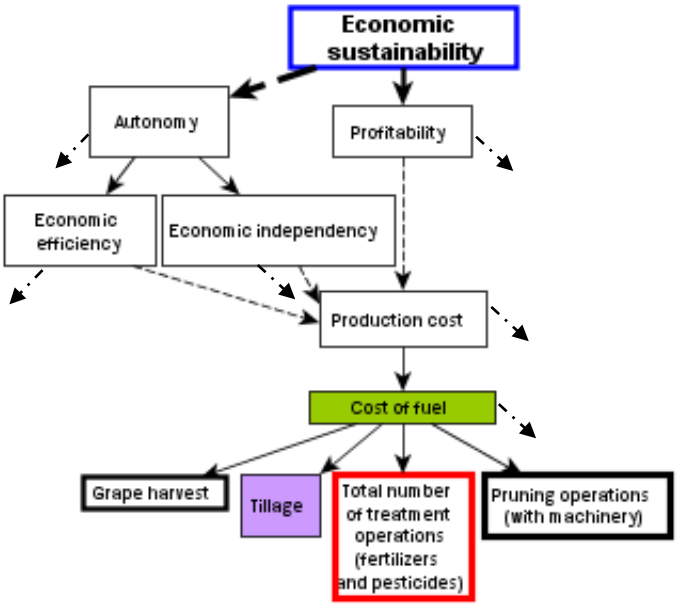
Source: document 'DEXiPM_Grapevine_inputs_october2012'

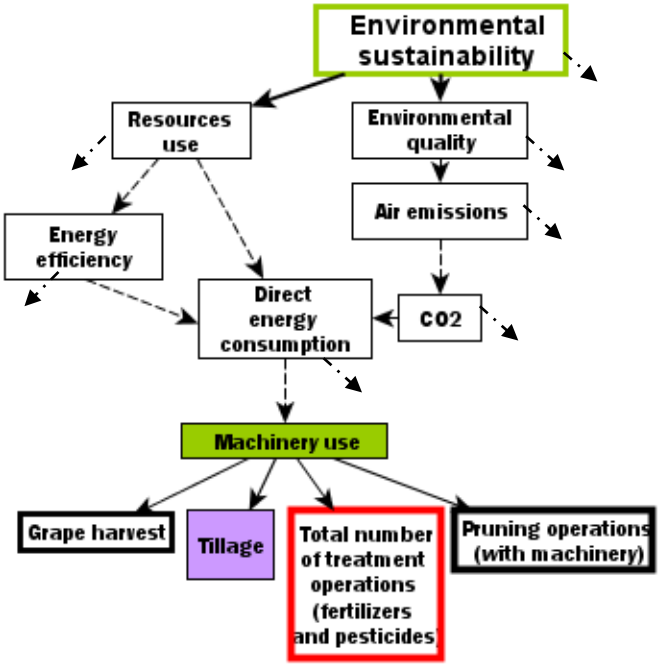
Total number of treatment operations (fertilisers and pesticides)

Criterion characteristics	
Sustainability	Economic Environmental
Secondary branch	Profitability Viability Resources used Environmental quality
No. appearances	Six times
No. classes	3
Category	Cropping system factors

Objective:

This criterion makes it possible to count the number **of passages** conducted for treatments (for fertilisation or crop protection) at the crop cycle scale. The objective is to evaluate the 'financial cost' of production and the 'environmental cost' of energy consumption but not the impact of treatments on different environmental compartments.





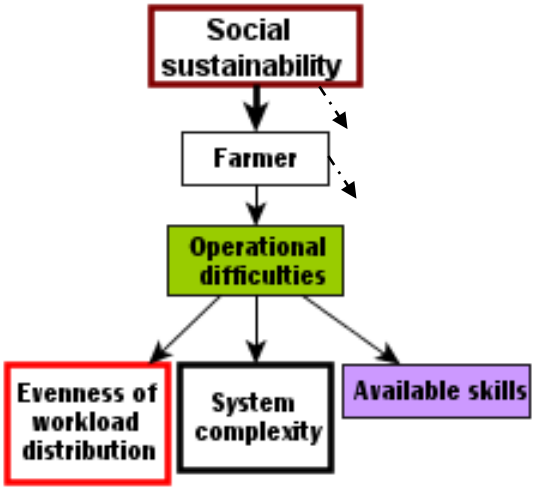
Qualitative classes:

------ Total number of treatments ------ (fertilisers and pesticides)	
Classes	No. of operations conducted
High	>= 14
Medium	[9 - 14 [
Low	< 9

Source: document 'DEXiPM_Grapevine_inputs_october2012'

Evenness of workload distribution

Criterion characteristics	
Sustainability	Social
Secondary branch	Farmer
No. appearances	Once
No. classes	3
Category	Cropping system factors



Objective:

This parameter is used to evaluate the homogeneity of the workload distribution over the year or over shorter periods (for example, harvesting periods). This data is taken into account when estimating the operational difficulties the farmer could face if the system is adopted. From the perspective of social sustainability, a system will be more appropriate than another if it is compatible with other cropping systems on the farm in terms of management and conducting cultural operations.

So, if many operations need to be completed at the same time, through a lack of personnel or equipment, the adoption of the system will not be sustainable for the farmer.

Calculation or evaluation method:

The suggested evaluation method has been defined *de novo* by an expert (D. Sauvage, CA71).
In viticulture, the most highly charged work period (not including harvesting) is during the months of May and June (for example, vegetative growth, crop protection, etc.). Concerning the harvest period, the workload depends primarily on the weather conditions. This is the reason we have chosen to focus only on the months of May and June.

During this period, the **farm's own characteristics** have a significant impact on the workload. These are:

- The surface area by Unit of Labour ('surface/UOL')
- In the context of mixed farms, the existence of another agricultural activity (for example, a fruit processing unit)

Concerning the **cropping system**, it is the practice of mechanical soil maintenance and/or organic production methods which are the key markers of workload.

In summary:

➔ **Critical work period = May-June**

→In May-June, <u>three principal determinants of workload</u>:

- *Surface size/UOL*
- *Existence of another agricultural activity*
- *Mechanical soil maintenance used and/or organic production methods*

If:

- 2 conditions/3 are verified for the cropping system
  ➔ Heavy workload = **poor distribution** of workload
- 1 condition/3 is verified for the cropping system
  ➔ Medium workload = **average distribution** of workload
- No condition is verified for the cropping system
  ➔ Low workload = **good distribution** of workload

The fact remains that a grower may or may not tolerate this workload according to the importance the system represents for his farm, following the financial evaluation, etc. Among all of these variables, job satisfaction is a limiting factor. Indeed if the grower is not satisfied, whatever the cause of the dissatisfaction, he will not tolerate an additional workload. Therefore the previous conclusion is modulated according to the criterion 'job satisfaction':

Job satisfaction	Distribution of workload
• Low	**- 1 class**
• High	**+1 class**

Note: the average ha/UOL ratios are available through regional management centres, and for segmentations of regional farm groups (for example, wine cooperative/private producer groups). We tolerate a margin of 0.5, which we had to the data given, a threshold from which we consider the balance ha/UOL to be important.

Qualitative classes:

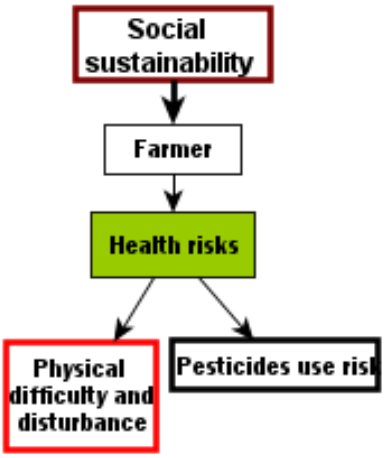
------ Distribution of workload ------	
Classes	**i.** Size of surface/ULO, **ii**. Existence of another agricultural activity, **iii.** Mechanical soil maintenance used and/or organic production methods
Poor	**2 conditions/3 are verified** for the cropping system
Medium	**1 condition/3 is verified** for the cropping system
Good	No condition is verified for the cropping system
⇨ **+ 1 class** if	• Grower **satisfaction** is **high**
- 1 class if	• Grower **satisfaction** is **low**

Complementary information:

------ Examples of 'ha/UOL'averages in different production areas ------				
'ha/UOL'	Saône-et-Loire	Savoie	Var	Maine-et-Loire
For different farm structures	▪ Cooperative winery: 5.7 ▪ Private producer: 3.3 *Source : CER France, Fermoscopie 2011*	▪ Coop. : 5.5 ▪ Private: 3	▪ Coop. : 13 ▪ Private: 8	▪ Farm 100% vine: 3.3 ▪ Mixed farm, vine dominant: 3.6
Threshold value	**➔ 6.2ha/UOL** **➔ 3.8ha/UOL**	**➔ 6ha/UOL** **➔ 3.50ha/UOL**	**➔ 13.5ha/UOL** **➔ 8.5ha/UOL**	**➔ 3.8ha/UOL** **➔ 4.1ha/UOL**

Physical difficulty and harshness of work

Criterion characteristics	
Sustainability	Social
Secondary branch	Farmer
No. appearances	Once
No. classes	3
Category	Cropping system factors



Objective:

This criterion concerns the level of physical and mental hardship associated with the cropping system. The higher this is, the less the system is deemed socially sustainable for the grower.
This harshness is expressed differently according to the wine-producing region concerned. This variability is mainly due to the production method used (for example, high/low vines). Climatic conditions also play a role (for example, work that has to be done in snowy conditions, etc.). Besides these points, farm organisation plays a role, too, in that tasks which must be performed force growers to maintain a high workpace at the expense of health precautions (personal communication, MSA Gironde). Added to this is the equipment used, which can significantly affect the difficulty of the tasks.
Concerning pathologies, musculoskeletal disorders (MSD) are the largest category of occupational disease among wine-growers (MSA 2010). They correspond to upper limb disorders and are caused by repetitive movements, carrying heavy loads, vibrations and cold, etc. Other conditions are also highlighted, such as intoxication. The latter will be addressed in the criterion 'health risk due to the use of pesticides'. Therefore, only the intensity of MSD symptoms and back pain are taken into account when estimating the physical difficulty and harshness of work.

Calculation or evaluation method:

The evaluation method proposed was defined *de novo* by an expert (Didier Sauvage), using data from the MSA and the results of interviews with wine-growers in the DEPHY network. The rationale behind the evaluation are wine-growers' perceptions of the harshness and physical difficulty of their work.

