Commentary on changes to the FOCUS LM report between v1.0 and v2.0[1] in response to comments from the PPR Panel – mitigation for transfer of pesticides in surface runoff

<u>Sources:</u>

FOCUS (2005). "Landscape And Mitigation Factors In Aquatic Risk Assessment. Volume 1. Extended Summary and Recommendations". Report of the FOCUS Working Group on Landscape and Mitigation Factors in Ecological Risk Assessment, EC Document Reference SANCO/10422/2005. 133 pp.

FOCUS (2005). "Landscape And Mitigation Factors In Aquatic Risk Assessment. Volume 2. Detailed Technical Reviews". Report of the FOCUS Working Group on Landscape and Mitigation Factors in Ecological Risk Assessment, EC Document Reference SANCO/10422/2005. 434 pp.

EFSA (2006). Opinion of the Scientific Panel on Plant Protection products and their Residues on a request from EFSA on the Final Report of the FOCUS Working Group on Landscape and Mitigation Factors in Ecological Risk Assessment. 13 December 2006.

FOCUS (2007). "Landscape And Mitigation Factors In Aquatic Risk Assessment. Volume 1. Extended Summary and Recommendations". Report of the FOCUS Working Group on Landscape and Mitigation Factors in Ecological Risk Assessment, EC Document Reference SANCO/10422/2005 v2.0. 169 pp.

FOCUS (2007). "Landscape And Mitigation Factors In Aquatic Risk Assessment. Volume 2. Detailed Technical Reviews". Report of the FOCUS Working Group on Landscape and Mitigation Factors in Ecological Risk Assessment, EC Document Reference SANCO/10422/2005 v2.0. 436 pp.

ter Horst, M.M.S., Adriaanse, P.I., Boesten, J.J.T.I. (2009) Mitigation of runoff in the FOCUS Surface Water Scenarios. Note of the fate group of the Environmental Risk Assessment team of Alterra on the interpretation of the mitigation of runoff in the FOCUS Landscape and Mitigation report (2007). Alterra report 1794 ISSN 1566-7197

There are two areas relating to mitigation of risk to the aquatic environment following entry via surface runoff that were commented upon by the PPR panel, and were modified between v1.0 and v2.0 of the FOCUS LM report. The relevant comment (covering both areas) from the PPR panel and the recorded response/action of the FOCUS LM group can be found below. This document then provides the text in Version 1.0 and Version 2.0 of the FOCUS LM report and outlines the changes that were made. Finally, there is a short discussion of the virtual nature of the upstream catchment defined in the FOCUS surface water scenarios and the consequences for the reductions of runoff as implemented via the SWAN tool.

<u>PPR comment</u>

The 90% maximum mitigation value for runoff ignores the Report's own summary in Vol. 2 Table 1.8. No evidence for 90% reduction of weakly soil-sorbed pesticides is presented, except for the obvious

[1] i.e. the version that was noted by the Commission and Member State standing committee

case of elimination of use. Thus the “90%” value proposed is possible only with strongly-sorbed pesticides, i.e., pesticides with a Koc value of at least 2000 l/kg (see Report Vol. 1, p. 78, line 19). Even in the case of strongly-sorbed pesticides the PPR Panel was not given enough information describing the specific circumstances under which the 90% or similar mitigation occurs. It is well known that the effect of a vegetated buffer strip is strongly dependent on a number of factors such as slope, soil type, area ratio of field to buffer, etc. These factors are not explored in the Report but all buffer experiments are simply correlated with buffer width. The PPR Panel is of the opinion that unless the specific conditions necessary for a given reduction are provided, the proposed mitigation factor is not defensible. Part of the problem may stem from what appears to be an assumption in the Report, namely that sediment load reductions observed from mitigation measures are the same as runoff water volume reductions, which is not the case.

<u>FOCUS LM Working Group response</u>

The critique of this component of the report is accepted. The analysis of reduction efficiencies has been revisited and this component of the report has been extensively revised. Note that both the volume of runoff/mass of eroded sediment and the flux of pesticide in the two phases are reduced by the vegetated buffer zone, so the total impact on exposure is less than the stated reduction in pesticide loading (i.e. mass transported) to water.

