CREATE AND MANAGE VEGETATED BUFFERS AT FIELD BOUNDARIES

2011 C. Gascuel, J.M. Dorioz, T. Krogstad & M. Bechmann

Description

Vegetative buffers are areas in the transition zone between the border of cultivated fields (e.g. croplands, grazing lands) and the hydrographic network (e.g. ditches, brooks, rivers and lakes) They are intended for removing sediments, nutrients and some others pollutants contained in flowing water. Buffers are located at the edge of the fields where the surface water flow leaves the fields. The intention is to “filter“ pollutants contained in surface flow originated from the fields; effects on subsurface flows are limited.

Vegetative buffers are often called ”vegetative filter strip” or ”buffer strip”, but it could be an area more than a small strip. A vegetative filter is a constructed device and has other and complementary functions than in-field buffer strips. It could be a grass buffer or a mixture of natural vegetation including grass, trees and bushes. It is critical that filters are managed specificaly to provide their designed performance since their ability to function will degrade with use.

Rationale, mechanism of action

The buffering effect results from a group of phenomena which are trigerred during runoff and are the consequences of the hydrological and biogeochemical properties of the zone.The surface runoff reaching a vegetative buffer flows over a rougher and more porous surface causing it to slow down and infiltrate into the soil. These changes in the properties are linked to the presence of a continuous soil cover of plants, hence a greater resistance to surface flow which decreases flow velocity and to a dense root system which increases the permeability of the surface soil layer.

Infiltration and decrease of flow velocity lead to a diminution of transport capacity for solid materials, and particles are progressively deposited. Soil particles or microaggregates, together with nutrients (especially particulate P) and other particle-associated pollutants are trapped [4].

The resulting deposits are not randomly distributed. Coarser sediments and the majority of the total retained sediment are deposited in the upstream part of the buffer strip. Consolidation of the deposits between periods of rainfall is a critical aspect of the buffer effect. Stabilisation is due to entrapment by fine roots, tillering of shoots and re-aggregation of fine particles into larger microaggregates.

Dissolved pollutants and especially dissolved P, are retained by the soil due to infiltration. Infiltrated water can be stored or can contribute to the groundwater recharge. This water carries dissolved compounds including P forms with it. The P forms are actively retained by soil constituents and biota which limits their transport to deeper soil layers.

Cumulative interception of total P tends to increase soil P content of the filter, and P is recycled, taken up and transformed by plants and microorganisms. Other nutrients and pollutants can be eliminated. Microbial decomposition of organic pollutants is also active in the root zone [1,2,3].

Applicability

The practice applies mainly on cropland at the lower edge of fields, generally downstream of erosive fields along ditches or waterway or water bodies.

A vegetated filter is a suitable option to trap P, and secondarily N, but also suspended matter and pesticides, in areas with problems with surface runoff, e.g. grain fields or cultivated fields on silt soil types sensible to crusting and thus highly erosive. Some authors also mention pastures on clay soils.

It is also applicable anywhere land areas contribute to contamination of water bodies , e.g. as a receiver and purifier for tile drain water prior to entering into a river or lake, for urban runoff, to treat polluted runoff from barnyards, or on forest land as a part of a forestry operation to reduce the delivery of sediment into waterways.

The applicability seems to depend on climatic conditions. Norwegian experiments have shown similar effect in periods with high precipitations in the autumn or summer and under the snowmelt in winter. On the contrary, other data have shown an important seasonal variability due to changes of the hydric state or temperature of soil.

Effectiveness, including uncertainty

The efficiency depends, on short term, on the balance between inputs (retentions) and outputs (release from or transport through the buffer strip) at the scale of the year. Factors controlling this balance are:

1) External factors, which control the properties of the incoming flow, its nature (subsurface/ surface, concentrated/diffuse). These factors depend on weather conditions, cultural practices, and the topography of the contributing area.
2) Internal factors, which regulate the time for which the water is retained by the grass buffer strip and its rate of infiltration into the soil and the potential for release e.g. P from soil surface stocks. These include topographical factors, notably the width and steepness of the slope of the strip, as well as the conditions of the vegetation (root density etc.) and of the soil (physical properties, roughness, wetness). The time between rainfall events controls the restoration of the buffer capacity between floods.

The relationships between the internal and external factors determines the contact time between the filter and the runoff and thus the input/output balance. Retention is greater when runoff is diffuse, has a shallow depth and a low velocity. A vegetated filter has less effect in depressions where runoff water is concentrated and tends to break through the zone with very little trapping of sediments. Moreover, soils in depressions tend to remain wet. Filter efficiency is inversely proportional to the ratio of the total drainage area to the filter area.