It emerged that the tasks classed as the most painful and difficult for wine-growers are:

- Manual tasks (versus mechanised tasks)
- Winter operations because of their repetitiveness and weather conditions (for example, pruning)
- Trellising work (particularly their construction)
- Operations which effect their morale (for example, having to work with an awkward stance because of very irregular topography in a plot).

(Field studies MSA Saône et Loire, interviews with wine-growers in the DEPHY 71 network)

Planting density has the greatest effect on the physical difficulty and harshness of conducting the above-mentioned tasks: the higher it is, the greater the number of manual tasks and the longer these tasks will take (increasing the number of repetitive movements, extending the time required for winter pruning, reduced opportunities for mechanising tasks, etc.). The intensity of MSD symptoms and back pain are therefore assessed as a function of planting density (see decision tree below).

We then complete the analysis of the potential physical difficulties with an estimation of the possible effect on morale that adopting the cropping system could generate. This evaluation is based on two parameters: the number of hectares/Units of Labour (UOL) and the degree of risk associated with the cropping system.
→ The first is justified by the fact that a grower can offset a decrease in density by increasing surface area, while keeping the same number of employees, which could increase the difficulty and harshness of operations.
→ The second is strongly correlated with the effect on morale the grower could feel if using new practices. This mainly concerns 'disease management' because the yield and quality of the crop is heavily dependent on this factor. Therefore, the assessment of taking this risk is based on a threshold value for TFI fungicides, defined by region.

1

Estimate of difficulty and harshness of work **according to growing method**

Physical difficulty

	Planting density		
	5000	7000	9000
MSD / **Back pain**	Low	Medium	High

2

Estimate of difficulty and harshness of work **according to strategy adopted**

		Associated risk taken
High TFI fungicides	> 9	None
Medium to low TFI fungicides	[5-9]	Significant

Challenge to morale

		ha/UOL	
		Constant	Increased
Risk taken	None	Low	Medium
	Significant	Medium	High

1+2

Overall estimate of difficulty and harshness of work

3

Overall difficulty and harshness

		According to strategy		
		Low	Medium	High
Accoding to growing method	Low	Low	Medium	Medium
	Medium	Low	Medium	High
	High	Medium	High	High

Qualitative classes:
See Step n°3 before

------ Examples of values for 'TFI fungicides threshold' for different vineyards ------				
'TFI fungicides threshold'	Saône-et-Loire	Savoie	Var	Maine-et-Loire
Threshold value	➔ **9**	➔ **9**	➔ **7**	➔ **8**
Source	ExpertsVinipôle & CA Saône et Loire	Experts CA Savoie	Experts CA Var	Experts CA Maine-et-Loire

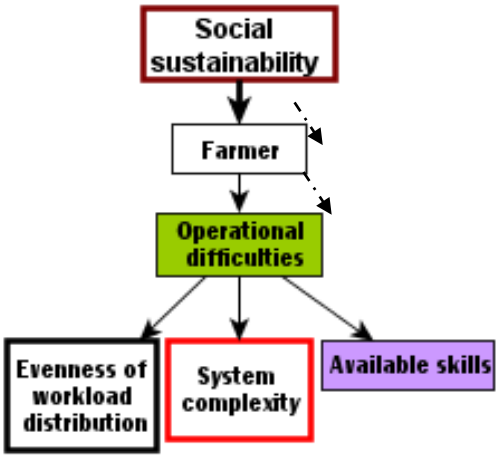
Bibliography:

MSA (2010a). Observatoire des troubles musculo-squelettiques des actifs agricoles - SYNTHESE NATIONALE 2006-2010: 89.

MSA (2006). Approche statistique des risques professionnels des non-salariés agricoles : Synthèse nationale. Santé-sécurité au travail, Caisse centrale de la MSA 6p. Disponible sur : http://references-sante-securite.msa.fr/files/SST/SST_1223465574817_NS_ATMP_2003_2006.pdf

System complexity

Criterion characteristics	
Sustainability	Social
Secondary branch	Farmer
No. appearances	Once
No. classes	5
Category	Cropping system factors



Objective:

This criterion estimates the ease of implementing an innovative system. The assessment takes into account the quality objectives and the difficulties of controlling the interventions associated with grape growing. The diversity of plots (each plot has its own characteristics in terms of variety, topography, climate, etc.) and/or the number of different operations and/or the complexity of some operations in particular are a source of difficulty in crop system management (taken from surveys with wine-growers in France's DEPHY network). For example, producing grapes in grassed vineyards is more complex than producing crops with full chemical weed control.
A system could also be considered complex as a function of the difficulty the producer would have in learning the strategies to be used, but this parameter is considered in the 'interaction with society' branch and should not be taken into account in the evaluation of this criterion.

Calculation or evaluation method:

The evaluation method proposed was defined *de novo* by an expert (D. Sauvage, CA71).

Four points should be considered:

1. Plot diversity
2. Presence of complex operations
3. Total number of operations
4. Use of Decision Support Systems (DSS)

The fact remains that if the grower has important qualitative goals for the cropping system, he will rationalise his system according to the physiology of the vines and the soil and climatic characteristics of each plot. Therefore, the system will be more complex to manage when the qualitative objective is high.

Diversity of plots in the cropping system

Three parameters have been selected as the main sources of measuring this heterogeneity:

- The **number of varieties** (if they are managed differently, at least during the harvest)
- The **diversity of growing systems** (planting density, pruning system, trellising etc.)
- The **number of plots** (division of plots more or less dispersed)

Complexity of operations

Operations to be considered as 'complex to implement':

- **Prophylactic measures**
- Interventions for the **control of yields**
- **Monitoring thresholds** for pest control
- **Ground cover** and/or **mechanical weeding**

Indeed, these require knowledge and greater vigilance on the physiology of the vine and the relationships between the soil-plant-ground cover. No other operation should be taken into account in the evaluation of this criterion.

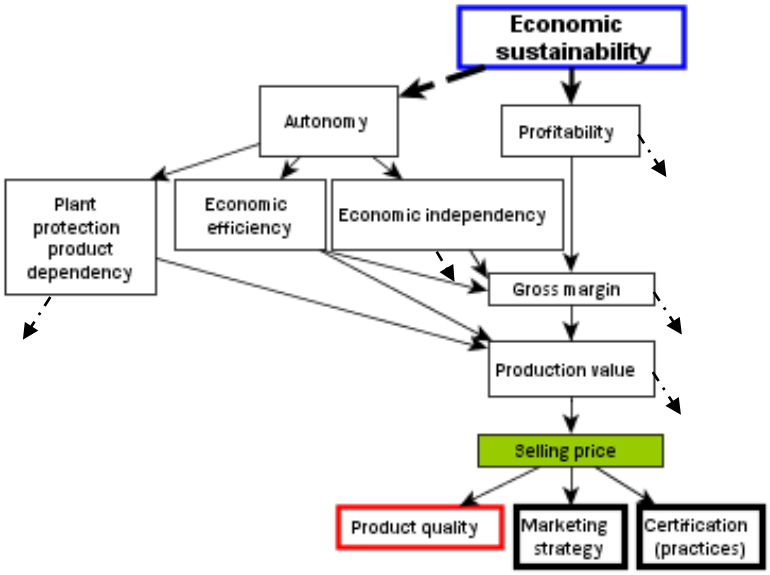
+ 1 class if	• **High** total number of operations
+ 1 class if	• **Use** of DSS

Qualitative classes:

------ Complexity of cropping system ------	
Classes	
Very high	According to expert opinion, considering the four points in the method proposed above.
High	
Medium	
Low	
Very low	

Product quality

Criterion characteristics	
Sustainability	Economic
Secondary branch	Profitability Viability
No. appearances	Five times
No. classes	3
Category	Cropping system factors



Objective:

This criterion provides information on the quality expected from products of the production system. It takes into account product development strategies other than those using certification. For example, a domain which has a policy of high yields but is seeking quality with value-creation on the estate will not necessarily have a sale price lower than that of an estate run on sustainable lines or a vineyard whose wines are sold under an AOP (PDO) label.

Calculation or evaluation methods:

The desired sale price of the product has been chosen to measure quality.
This proposition is based on the premise that quality is better remunerated. From this, price is a simple indicator enabling us to position each product in its market, compared to an average product from the same appellation. In addition, this variable better reflects better the quality of the wine class sought rather than simple phrases such as 'top of the range' or 'entry level', which are specific to each operation and mean nothing when taken out of context.
To ensure that the tool is sensitive enough to discriminate between vineyards, the choice has been made to refer to the average price for each category of wine (AOP or PDO, IGP, Vin de France).

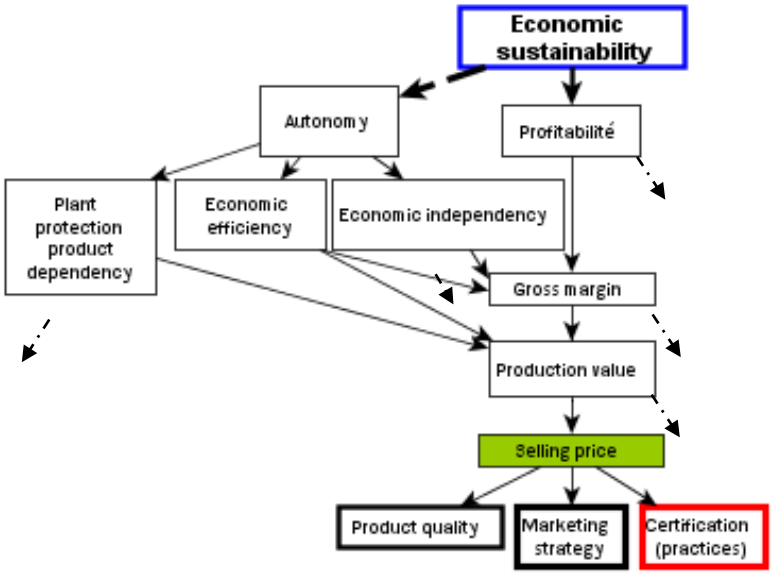
Note: To compare several systems which are evolutions of the first and, for example, tend to reduce environmental impact, we must try to assess the impact of this progress on the quality of the wine produced and whether this gain can be passed on in the final selling price.

Qualitative classes:

------ Product quality ------	
Classes	
Price < Average departemental price	Take as a reference the departmental average price for this appellation
Price = Average departmental price	
Price > Average departmental price	

Certification

Criterion characteristics	
Sustainability	Economic
Secondary branch	Profitability Viability
No. appearances	Five times
No. classes	2
Category	Cropping system factors



Objective:

The criterion for certification of a mode of production is integrated in the estimation of the selling price because, in the majority of cases, compliance with specifications allows an additional supplement to be charged for the final product. Some of them (or charters) such as agriculture raisonnée (sustainable farming) are more about gaining market access. These labels are not to be considered in this regard.