<u>Change(s) made to FOCUS LM report</u>

Table 5 and associated text has been changed to suggest a 90% cap on mitigation of exposure via runoff. The revised analysis of reduction efficiencies for vegetated buffer zones is described in the text. An additional table has been added differentiating reduction efficiencies for aqueous and sediment-phase transfer. *Through this differentiation, it is intended that the figures in the new table should be applicable to both weakly and strongly sorbed pesticides (i.e. differences in efficacy will result because weakly and strongly sorbed pesticides will be present in aqueous and sediment-bound phases in different proportions).* Text informing the user that they need to reduce BOTH the volume of runoff/mass of eroded sediment AND the flux of pesticide in the two phases has been reinforced.

Detail on changes made to the FOCUS LM report

A. FOCUS LM Recommendation 6: absolute caps for the maximum level of mitigation to be incorporated into risk assessments for Annex 1 listing

Context

The FOCUS LM working group remit included review of:

- Development of harmonised approaches to mitigation measures;
- Incorporating [modelling refinements and] mitigation into aquatic exposure assessment at Step 4;

A range of mitigation measures were discussed for reducing exposure via spray drift, surface runoff, or drainflow. These measures were considered to have different effects in reducing exposure and to be at different states of readiness for implementation in the field and for incorporating into exposure assessment procedures.

The working group discussed issues around how to ensure compliance with mitigation measures at the point of application. Given that compliance cannot be 100% guaranteed, the working group decided that a maximum level of mitigation should be established and that this would act as a cap for the maximum reduction in exposure estimates, even where mitigation might allow greater reduction. This was a pragmatic recommendation aimed at ensuring that applications carrying a very high risk were not permitted through the regulatory system based on very high levels of exposure mitigation.

In reviewing the FOCUS LM report, the PPR panel interpreted Table 5 as indicating that the levels of mitigation (e.g. 90% for surface runoff) could be delivered in all cases. Note, that this was not the intended meaning of the text, as the values were proposed as setting the absolute upper limit for mitigation within the risk assessment scheme even if highly effective mitigation measures were developed further in future.

In response to the PPR opinion, the FOCUS LM working group clarified the wording of its recommendation, providing a clearer statement of why the working group considered that a maximum cap on mitigation was necessary. This wording emphasises that the values in Table 5 are not proposed mitigation values, rather they are suggestions that mitigation included within the risk assessment should never be larger than this, whatever mitigation approach is proposed. The working group also revised the maximum mitigation down for exposure via spray drift and drainflow. The maximum mitigation was retained at 90% for exposure via surface runoff because there was clear evidence that mitigation of 90% was possible for some pesticides under some circumstances.

Original text

Based on the list of measures in Table 4, it is possible to establish a realistic level of mitigation that can be achieved for the different routes of exposure (Table 5). ***[Recommendation 6] It is recommended that the maximum values identified in Table 5 act as an absolute cap for the incorporation of mitigation into risk assessments for Annex 1 listing (more differentiated maxima can be derived on a case-by-case basis according to the use conditions and options for mitigation).*** The values in Table 5 are intended to be overall maximum possible reductions in exposure. Options are also provided to give reductions in exposure that are less than this maximum (e.g. for mitigation of spray drift). Risk managers will need to decide the applicability and usefulness of particular mitigation measures at the Member State level.

Table 5. Maximum levels of exposure mitigation in risk assessment for Annex 1 listing (note that the largest reductions in exposure may require significant restrictions to the usage area or widespread enforcement of mitigation measures)

Route of exposure	Maximum reduction in exposure recommended for current mitigation approaches
Spray drift	99% (e.g. no-spray buffer and or drift-reducing techniques)
Surface runoff	90% (e.g. 15-20 m vegetated buffer)
Drainflow	100% (e.g. prohibit application to drained soils)

Revised text (changes marked in red):

Based on the list of measures in Table 4, it is possible to establish a realistic level of mitigation that can be achieved for the different routes of exposure. However, there may be concerns over guaranteeing the effectiveness of a particular measure when concerning very high levels of mitigation (e.g. 99% reduction in exposure) for relatively hazardous materials.

For this reason, it is expedient to set upper limits to the extent of mitigation that can be consider at present based both on technical and political considerations. ***[Recommendation 6] It is recommended that the maximum values identified in Table 5 act as an absolute cap for the incorporation of mitigation into risk assessments for Annex 1 listing (more differentiated maxima can be derived on a case-by-case basis according to the use conditions and options for mitigation).*** The values in Table 5 are intended to be overall maximum possible reductions in exposure. Options are also provided to give reductions in exposure that are less than this maximum (e.g. for mitigation of spray drift). Risk managers will need to decide the applicability and usefulness of particular mitigation measures at the Member State level.