For a given vegetated filter the effectiveness also varies according to the properties of the compounds considered. The efficiency to reduce particle bound compounds is much greater than for dissolved compounds. Consequently, the rate of retention will be greater for particulate P than for dissolved P or nitrates, greater for particulate P associated with a coarse sediment fraction than when associated with clays. Finally, the efficiency is better for total-P than for bio-available P [4].

Some uncertainties remain however: experiments showed a seasonal release of dissolved P. Moreover, under extreme events or saturated conditions, a grass filter might be ineffective and /or eroded, which results in outputs of some of the particulate P previously stored. The influence of these situations on the nutrient balance of the filter is not well documented.

The diversity of factors described above explains the difficulties to establish standards to design a vegetated filter. There is no definitive plan which can be used in all areas. A general idea is that a strip of 3 to 10 meters width on slopes <6%, reduce ca. 70 to 90% sediment and particulate P and 30-50% of dissolved nutrients. Norwegian experiments showed a retention efficiency varying from 42-96%, 27-81%, 55-97% and 83-90% for P, N, particles and organic matter, respectively [3]. Properly placed and managed vegetative buffer effectiveness can be expected to be more than 70 % for sediments and 50% for dissolved compounds (PO_4, NO_3, pesticides). Even a small filter (e.g. 2 m) along ditches has positive effects in reducing P transfer due to the protection of the banks.

Whatever the dimensions are, an appropriate management is needed to maintain vegetation dense and short, and the soil surface in an optimal state to avoid preferential flows and saturation with deposited sediment. Mowing grass and export of biomass reduce P release from leaching of litter in autumn, maintain a good vegetation cover and contribute to a decrease of total P accumulation in the soil of the filter. This is specifically important if the filter has been implemented on a formerly cultivated area, with a topsoil rich in P.

Fertilisation, weeding with herbicides, livestock grazing *(see factsheet 7.2)* might be excluded. Farm machinery wheel tracks might be limited when possible to avoid soil compaction and rill forming. Management might include repairing rills and removal of accumulated sediment.

Time frame

The effect starts as soon as the vegetative zone is established and a good root system is developed [3]. But it takes some time (1 to 3 years) to obtain a well established and healthy vegetation with a powerful root system that improves soil structure and porosity with the maximum effectiveness expected.

The filtering efficiency for sediments and particulate P remains for a long time if the filter is managed in a proper way, and average life time is 10-15 years according to USDA experts [3]. If not, the ability of the filter to function will degrade with use, accumulation of sediment or P in excess, preferential surface flows etc.

Since no biogeochemical process is able to reduce the total amount of P within the filter, total P inputs will cumulate, generating an enriched soil surface layer. A long term effect of these dynamic is not well documented. Consequently, the long term sustainability of a filter is unknown and it seems better to use filter strip in addition with other BMP's applied at the field and farm level [7].

Environmental side effects

In addition to a better water quality, the vegetated zone has some positive side effects. It increases the slope stability by armouring the soil with plant roots which reduce the erosion and P loss. The filters can also prevent damage due to the transfer of sediments to roads or to other properties like houses in urban sprawl areas.

Benefits include not only water quality improvement but also aesthetic values and ecological benefits. Vegetated filters provide a permanent habitat for wildlife, but also for some kinds of pest species such as slugs. Thus vegetated buffers contribute to an increase in biodiversity . The vegetated zone can act as a corridor for wild animals which will tend to reduce animal tracks on the cultivated fields. Nutrients and biomasses available in vegetated filters limit stress to wild animals caused by dry summers or cold winters.

Relevance, potential for targeting, administrative handling, control

Vegetated filters in tilled croplands are vital components of the overall regional conservation plans. The measure has relevance for areas with surface runoff and erosion, probably under all climatic conditions. An important condition is a relatively uniformly sloping landscape, since the buffer effect is better with diffuse surface runoff.

Filters are easy for administrative handling and can be controlled visually or by remote sensing.

Costs: investments, labour

Implementation does not need specific machines or skills but implies:

1) Assistance of an extension expert to adapt the design to local conditions of soils, etc.

2) Investments in term of seeds and labour.

3) The area used for a vegetated filter remains uncultivated which means loss of crops.
4) Harvesting the hay of the filter is not profitable, so some way to compensate the farmers should be included in the conservation plan.

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