Calculation or evaluation method:

This criterion is to be completed directly by an expert, based on:

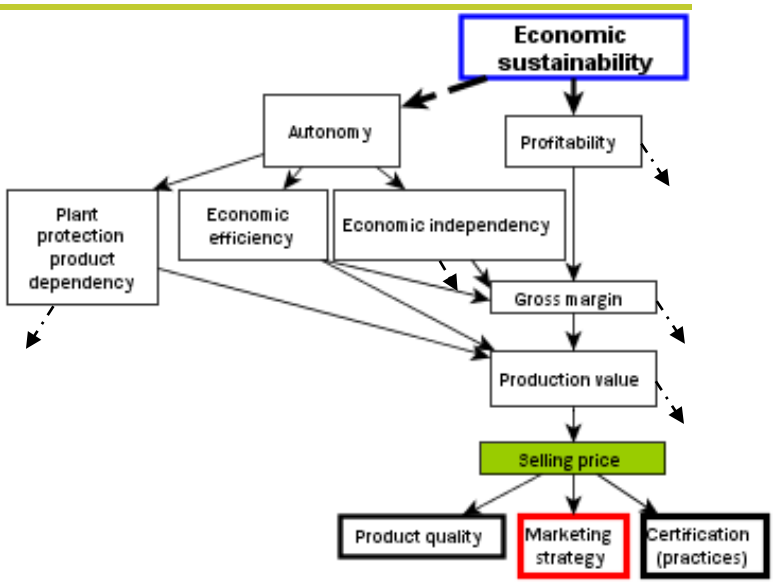
- The ways for adding value to the wine envisaged by the wine-grower
- Existing markets for these methods and their recognition by consumers

Qualitative classes:

------ Certification ------	
Classes	
No or little added value	**Certification does not justify additional price** (significant) for the product and/or **no existing or accessible market** to take advantage of this certification
Strong added value (significant)	**Certification justifies a significant rise in the price of the product** and **existing markets** for marketing this product under the certification (consumers willing to pay more for a product carrying this certification)

Marketing strategy

Criterion characteristics	
Sustainability	Economic
Secondary branch	Profitability Viability
No. appearances	Five times
No. classes	2
Category	Cropping system factors



Objective:

The inclusion of this criterion is to offset the fact that obtaining certification for some products is impossible (unauthorised cultivars in the specifications of an AOP/PDO etc.).
Aside from certification, an effective marketing strategy is therefore an important tool for promoting the product. This criterion makes it possible to answer the question 'Do we have the means to commercially enhance our product and are we doing everything in our power to implement it effectively?'

Calculation or evaluation method:

For an ex-post evaluation of this parameter we can follow gains in market share as an indicator, corresponding to changes in turnover compared to a benchmark (turnover of enterprises in the same category). Therefore, gains in market share allow us to assess the effectiveness of the marketing strategy deployed (personal communication, F. Cheriet, Montpellier SupAgro).
If we do not have access to this information, the marketing strategy can be evaluated by examining the marketing actions conducted in order to better promote the product. For example (*surveys conducted in 2013 among growers in the DEPHY 71 network*), a good marketing strategy involves:

- Participation in exhibitions and competitions
- A varied and easily understood range of wines
- Activities at the point-of-sale (for example, the organisation of a picnic and wine tasting in the cellar etc.)
- Careful monitoring of customers (and, especially, for export)

But also,

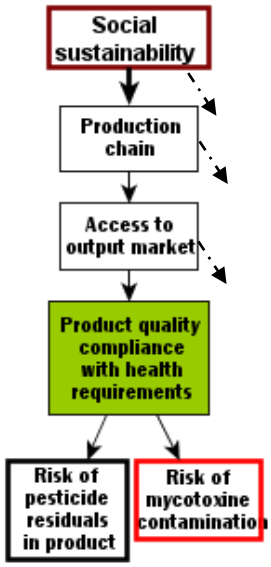
- Conducting an active and continued exploration for customers, thereby continually seeking new markets and, particularly, exports.

Qualitative classes:

------ Marketing strategy ------	
Classes	
No creation of added value	To be completed by an expert considering the elements listed above
Creation of added value	

Risk of mycotoxin contamination

Criterion characteristics	
Sustainability	Social
Secondary branch	Production chain
No. appearances	Once
No. classes	2
Category	Cropping system factors



Objective:

The mycotoxin which can be found in wine is Ochratoxin A (OTA), secreted by the fungus *Aspergillus carbonarius*. This can develop when grapes begin to change colour on damaged (caused by hail, grape berry moth attacks, etc.), burst or withered berries. High humidity and temperatures favour its development. A survey by ITV (Lataste *et al*., 2004) investigated the level of OTA in French production: 97% of wines contained less than 1 µg/L of Ochratoxin A and 92% less than 0.5 µg/L. It also appears that the musts from vineyards more than 60km from the Mediterranean Sea (contamination basin in France) contain an average of 0.5 µg/L of OTA (Lataste, 2004). This concentration tends to decrease during fermentation (Lataste, 2004). European regulations set a maximum OTA level of 2 µg/L for wines for commercial sale. However, we should pay attention because in Canada, for example, a maximum of only 1 µg/L is allowed (Kyprianou, 2005).

Calculation or evaluation method:

There are maps of European wine-growing areas classified according to their 'OTA risk', produced by analyses of must destined for processing for grape juice. However, their scale is not precise enough for their use in DEXiPM Vine.

The proposed method has been defined by the ICV group. It takes into account several characteristics: geographical and climatic (altitude, distance from the sea, etc.), environmental (risk of grapemoth attack), agronomic (vigour, presence or absence of damage to grapes) and oenological (the intended destination of grapes largely determines the harvest date). An evaluation of moth pressure and associated damage is important to refine the risk estimate. However, if quantitative data is not available for the tested cropping system, these variables should be indicated by an expert based on his knowledge of the vineyard.

Two risk assessment grids are available, depending on the period in which the study is conducted ('before the first generation of moths' (Table 9) and 'before the second generation' (Table 10)).

Table 8: Risk assessment grid for Ochratoxin A before the first generation of moths

Critères	Echelle de notation			Notes
	1	2	3	1, 2 ou 3
Type de vinification	Blanc, rosé [1]	Rouge classique [2]	Rouge phénolique [3]	
Distance mer [4]	> 60 km	30 à 60 km	< 30 km	
Altitude	> 200 m	100 à 200 m	< 100 m	
Analyses antérieures d'OTA	< 0,5 µg/l	0,5 à 1 µg/l	> 1 µg/l	
Pression habituelle de tordeuses à la vendange dans la zone viticole (en % de grappes avec foyers)	< 10%	10 à 30 %	> 30 %	
Palissage	oui		non	
Etat sanitaire l'année précédente à la vendange (% de grappes atteintes)	< 2 %	2% < < 10%	> 10 %	
		INDICE DE RISQUE OTA		

[1]: Grapes for the production of fruity white and rosé wines. [2]: Grapes for the production of supple and fruity red wines. [3]: Grapes harvested at phenolic maturity (later than fruity reds) for the production of concentrated red wines. [4]: Distance between the vineyard and the sea. For vineyards where summer rainfall is high, we can consider them as being in a similar situation to a coastal vineyard.

Table 9: Risk assessment grid for Ochratoxin A before the second generation of moths

Critères	Echelle de notation			Notes
	1	2	3	1, 2 ou 3
Type de vinification	Blanc, rosé [1]	Rouge classique [2]	Rouge phénolique [3]	
Distance mer [4]	> 60 km	30 à 60 km	< 30 km	
Altitude	> 200 m	100 à 200 m	< 100 m	
Analyses antérieures d'OTA	< 0,5 µg/l	0,5 à 1 µg/l	> 1 µg/l	
Pression de tordeuses observée (en % de grappes avec foyers)	< 10%	10 à 20 %	> 20 %	
Aération des grappes [6]	correcte	insuffisante	entassements	
Etat sanitaire des baies (% de grappes atteintes)	< 1 %	1% < < 5%	> 5 %	
		INDICE DE RISQUE OTA		

[1]: Grapes for the production of fruity white and rosé wines. [2]: Grapes for the production of supple and fruity red wines. [3]: Grapes harvested at phenolic maturity (later than fruity reds) for the production of concentrated red wines. [4]: Distance between the vineyard and the sea. For vineyards where summer rainfall is high, we can consider them as being in a similar situation to a coastal vineyard.

Source: ICV group, 2008

Qualitative classes:

------ Risk of mycotoxin contamination ------	
Classes	**OTA risk index** = average of scores obtained
Yes	Elevated risk: **> or = 2.2**
No	Moderate risk (considered nil) : **> or = 1.6**

Source: ICV group, 2008

Bibliography:

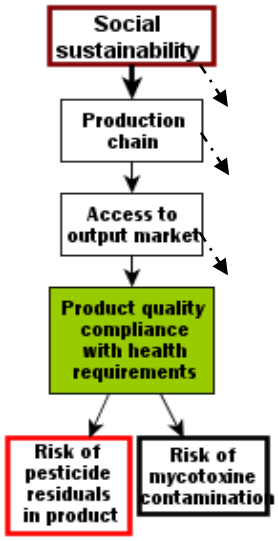
Lataste, C., L. Guérin, *et al*. (2004). Évolution de la contamination en ochratoxine A : du vignoble français au vin, ITV France.

Kyprianou, M. (2005). Règlement (CE) No123/2005 de la commission du 26 janvier 2005. Bruxelles, Journal officiel de l'Union européenne.

Rousseau J (2008) Maitrise du risque ochratoxine A dans les vins. Lattes: ICV, Département Vignes & Vins.

Risk of pesticide residuals in product

Criterion characteristics	
Sustainability	Social
Secondary branch	Production chain
No. appearances	Once
No. classes	3
Category	Cropping system factors



Objective:

This criterion addresses the probability of finding pesticide residues in wine in significant concentrations (greater than the maximum residue limits (MRLs) for wine grapes).
The probability of finding pesticide residues in the finished product depends on two main variables: (i) the doses of pesticides applied and (ii) the time between 'treatment dates' and 'harvest'. The first variable is estimated by the number of active ingreients (a.i.) applied at least three times in the season. The second variable is a general indication: if pre-harvest intervals (PHI) are not adhered to, then there is an increased risk of finding residues in wine.