Table 5. Maximum levels of exposure mitigation in risk assessment for Annex 1 listing (note that the largest reductions in exposure may require significant restrictions to the usage area or widespread enforcement of mitigation measures)

Route of exposure	Maximum reduction in exposure recommended for current mitigation approaches
Spray drift	95%[1] (e.g. no-spray buffer or drift reducing technique)
Surface runoff	Variable but not to exceed 90% reduction in PEC (e.g. 20 m vegetated buffer)[2]
Drainflow	90% (e.g. prohibit application to drained soils)[3]

[1] Reductions in exposure of greater than 95% have been obtained using no-spray buffer zones and are also possible based on the most effective drift reduction techniques; EFSA (2006) expresses concern about very large reductions in exposure arising when combining more than one mitigation approach for spray drift. The 95% limit on mitigation at Annex I is proposed to address this concern.

[2] Maximum reductions in the loading of pesticide to water are proposed to be 80 and 95% for compounds transported in the aqueous and sediment phases of surface runoff, respectively. Associated reductions in the volume of water mean that the maximum reduction in exposure concentration will vary on a case-by-case basis.

[3] More completely, the restriction would apply to all soils susceptible to periodic water logging because of slow permeability or rising ground water tables (EFSA, 2006). The connection between upper groundwater and surface water means that the reduction in exposure is difficult to quantify with current tools. The 90% maximum reduction in exposure reflects this fact. A detailed analysis could link predicted concentrations in upper groundwater into the baseflow component within the FOCUS surface water scenarios or use a validated catchment-scale model.

B. Approach to incorporating mitigation from vegetated buffer zones into the risk assessment

Context:

Volume 1 of the FOCUS LM report summarised mitigation options for runoff, mechanisms to implement runoff mitigation into the risk assessment, and research needs. Version 1.0 suggested a simplified approach to quantifying the efficacy of vegetated buffer zones that was in line with existing practice in some member states and applied a reduction in volume of runoff water and mass of pesticide load based on width of the buffer zone. Version 1.0 further referred to a data collation and analysis exercise that was in progress, but not available within the timescale of completing version 1.0 of the report.

Version 2.0 presented a revised analysis of buffer strip efficiency that was based on results of the data collation and analysis exercise, as well as reflecting PPR comments in relation to Version 1.0. More detailed material on the proposed approach was moved from Volume 2 (detailed technical reviews) to Volume 1 (extended summary).

Original text:

3.5.2 Mitigation Options for Annex I Registrations

Three mitigation options that are suited to regulatory assessments are:

1. A reduction in the application rate, giving a similar reduction in losses to surface waters via surface runoff or erosion;
2. A restriction in the application window, normally to avoid application during or immediately before periods when the risk of runoff is greatest.
3. The application of a vegetated buffer zone (or filter strip) to intercept runoff prior to entry into surface water.

For the first two options, the principles are similar to approaches applied in many Member States to mitigate the risk of leaching to groundwater. Both options should thus be broadly acceptable. The FOCUS surface water scenarios provide a harmonised approach to investigate the impact of the mitigation on pesticide exposure in surface waters. Further work is currently underway (M. Russell & P. Adriaanse, pers. comm.) to develop improved modelling algorithms to account for runoff volumes and fluxes as a way of refining runoff exposures for Step 4 calculations. These should be available in the near future.

For the third option, there are already good examples of such approaches being successfully applied at Member State level, where label restrictions are applied to limit runoff input at the point of entry (i.e., next to the water body). For example, in Germany, 5 m and 10 m buffer strips are respectively considered to provide 50% and 90% reduction in runoff inputs (i.e. both water and pesticide load). These measures have been tested in several field studies over recent years and have been found to be effective.

The scientific literature indicates that the main action of vegetated buffer zones (i.e. those comprised of relatively dense vegetation like grass at the soil surface) in reducing pesticide load transported to surface waters is through an equivalent reduction in the volume of runoff water. The efficacy of vegetated buffer zones depends on many inter-related factors (see Section 1.4.2 of Volume 2) and deriving generalised relationships is difficult at present. Furthermore, the experimental conditions of typical runoff studies may not be directly comparable to those in the field as they tend to be undertaken on small plots, often include artificial rainfall at high intensity and normally only consider sheet flow. However, a substantial number of runoff studies have been conducted under Good Laboratory Practice (GLP) for registration purposes by the agrochemical industry (not currently available in the public domain) to demonstrate the value of vegetated buffer zones. A review of these studies is underway, and these data may then be appropriate for developing more specific guidance. An addendum to the current report could therefore be considered when these further data become available in the second half of 2005.

