LAND USE RE-LOCATION

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Description

Agricultural landscapes are composed of various elements related to many environmental and human factors which are structured by a mosaic of farmers' fields, semi-natural areas and human infrastructures. The spatial patterns of fields and crops vary in time according to the management of cropping systems and the farm-scale allocation of land use. Land use relocation options consist of changing the patterns of land use and crop allocation in order to increase the buffer capacity, i.e. the ratio between pollutant output and input, of the landscape.

Rationale, mechanism of action

Land use or crop re-location allows water, sediments and nutrients produced upslope to be infiltrated, deposited or be trapped downslope, regarding to the flow pathways and the properties of the transported elements.

Surface runoff generated on a given field can infiltrate on a field located downslope that has a higher infiltration rate. Sediment particles and thus the adsorbed P can be deposited. This is particularly the case when fields with low and high infiltration rates alternate along the hillslope. The generated surface runoff can infiltrate all along the hillslope before reaching the stream.

Nitrate migrating in subsurface runoff and draining in shallow groundwater can also be concerned, taken up by the crops growing downslope where the groundwater is close to the surface, and can interact with the root zone of the crop. It is the case when the crop located downslope, such as maize, requires a higher nitrate uptake compared to crops located upslope such as wheat. More generally, this is the case for all cereals which can assimilate the nitrates differently. But a strict control of fertilisation has to take place too. Generally, in a region where an excess of manure exist, fertilisation is often already higher on such crops, so that the uptake is low or nil.

The set of the plots acts from plot to plot as successive buffers along the slope, similarly as the field boundaries around each plot. The mechanisms are similar to those mentioned for buffer field boundaries (see Gascuel-Odoux & Dorioz, 2008).

Applicability

This mitigation option is only applicable under moderate slope conditions, with surface sheet flow and a low flow velocity, for surface flow as well as subsurface flow. It does not concern surface flow on bottomlands (saturated areas) which show no infiltration at all.

It may concern short periods when different infiltration rates along the slope are observed, determined by soil surface conditions like vegetation cover, roughness, and soil structure, and thus, by the interaction between agricultural operations and climate. Thus, it is important to identify critical periods for which the mitigation option can be effective.

At the farm scale it requires the introduction of new decision rules for the organization of the allocation of crops on the farm, while the location of the crops on the farm is generally decided according to technical constraints (subset of plots, calendar, machinery etc.) on farm, and not on the topography. It also requires an adaptation of the fertilization plans.

It may require the application of transfer models for a precise evaluation of surface and subsurface flow of nutrients.

At the landscape scale, it requires a collective planning of the crops within the catchment by the farmers in the catchment, particularly between neighbour farms.

Effectiveness, including uncertainties

The effectiveness is mainly evaluated by hydrological modeling including a detailed description, with functions, of the agricultural landscape. Catchment experiments cannot be easily used to evaluate the effectiveness, since many other effects are often included in such experiments. Modeling shows a high effectiveness of the mitigation option on surface runoff and erosion, thus on particulate P, similar to vegetative buffer strips, and a low effectiveness on the nitrate budget.

Time frame

The effect starts as soon as the crop alternates are established. However, the effectiveness may only concern short periods along the year, both for nutrient transport via surface flow since the infiltration rate highly varies with time, and for nutrient transport via subsurface flow since the interaction between the root zone and the groundwater is seasonal.

Environmental side-effects / pollution swapping, e.g.

In addition to a better water quality, a relevant crop allocation has some positive side effects. It increases the slope stability by armouring the soil with plant roots which reduce erosion and P loss. The filters can also prevent damage due to sediment transfer to roads or e.g. houses in urban sprawl areas.

Benefits include not only water quality improvement but also aesthetic values and ecological benefits. The landscape heterogeneity can contribute to increasing biodiversity.

In addition, the crop rotation in time and space can contribute to an improved soil aggregate stability and thus to maintaining high soil infiltration rates.

Relevance, potential for targeting, administrative handling, control

The measure has relevance for areas affected by surface runoff and erosion, probably under all climatic conditions. An important condition is a relatively uniformly sloping landscape, since the buffer effect is more efficient with sheet surface runoff. The crop plan can be controlled visually or by remote sensing.

Costs: investments, labour

Implementation needs the assistance of a catchment water manager to promote the application of models and fertilization plans, the implementation of new decision rules and collaboration between farmers for defining collective cropping plans.

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