Calculation or evaluation method:

To complete this parameter, the expert needs to identify active ingredients applied more than three times during the season. Of these, all those of which the last application was made in the corresponding period of 2-3 times the PHI will be counted. Their number allows us to estimate the risk of contamination of wine with pesticide residues.

Qualitative classes:

------ Risk of contamination with pesticide residues ------	
Classes	No. of a.i. applied more than three times in the season and whose last application was in the period 2-3*PHI
High	**>1 a.i.** applied more than three times
Medium	**1 a.i.** applied more than three times
Low	**No a.i.** applied more than three times

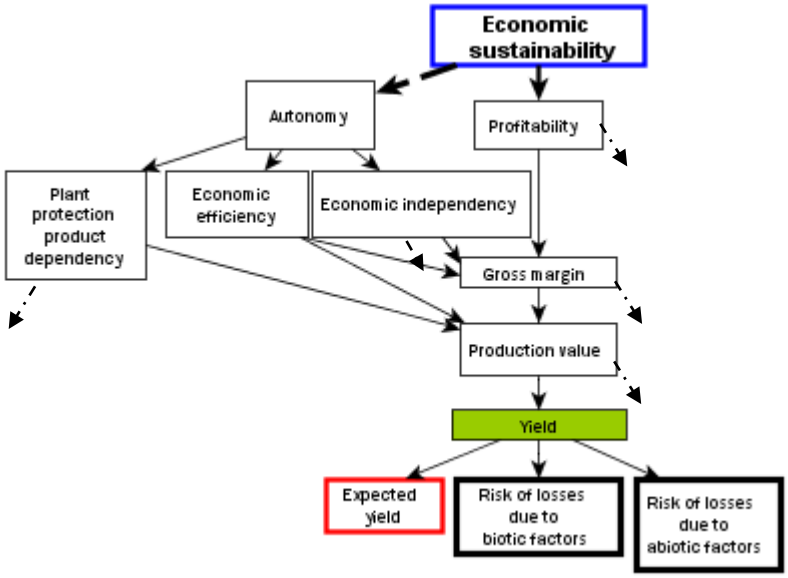
Source: document 'DEXiPM_Grapevine_inputs_october2012'

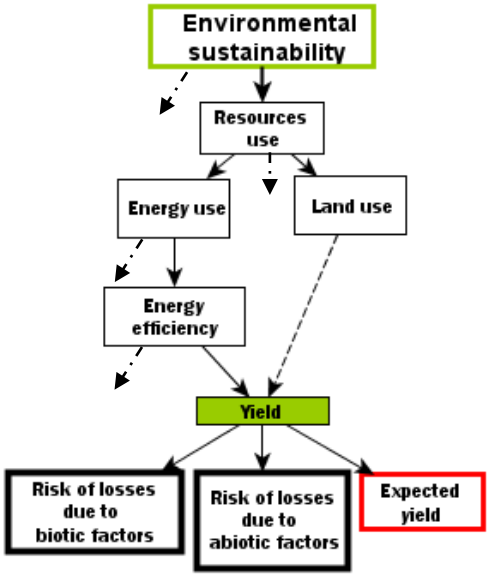
Bibliography:

Fortino, G., E. Lô-Pelzer, *et al*. (2007a). "Presentation of the updated version of DEXiPM arable crops. A qualitative multi-criteria model for the assessment of the sustainability of pest management systems" INRA, Deliverable DR2.22a.

Expected yield

Criterion characteristics	
Sustainability	Economic Environmental
Secondary branch	Profitability Viability Resources used
No. appearances	Seven times
No. classes	3
Category	Cropping system factors





Objective:

This criterion reflects the grower's target yield for the cropping system. Its assessment considers the commercial objectives and the impacts of innovative methods on yield (for example, the practice of minimal pruning for Merlot leads to a significant increase in yield in the early years which fades after two to three years (+20% to +70%) (IFV, 2011).

The main cultural practices (other than pruning method) which should be taken into account in assessing the expected yield are: (i) ground cover, (ii) disbudding, and (iii) thinning (Aouadi, 2010). Planting density also has an impact (Ollat, 2002): high densities are characterised by a high potential production (good light interception); those of low-density vineyards less so, though this should be qualified somewhat according to growing method. To these parameters we add the introduction of mechanical weeding, which affects the shallow root system of vines (these grow without constraint, on the surface, in the absence of tillage, ground cover or shallow ground). Reduced vigour and yield caused in the early years may be net according to the type of equipment used. The effects observed during this transition phase may be reversible or not, depending on the capacity of the vine to adapt to the distribution of its root system (Gaviglio, 2009).

Calculation or evaluation method:

In the context of an *a priori* evaluation, the assessment should be conducted by an expert who will modulate the yield of the previous system if the following practices are implemented in the new system:

- Change in the pruning method
- Introduction of ground cover
- Disbudding, thinning
- Change in planting density
- Transition to mechanical weeding if sustainable in the short term

In the context of an ex post evaluation, it could be the average yield over the past three years which is considered.

In all cases, the estimated yield should be compared with that of regional references for this product category (ex: yield of the appellation).

Qualitative classes:

------ Expected yield ------	
Classes	
< regional reference	Estimated yield taking into account cultural practices compared to the regional yield of the appellation
= regional reference	
> regional reference	

Source: document 'DEXiPM_Grapevine_inputs_october2012'

Bibliography:

Aouadi, N. (2010). DEXIPM-vine : un outil d'évaluation multicritères de stratégies phytosanitaires en viticulture, Centre International de Hautes Etudes Agronomiques Méditerranéennes: 95p., p. 34.

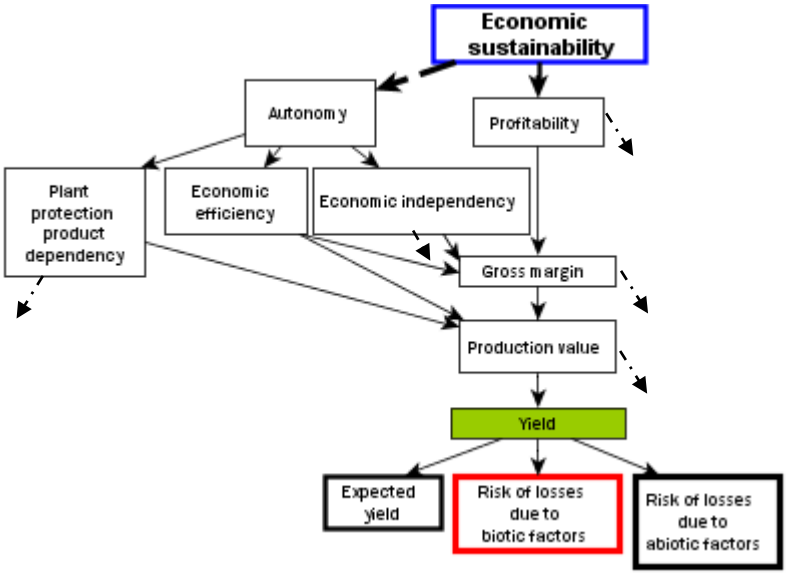
Gaviglio, C. (2009). Alternatives au désherbage chimique sous le rang : désherbage mécanique. Collection itinéraires IFV. n°21: 24p.

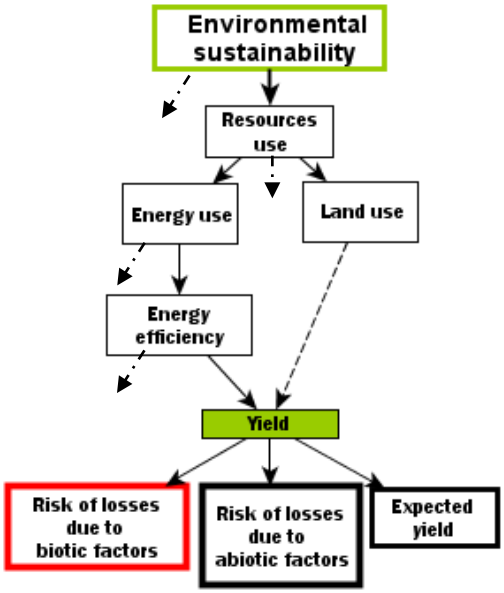
IFV (2011). Taille en haie, Taille Rase de précision et non taille ou taille minimale de la vigne (minimal pruning). Fiches pratiques.

Ollat, N. (2002). Influence des systèmes de conduite sur la production des raisins. Journée technique régionale - Gestion du rendement, vers une recherche de la qualité. S. R. ITVMidi-Pyrénées. Toulouse.

Risk of losses due to biotic factors

Criterion characteristics	
Sustainability	Economic Environmental
Secondary branch	Profitability Viability Resources used
No. appearances	Seven times
No. classes	3
Category	Contextual factors dependent on the system





Objective:

This criterion assesses the risk of yield losses due to pest pressure (both insects and diseases) in relation to the control methods used (not only chemical methods).
In the case of an ex-ante evaluation, we assess this risk according to the plant health strategy envisaged and the average pest pressure over recent years. For example, if a grower wishes to use alternative products precisely positioning the treatments and the pressure from fungal diseases has been significant in recent years, we estimate the risk as high.

In the case of an *ex-post* evaluation, it can be based on the intervention thresholds recommended by the Chambers of Agriculture. For example, to assess the risk of yield losses due to insect pests, reference is made to the intervention thresholds for each generation of pests in Burgundy (Burgundy Chamber of Agriculture and CAVB, 2005). Beyond these thresholds, the potential yield losses are not acceptable (estimated losses of 10 to 15% of the crop (Benjamin Alban, adviser CA71)). Observation and counting methods are suggested by the Chambers of Agriculture (example: Appendix 2) and provide growers with a common basis on which to conduct their thinking.

Calculation or evaluation method:

The estimate is centered on the pests and diseases considered most 'harmful' for the harvest (in terms of both yield and quality, since the latter could justify the rejection of part of the harvest if the quality is low).

Evaluation *ex-ante :*

➔ According to the intended plant health strategy and the average pest pressure in recent years.

Evaluation *ex-post :*

➔ If the threshold level is reached for these pests, we estimate the risk as 'high', which will impact on yield, and therefore the value of the production. Below these thresholds, the risk of crop loss is considered acceptable (either 'medium' or 'low' depending on the extent of disease/pest populations).

Qualitative classes:

------ Risk of losses due to pests ------	
Classes	*Ex-ante*
High	According to the intended plant health strategy and the average pest pressure in recent years
Medium	
Low	

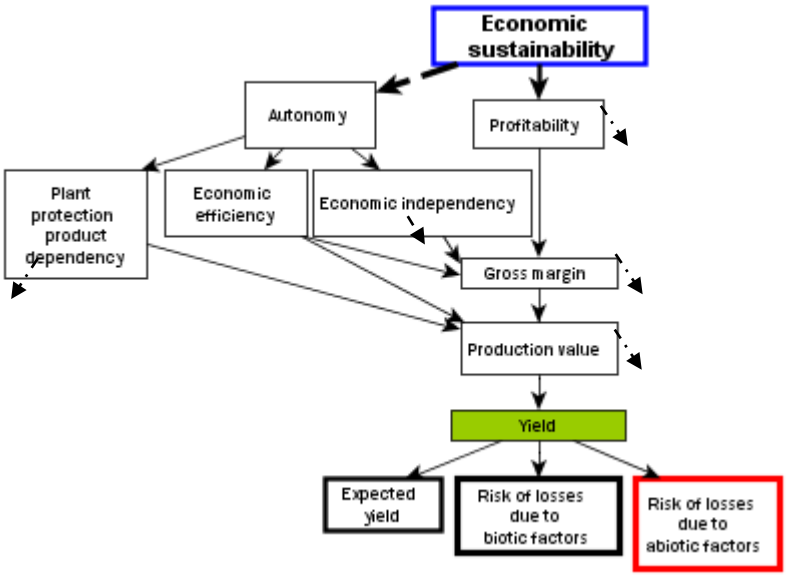
Classes	*Ex-post*
Elevé	Threshold level(s) reached
Moyen	Below threshold level(s), according to extent of dieases/pest populations
Faible	

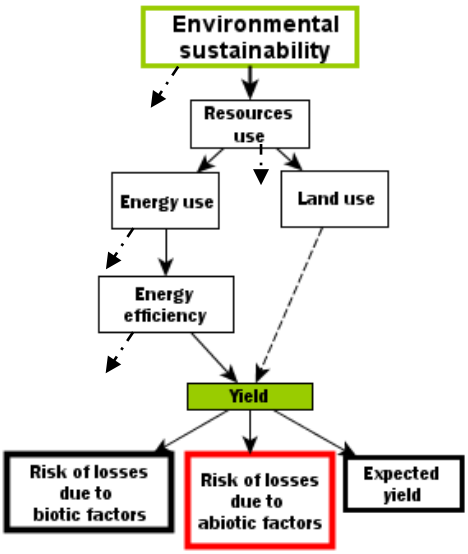
Bibliography:

Chambre d'Agriculture Bourgogne (Burgundy Chamber of Agriculture and CAVB (2005)). Guide technique Viticulture durable de Bourgogne.

Risk of losses due to abiotic factors

Criterion characteristics	
Sustainability	Economic Environmental
Secondary branch	Profitability Viability Resources used
No. appearances	Seven times
No. classes	3
Category	Contextual factors dependent on the system





Objective:

This criterion assesses the risk of yield losses due to abiotic factors: hail, heavy rainfall, the risk of water stress etc. This will depend on the nature of the soil, irrigation practices, the water requirements of the grape varieties, the presence of ground cover to ensure entry to the plots.

Regarding water stress in particular, this depends on water availability in the milieu and the water needs of the vine (Riou *et al*., 2001). This is why climatic conditions, soil type and average topography of the plots is taken into account for this information, as well as the water needs of the varieties (Fortino *et al*., 2007a).

The age of the vines has a significant impact on their behaviour when facing water stress (Zufferey and Lean, 2007). A young vine is subject to greater water stress than older vines under the same conditions, largely because their root systems are less developed and their sensitivity increased. Therefore, this data must be taken into account in the risk assessment.

Tillage also influences vine water stress. Indeed, although it can damage a part of the root system, this work breaks hydraulic continuity on the soil and therefore limits losses through evaporation from the soil. The resulting benefit is greater than the damage caused by tillage. Obviously this is not the case if tillage is conducted during droughts or the vineyard has a very shallow root system.

Finally, the presence of ground cover competing for water during risk periods should not be neglected because we know that the period from flowering to the onset of ripening is the most sensitive to water stress in terms of impact on yield (Ojeda *et al*., 2001).

Calculation or evaluation method:

Only an expert can complete this criterion, taking into account:

- The sector's climatic conditions (rainfall, intensity of solar radiation during the period from flowering to the onset of ripening, hail storms) and the topography of the plots concerned
- The water needs of the principal varieties in the cropping system
- The average age of the vines
- The type of soil which predominates and its average depth
- The characteristics of ground cover during risk periods (principally flowering to the onset of ripening)
- Tillage
- Irrigation

Qualitative classes

------ Risk os losses due to abiotic factors ------	
Classes	*Expert opinion*
High	Depends on the different points mentioned above
Medium	
Low	

Bibliography:

Fortino, G., E. Lô-Pelzer, *et al.* (2007a). Presentation of the updated version of DEXiPM arable crops. A qualitative multi-criteria model for the assessment of the sustainability of pest management systems INRA Deliverable DR2.22a 111p., p.39.

Ojeda, H., A. Deloire, *et al.* (2001). Influence of water deficits on grape berry growth. Vitis 40, 141-145.

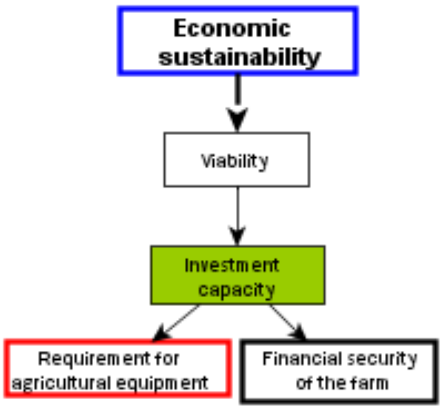
Payan, J.-C. and E. Salançon (2008). Effet de la charge en raisin sur la contrainte hydrique de la vigne, IFV- Institut Français de la Vigne et du vin: 6p.

Riou, C., B. Rodriguez-Lovelle, *et al.* (2001). Outils de diagnostic du stress hydrique et suivi au vignoble, Institut Rhodanien: 3p.

Zufferey, V. et D. Maigre (2007). Age de la vigne. I. Influence sur le comportement physiologique des souches. *Revue Suisse Viticulture Arboriculture Horticulture*, Agroscope Changins. 39**,** 257-261.

Requirement for agricultural equipment

Criterion characteristics	
Sustainability	Economic
Secondary branch	Viability
No. appearances	Once
No. classes	3
Category	Contextual factors dependent on the system



Objective:

This criterion provides information about the investment required for equipment in order to introduce an innovative cropping system. It concerns both the equipment necessary for the introduction of new cultivation techniques, and marketing of products (for example, 'storage before delivery') and investments for system management.

Calculation or evaluation method:

The proposed method was determined *de novo* by an expert (D. Sauvage, CA71).
This entry is considered to evaluate the investment capacity of the farm and thus its economic viability. Therefore, only major investments (such as tractors or harvesting machines) are considered significant enough to impact on the investment capacity of the farm and significantly influence its economic viability. Therefore:

- Investments in secondary equipment (such as a leaf-stripper, inter-vine hoe etc.) ➔ Requirement for equipment is recorded as **low**
- Investment in spraying equipment or any other sort of material in the €15,000 to €30,000 price range ➔ Requirement for equipment is recorded as **medium**
- Beyond this (investments in high-clearance tractors, harvesting machines and other equipment in the same price range) ➔ Requirement for equipment is recorded as **high**

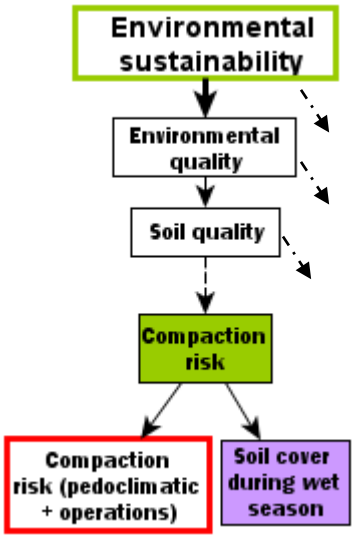
Note : to have an order of magnitude for the price of equipment, we referred to the national booklet 'Coût des Fournitures en Viticulture et Œnologie'.

Qualitative classes :

------ Equipment requirements ------	
Classes	
Low-none	Investment in secondary equipment (leaf-stripper, hoe etc.)
Medium	Investment in spraying equipment or any other sort of material costing in the order of €15,000 to €30,000
High	Beyond this (investment in high-clearance tractor or harvesting machine and other equipment in the same price range)

Compaction risk (pedoclimatic and operations)

Criterion characteristics	
Sustainability	Economic
Secondary branch	Viability
No. appearances	Once
No. classes	3
Category	Contextual factors dependent on the system



Objective:

This criterion evaluates the soil compaction risk based on pedoclimatic (soil and climate) characteristics of the plot and the cultural operations performed. It does not consider the presence of ground cover. Evaluating this risk is very important since soil compaction can greatly reduce the production potential of a vineyard, reducing the penetration and circulation of water, air, organisms and vine roots. In addition, once a soil is compacted, regenerating its structural state can be very tricky and time consuming.

The pedological nature of the soil is the main factor in its vulnerability (texture, stone content, hydromorphy). Cultural practices then modulate this risk according to how they are implemented (coherent access paths, multiple access paths, tyre pressure, etc.), frequency (limiting the number of interventions by coupling two operations, good distribution of operations over time, etc.) (Polge de Combret-Champart *et al*, 2013).

Calculation or evaluation method:

To evaluate the risk, the expert must take into account:

1. **The soil's vulnerability to compaction** → *cf. evaluation method for compaction risk near vines (Polge de Combret-Champart et al, 2013) which was extended to the risk at the inter-row scale* (**Erreur ! Source du renvoi introuvable., Erreur ! Source du renvoi introuvable., Erreur ! Source du renvoi introuvable.**)
   Note: Damage caused by soil compaction is all the more important and less reversible when compaction is close to the vine. Therefore, the risk of compaction near the vine should be entered as 'high', while the risk of compaction in only the inter-row may be entered as 'medium'.
2. **Conducting cultural operations**: Is the grower seeking to reduce this risk through his working methods?
3. **The number of mechanised operations conducted** (*i.e.* number of vehicle passages)

In brief :

Compaction risk:

- **High**: compaction of inter-row and row
- **Medium**: compaction of inter-row
- **Low**: no compaction

Moduated by the **number of mechanical operations** ➔

High + **low** number of mechanical operations ➔ **Medium**

Medium + **high** number of mechanical operations ➔ **High**

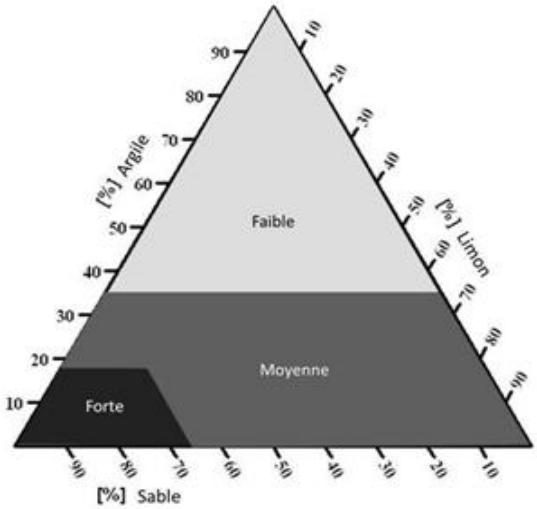


Figure 2. Classes of compaction risk in the FAO triangle (adapted from Jones *et al*, 2003), (Polge de Combret-Champart *et al*, 2013)

Vulnérabilité liée à la texture (Jones et al., 2003)	Taux de cailloux	
	≤50%	>50%
Faible	Faible	Faible
Moyenne	Moyenne	Faible
Forte	Forte	Moyenne

Figure 3. Vulnerability of soil to compaction as a result of texture and stone content in soils without standing water (Polge de Combret-Champart *et al*, 2013)

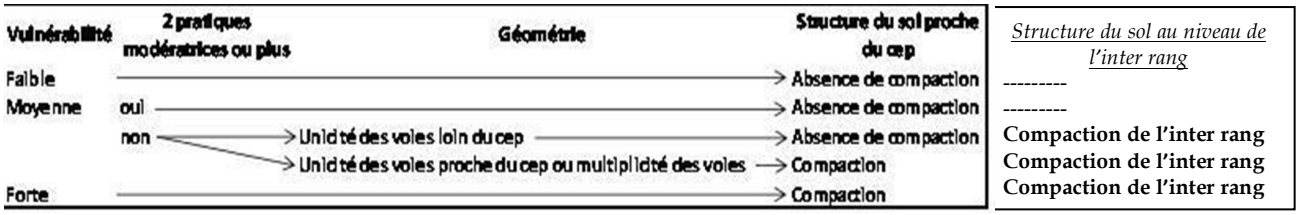


Figure 4. Structure close to the vine and at the inter-row scale as a result of soil vulnerability to compaction, the presence of moderating practices and the geometry of the wheels of viticultural machinery **(Adapted from the publication Polge de Combret-Champart *et al*, 2013)**

Classes qualitatives

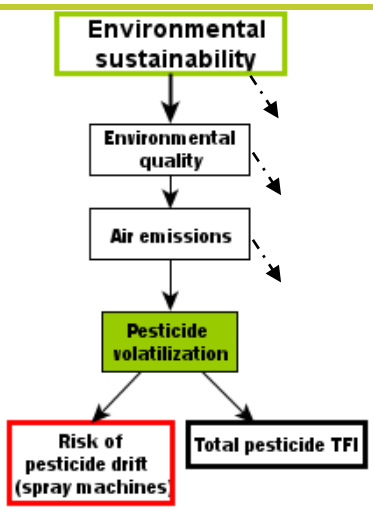
------ Risk of compaction (pedoclimatic and operations) ------	
Classes	*Compaction risk*
High	• Compaction of inter-row + row • Compaction of inter-row & **high number of mechanised operations**
Medium	• Compaction of inter-row • Compaction of inter-row + row & **low number of mechanised operations**
Low	• Absence of compaction risk in row and inter-row

Bibliography:

Polge de Combret-Champart, L., Guilpart, N., Mérot, A., Capillon, A., & Gary, C. (2013). Determinants of the degradation of soil structure in vineyards with a view to conversion to organic farming. Soil Use and Management, 29, 557-566.

Risk of pesticide drift (spray machine)

Criterion characteristics	
Sustainability	Environmental
Secondary branch	Environmental quality
No. appearances	Once
No. classes	3
Category	Contextual factors dependent on the system



Objective:

This criterion considers the magnitude of direct pesticide emissions in the air. Indeed, it is now accepted that any treatment causes aerial emissions over varying distances (Groupe Phyt'air, 2007). It has been shown that below 100µm in diameter, drops tend to disperse in the air and evaporate.

The factors influencing drift are: the type of spray equipment, its adjustment and maintenance, and the application conditions (weather conditions, growth stage, growing method for the variety etc.) (CODIS *et al* 2011). Remember, the weather conditions recommended for treatments are 'low wind, high humidity'.

Calculation or evaluation method:

Evaluation in two steps:

1. **Spraying equipment** used (= a priori risk) & **landscape**:
   - Models characterised according to the amount of drift caused ➔ low, medium, high
     Example:Table 11: Classification of different spraying models according to potential drift risk
   - First estimate to be revised if original nozzles have been replaced by nozzles approved by the ministry as 'equipment for limiting drift from spraying' (DGAL, 2012)
     ➔ - 1 risk class
   - First estimate to be revised if, in the majority of plots, there are (i) leafy and dense hedges forming a physical barrier and/or (ii) buffer zones (grassed strips) larger than the regulated size in risk zones ➔ - 1 risk class

2. A priori risk to be qualified according to the **response/reaction of the grower to the following question:**
   'Can you tell me in what humidity and wind force conditions you usually treat your vines in?'

   The expert must pay close attention to the precision of the response in order to estmate the risk class of spraying practices.

Additional information:

Helicopters do not meet current environmental concerns about decreasing pollution due to pesticides: the losses in the environment remain very large despite the use of anti-drift nozzles (Burgundy Chamber of Agriculture and CAVB, 2005). The risk of drift generated by this type of spraying is therefore always recorded as high.

Tableau 10. Classification of different spraying models according to the potential drift risk (Burgundy Chamber of Agriculture and CAVB, 2005).

Type de pulvérisateurs	Dérive
Pulvérisateurs à jet projeté	
Bobard Pulvé 600	moyenne à forte faible si injection d'air
Tecnoma GDI	
T2M Muizon	
TSM	
Pulvérisateurs à jet porté	
Tecnoma FOD Turbine oscillante	forte
Berthoud Maxair 600-840	moyenne à forte
Idéal Orion 800	moyenne à forte
Turbine Solo (brouette auto-motrice et tractée)	faible à moyenne
Tecnoma Turbocoll	faible
Faupin TB	faible
Grosjean GRV	faible

Type de pulvérisateurs	Dérive
Pulvérisateurs pneumatiques	
Berthoud Canon 250 Oscillant	forte
Berthoud Voûte "10 sorties"	moyenne
Berthoud Voûte Sitex	moyenne
Tecnoma Pulsar	moyenne
Berthoud CGL CGS CGSt	faible à moyenne
Bobard Jet 6000, anciens modèles : Jet 5000 HardiJet	
Hardi voûte champagne	
Idéal Rampe de couverture	
Berthoud AB Most	faible
Grégoire Cx et Ex plus	faible
Hardi Parafllow	faible
Idéal Hercule	faible

Qualitative classes:

------ Risk of pesticide drift ------

Classes	*Potential drift estimated according to model of sprayer*	
High	Oscillating cannons, etc.	*See Table 11 + expert knowledge*
Medium	Turbines, etc.	
Low	Jet-projected, etc.	

- **- 1 classe** if anti-drift nozzles (approved by the Ministry) and /or leafy , dense hedging forming a physical barrier and/or buffer zones (grassed strips) larger than the regulated size for risk zones
- **+ 1 classe** if the grower hesitates in his response to application conditions for treatments or if he clearly responds that he treats when he can, regardless of weather conditions

Bibliography:

Chambre d'Agriculture Bourgogne (Burgundy Chamber of Agriculture) and CAVB (2005). Guide technique Viticulture durable de Bourgogne.

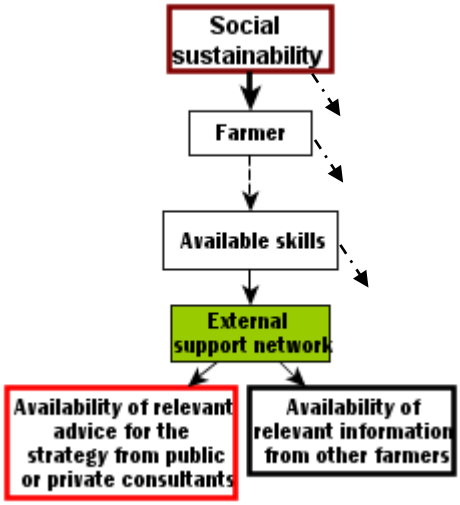
Codis, S., C. Bos, *et al*. (2011). Réduction de la dérive, 8 matériels testés sur vigne. PHYTOMA - La Défense des Végétaux. n°640: 1-5.

Direction générale de l'alimentation (2012). Note De Service DGAL/SDQPV/N2012-8203, Ministère de l'Agriculture, de l'Agroalimentaire et de la forêt.

Groupe Phyt'air. (2007). Les produits phytosanitaires dans l'air : origine, surveillance et recommandations pratiques en agriculture Comité d'ORientation pour des Pratiques agricoles respectueuses de l'Environnement 122p.

Availability of relevant advice for the strategy from public or private consultants

Criterion characteristics	
Sustainability	Social
Secondary branch	Farmer
No. appearances	Once
No. classes	3
Category	Contextual factors dependent on the system



Objective:

This criterion reflects the availability of technical support for introducing and managing an innovative strategy, from public or private consultants (excluding technical sales representatives from agricultural supply companies). Access to relevant and objective advice facilitates the adoption of a cropping system or innovative cultural practices by the grower.

Calculation or evaluation method:

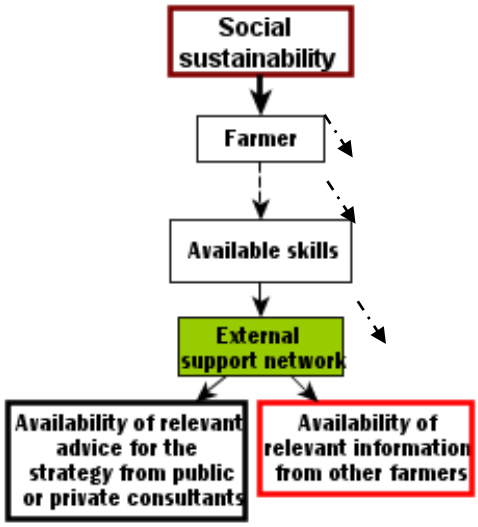
The possibility of having access to such advice is exclusively dependent on the location of the farm and the grower's professional network. Because of this, the criterion should be completed by an expert who can judge the objectivity of the advice received by the grower.

Qualitative classes:

------ Availability of relevant advice from private or public consultants ------	
Classes	*Expert opinion*
No	*See evaluation mode*
Low to medium	
Easy	

Availability of relevant information from other farmers

Criterion characteristics	
Sustainability	Social
Secondary branch	Farmer
No. appearances	Once
No. classes	2
Category	Contextual factors dependent on the system



Objective:

This criterion evaluates the adoptability of the innovative system in terms of the knowledge and skills in cultivation techniques the grower requires to implement it and the production strategy. If a shared experience within a group or network is possible, then the operational difficulties in implementing new practices will be reduced.
This criterion should not to be overlooked since confidence is important between farmers and their discussions about their respective experiences strongly influence their opinions and decisions.

Calculation or evaluation method:

This binary criterion should be completed by growers themselves because:

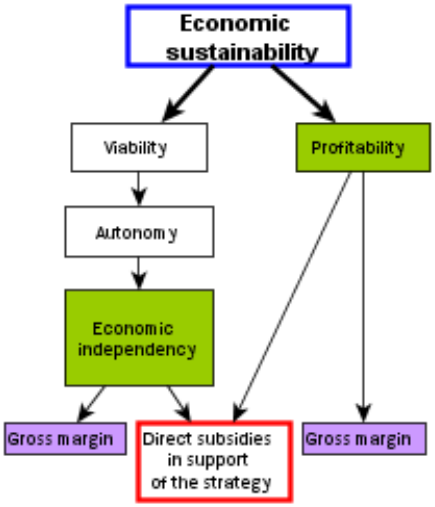
- They are best placed to be conversant with the practices of other growers.
- They are best able to meet people with whom they can discuss their respective practices.

Qualitative classes:

------ Availability of relevant information from other farmers ------	
Classes	
No network or affiliation with a network familiar with the strategy	To be completed by grower
Affiliation with a network familiar with the strategy	

Direct subsidies in support of the strategy

Criterion characteristics	
Sustainability	Economic
Secondary branch	Profitability Viability
No. appearances	Twice
No. classes	2
Category	Contextual factors dependent on the system



Objective:

This binary criterion is based on the premise that a subsidised system is potentially less sustainable in economic terms because it is not self-sufficient. However, obtaining grants favours adoption by growers.

Calculation or evaluation method:

This criterion should be completed by an expert due to the continuous development of national and European subsidies.
All agri-environmental measures such as grants for organic conversion or subsidies linked to operational programmes should be taken into account. However, one-off grants are not considered because they do not impact on the strategic choices of growers.

If the evaluation is based on an existing system, this criterion should be marked in the negative.

Qualitative classes:

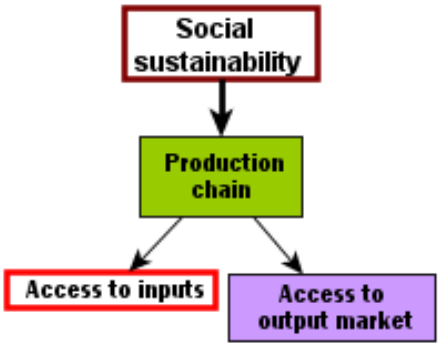
------ Subsidies in support of the strategy ------	
Classes	
No	According to expert opinion
Yes	

Limit:

The value of subsidies is not taken into account.

Access to inputs

Criterion characteristics	
Sustainability	Social
Secondary branch	Production chain
No. appearances	Once
No. classes	3
Category	Contextual factors dependent on the system



Objective:

This criterion reflects the ease of access to inputs, in other words the ease with which the grower manages to obtain inputs, either financially or geographically (Fortino *et al*, 2007a). In the case of innovative technology, access to production factors is always possible, but not necessarily easy. And if the grower has difficulty in obtaining the materials and technologies needed for an innovative cropping system, this will be a barrier to adoption.

Calculation or evaluation method:

In the first instance, the evaluation of this criterion is based on the decision table below (Table 12). The result is then modulated according to the state of the farm's 'Financial security' and the degree of purchases required in the off-season (*see Qualitative classes*).

Table 12. Decision table for evaluating the ease of access to inputs.

Km farm/supplier Delivery service	<10km	10-20km	>20km
Yes	Easy	Easy	Possible
No	Easy	Possible	Difficult

Qualitative classes:

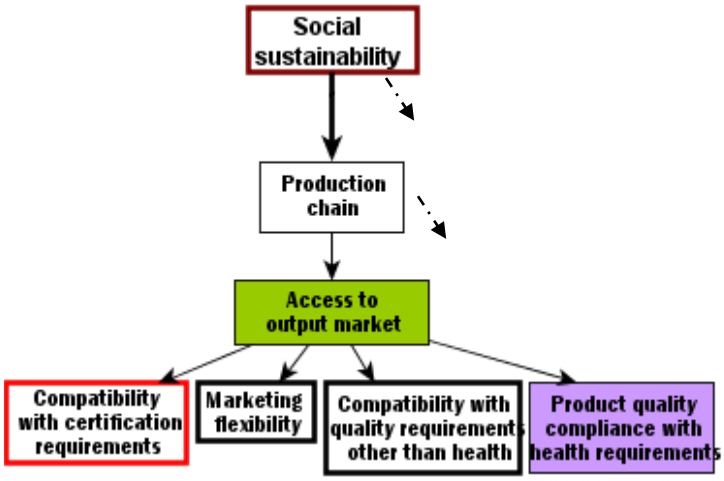
------ Access to inputs ------	
Classes	
Difficult	Supplier(s) situated > **20km** from farm & **no delivery service**
Possible	• Supplier(s) situated > **20km** from farm & **delivery service** offered • Supplier(s) situated **between 10-20km** & **no delivery service**
Easy	• Supplier(s) situated **between 10-20km** & **delivery service** offered • Supplier(s) situated < **10 km** from farm (**with or without** delivery season)
• **Financial security** : **- 1 class** if low **+ 1 class** if high • **Purchase of majority of inputs in the off-season**: **+ 1 class**	

Bibliography:

Fortino, G., E. Lô-Pelzer, *et al*. (M46). Presentation of the updated version of DEXiPM arable crops. A qualitative multi-criteria model for the assessment of the sustainability of pest management systems, INRA, Deliverable DR2.22a

Compatibily with certification requirements

Criterion characteristics	
Sustainability	Social
Secondary branch	Production chain
No. appearances	Once
No. classes	2
Category	Contextual factors dependent on the system



Objective:

This criterion addresses the fit between the innovative system and the certification's legislative context. Indeed, incompatibility of the cropping system with the requirements imposed by the specifications of the desired certification can hamper its adoption by the grower.
For example, the specifications of an AOP (PDO) generally impose specific varieties: an innovative system which includes varieties resistant to fungal diseases is hardly feasible and adoptable if the objective of the wine-grower is to continue to promote their wines under an AOP (PDO). Before any possible amendment of the appelation's decree, this would involve a downgrading of the wine to Vin de France or IGP (PGI).

Calculation or evaluation method:

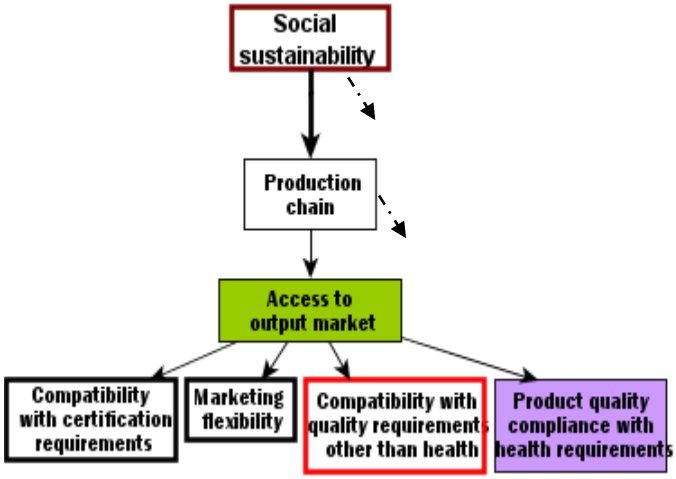
Due to the variety of specifications of certifications, information from an expert is essential.

Qualitative classes:

------ Compatibility with certification requirements ------	
Classes	
No	According to expert opinion
Yes	

Compatibility with quality requirements other than health

Criterion characteristics	
Sustainability	Social
Secondary branch	Production chain
No. appearances	Once
No. classes	2
Category	Contextual factors dependent on the system



Objective:

This criterion is designed to assess the risk of not achieving, on harvested products, the quality requirements (other than sanitary) demanded by the distribution channel (sold through AOP (PDO) => specifications for the appellation, sold to traders = > specifications imposed by the buyer etc.). Indeed, actors in the wine and food industry demand technological properties and/or particular aesthetic qualities for some harvested products (for example, strict absence of Botrytis on grapes, grapes from selected plots with specific soils etc.). In the case of non-compliance with these requirements, products may be rejected or downgraded, which will result in all cases in an economic loss.

Calculation or evaluation method:

Due to the multiplicity of qualitative requirements, the only approach envisaged is expert opinion to estimate the risk of not achieving the quality objectives in these plots.
These quality requirements may be set either by the grower himself or by the specifications of the distribution channel (AOP/PDO wines, organic wines etc.). The expert should take into account only the most stringent of these requirements. Having defined these, he can evaluate the risk of not achieving these quality objectives based on the production tool (productivity of the variety etc.), how it is grown (effects of fertilisation, pruning etc.) and the vagaries of the climate (Craheix, 2011).

Qualitative classes:

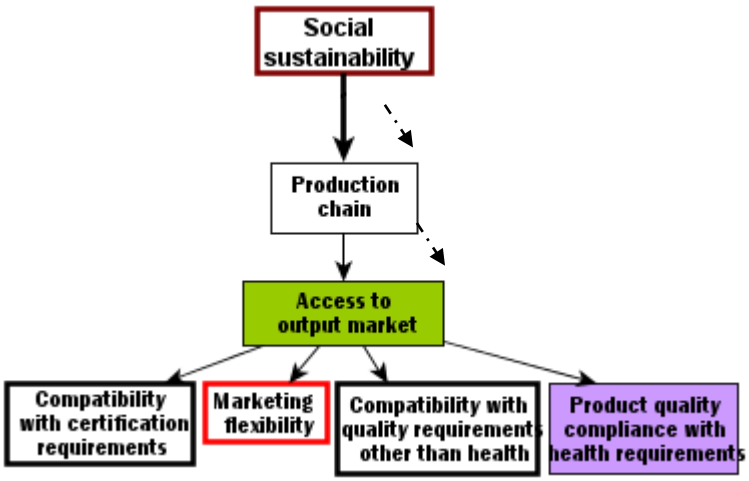
----- Compatibility with quality requirements other than health -----	
Classes	
No	According to expert opinion
Yes	

Bibliography:

Craheix, D., F. Angevin, *et al* (2011). Un outil pour l'analyse de la contribution des systèmes de culture au développement durable. Jeu complet de fiches critères de MASC 2.0. INRA – AgroParisTech – GIS GC HP2E. 133 p.

Access to output market

Criterion characteristics	
Sustainability	Social
Secondary branch	Production chain
No. appearances	Once
No. classes	3
Category	Contextual factors dependent on the system



Objective:

This criterion reflects the oportunities for adding value to the product. The greater the flexibility of the market is estimated to be for the product, the greater the guarantee that the grower will be able to sell his production and maintain satisfactory financial security.

Calculation or evaluation method:

Market flexibility depends primarily on the following factors (in order of importance):

- **The number of sales channels that are accessable** (vineyard sales under another appellation, sales by a wine merchant specialising in this kind of product, etc.)
- **The level of added value to the product** through these secondary sales channels (equivalent or inferior value)
- **(Competition in corresponding markets)**. This last criterion is very difficult to assess and is therefore not taken into account in the assessment.

Consequently:

If no secondary sales channel accessable ➔ flexibility is **low**

If one or more possibilities is open to the grower, then:

Then

→ Equivalent product value through these channels ➔ flexibility is **high**

→ - - - - - inferior but acceptable for the grower ➔ flexibility is **medium**

→ - - - - - - - - - - - - - - - significantly inferior ➔ flexibility is **low**

Qualitative classes:

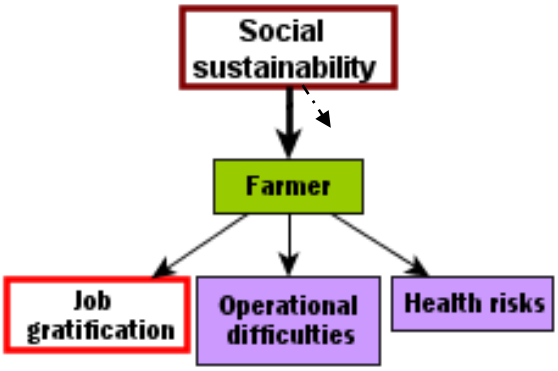
----- Access to output market -----	
Class	
Low	• No secondary sales channel accessible • One or more secondary sales channels but value of product significantly inferior
Medium	• One or more secondary sales channels and value inferior but acceptable for the grower
High	• One or more secondary sales channels and equivalent product value

Bibliography:

Validation par Hubert Brivet (CER France 71).

Job satisfaction

Criterion characteristics	
Sustainability	Social
Secondary branch	Farmer
No. appearances	Once
No. classes	3
Category	Contextual factors dependent on the system



Objective:

This criterion concerns the grower's 'social' satisfaction in his work and thus reflects his quality of life (Fortino *et al*., 2007a). This point is closely correlated with the operational difficulties of the cropping system and its impact on the health of the producer. However, these last two points are considered elsewhere and are not to be considered here.

Calculation or evaluation method:

The satisfaction a wine-grower derives from his work depends on his expectations from a professional point of view, philosophy, way of life, etc. (Fortino et al, 2007a). Some prefer to implement cropping systems which favour the mechanisation of tasks to reduce working time. Others will use systems more demanding in terms of labour but more consistent with their philosophy on life.

As the level of satisfaction is unique to the person concerned, only the grower is able to express himself on this subject (important: he should explain why or why not he is satisfied).

Qualitative classes:

----- Job satisfaction -----	
Classes	
Low	According to the farmer
Medium	
High	

Bibliography:

Fortino, G., E. Lô-Pelzer, *et al*. (2007a). Presentation of the updated version of DEXiPM arable crops. A qualitative multi-criteria model for the assessment of the sustainability of pest management systems INRA, Deliverable DR2.22a

Social accessibility of product for consumers

Criterion characteristics	
Sustainability	Social
Secondary branch	Interaction with society
No. appearances	Once
No. classes	2
Category	Contextual factors dependent on the system

Objective:

This criterion examines the obstacles encountered by consumers wishing to purchase the product (ex: sale price too high, insufficient sales outlets). Indirectly, we therefore estimate the risk posed by the positioning of products in niche markets: the greater the target clientele is limited (ex: more affluent social classes), the greater the risk of not being able to sell the stock and the less easy it becomes to adopt such a system. Therefore, the social sustainability of the innovative system will be undermined because of the uncertainty.

Calculation or evaluation method:

The evaluation should be conducted by an expert, who will be better able to discuss with the wine-grower the markets in which he intends to place the products of the cropping system. To judge the affordability of the product, the expert may consider:

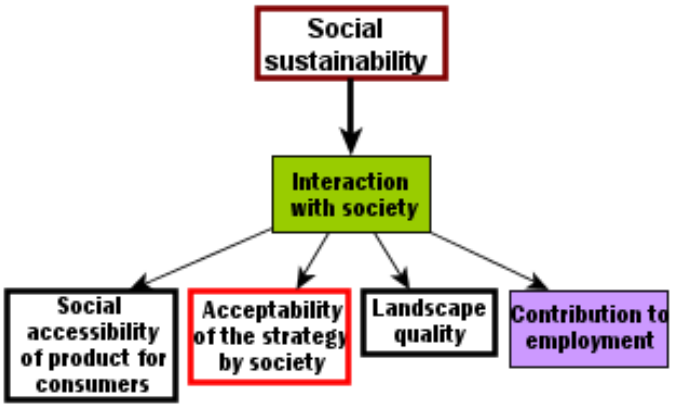
- The **coupling(s) of price-product** (from the cropping system)
- The balance between price and the production and marketing methods
- The **physical availability of the product**, in other words, the ease with which the consumer can purchase the product in the environment in which he lives, questioning the wine-grower on the points of sale for his products and marketing methods (product sold locally through direct sales/supermarkets, national sales, international exports etc.).

Qualitative classes :

----- Social accessibility of product -----	
Classes	*According to expert opinion*
Not very accessible	• Expensive price demanded compared to average salary in the region • Price accessible but few points of sale (or difficult opening hours)
Accessible	• Price accessible, numerous points of sale

Acceptability of the strategy by society

Criterion characteristics	
Sustainability	Social
Secondary branch	Interaction with society
No. appearances	Once
No. classes	3
Category	Contextual factors dependent on the system



Objective:

This criterion questions the social acceptance of the practices and strategies implemented by the wine-grower within the cropping system. This is closely related to the current socio-political context. Certifications are a good indicator: the AB label (organic), Haute Valeur Environnementale (HVE or high environmental value) and the Vignerons en Développement Durable approach (VDD or wine-growers in sustainable development) are some examples. It is the production method which is considered here and not, directly, the final product (wine-making practices are not taken into consideration).
A grower opting for a cropping system in which the strategies are recognised and accepted by society can communicate about it to highlight his work and, from a social point of view, it will be evaluated as more sustainable.

Calculation or evaluation method:

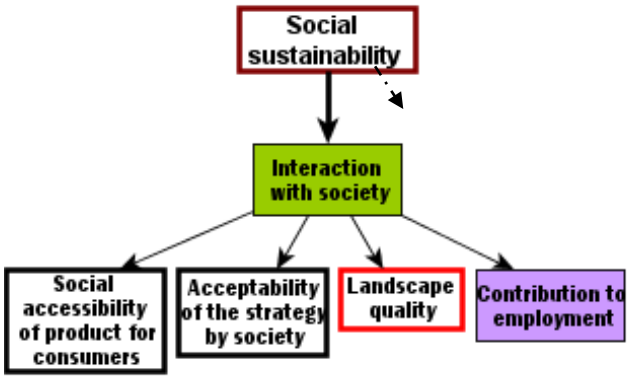
Given that this recognition may vary depending on the scale (spatial and temporal) we choose, it is important that the grower provides information himself (or to an expert) according to the local socio-political context.

Qualitative classes:

----- Acceptability of the strategy adopted -----	
Classes	*According to expert opinion*
Weak	According to expert knowledge and the information given by the grower on the local socio-political context
Neutral	
Acceptable	

Landscape quality

Criterion characteristics	
Sustainability	Social
Secondary branch	Interaction with society
No. appearances	Once
No. classes	3
Category	Contextual factors dependent on the system



Objective:

This criterion considers the impact of the cropping system on society's aesthetic perception of the landscape. There are three different concepts behind this term: (i) conservation/respect for the surrounding landscape during the introduction of the crop (deforestation, etc.), (ii) the aesthetics of the cropping system plots (inter-row cover, etc.), (iii) the integration of the system within its environment (neighbouring agricultural crops). Being very subjective, this concept will evolve along with society. The data is nevertheless interesting in order to make a comprehensive assessment of the sustainability of the cropping system.

Calculation or evaluation method:

Due to its high degree of subjectivity, the evaluation of this criterion should be conducted by an expert. A list of practices considered to be 'improving or derogatory for landscape quality' has nevertheless been suggested. The expert may inquire whether the grower has retained and/or maintains walls and other elements segmenting the landscape. This is an indirect way to see if he is careful to respect, preserve and maintain the surrounding environment, which can only be good for the landscape quality of his farm.

List of practices considered as 'improving for landscape quality'

\+
_Working with horses
_Grass/flower strips
_Roses bordering plot
_Grassed vines, grassed headlands
_Hedges/fruit trees
_Nesting boxes
_Presence of animals for winter plot maintenance
_Conservation and maintenance of walls, etc.
_Introduction of animals in plots to control grass

\-
_ Soil completely bare
_ Vineyard in poor aesthetic condition (fallow)
_Yellow soil due to chemical weeding

Qualitative classes:

----- Landscape quality -----	
Classes	*Expert opinion*
Poor	According to expert opinion, based in part on the list proposed above
Neutral	
Good	