The current literature data only apply to situations where: (i) surface runoff enters the buffer as sheet flow (rather than as channelled flow), and (ii) the soil in the buffer is not saturated and the infiltration capacity of the buffer is not reduced by soil surface sealing. A straight-forward analysis of these data is difficult because of the different experimental conditions and the measured variation in buffer efficacy for buffer zones of different sizes. There are also some references where the efficacy of the buffer can only be approximated. If the European data are pooled by buffer width and the distribution of reduction in pesticide load is analysed independently using the percentile function in Excel, the following data result: 5-6 m buffer (90th percentile worst-case value = 48% reduction; 50th percentile = 89% reduction; n=14); 10-12 m buffer (90th percentile worst-case = 68% reduction; 50th percentile = 95% reduction; n=25); 15 m buffer (90th percentile worst-case = 94% reduction; 50th percentile = 95% reduction; n=3); 18-20 m buffer (90th percentile worst-case = 90% reduction; 50th percentile = 98% reduction; n = 16). This analysis is not completely satisfactory because there is not a direct relationship between buffer width and percent reduction, and because the number of points used to derive a 90th percentile is less than 10 in some cases, meaning that a certain degree of extrapolation is needed. However, the available data clearly show that reductions in sheet runoff of more than 90% can be achieved by the use of vegetated filter strips of sufficient size.

Despite the difficulty of quantifying the runoff reduction efficiency of vegetated buffer zones of a specific size, the view of the majority of the Work Group was that some broad recommendations can be used to guide appropriate mitigation measures to apply to EU Annex I registrations (in the absence of channelled flow, saturated or capped soil). These pragmatic recommendations have been developed with due consideration that the aim of the EU Annex I risk assessment is to demonstrate that a major safe use of the compound in the EU is possible (i.e. not necessarily to be protective of every individual set of circumstances). However, the principles are also applicable at Member State level for national approvals, albeit that more detailed consideration of the local conditions should be applied. In some cases, smaller buffers may be appropriate to achieve the necessary mitigation (as has been demonstrated in Germany, e.g. with 90% reduction for 10-m strips), and elsewhere larger buffers may be required.

The following general interim values are recommended as reasonable worst-case assumptions for efficacy of vegetated buffer zones in good condition: 50% reduction in volume of runoff water and pesticide loading (mass) for buffers of 5-m width, 75% reduction for buffers of 10-m width and 90% reduction for buffers of 15-20 m width. These reduction values represent 90^{th} percentiles from measured distributions; their use in combination with Step 3 exposure values that are themselves realistic worst-case is expected to yield highly conservative values for use in risk assessment. The possibility for lower or higher efficacy under some conditions cannot be excluded and needs to be considered on a case-by-case basis at Member State level. These values should also be reviewed in the light of the detailed analysis of regulatory studies mentioned above (likely to be available during the second half of 2005). Furthermore, the availability of experimental data should be considered when determining suitable buffer zones, and values different from those above may be appropriate depending on the results of studies on specific compounds.

3.5.3 Implementation of runoff mitigation into exposure assessment

The reduction in pesticide load for compounds dissolved in runoff results from a corresponding decrease in the volume of water moving as surface runoff. An example of how this relationship can be included into the calculation of predicted environmental concentrations is provided in Section 2.1.2.2 of Volume 2. For some compounds, it may be necessary to consider the fate of pesticide infiltrating into the vegetated buffer zone. It is recommended that appropriate literature citations or experimental data be provided to support the claimed mitigation effect of buffer zones for a specific chemical in recognition of the influence of sorption behaviour on soluble runoff *versus* erosion as key transport mechanisms.

When considering the implementation of runoff mitigation for national authorisations, Member States should also take the following considerations into account. The mitigating effect of buffer zones is reduced or negated for pesticide losses with runoff water when soils become saturated (this does not apply for highly sorptive compounds that are primarily transported with soil particles) or if a significant component of runoff reaches the buffer as concentrated flow. Experimental or literature data should consider these effects. Vegetated buffer zones have been shown to be an efficient measure to reduce soil erosion in agricultural landscapes and are therefore likely to reduce particle-bound pesticide losses to a great extent. It may be necessary to have additional restrictions on use of a pesticide during periods when the buffer is expected to be saturated. At Member State level, the appropriate width of the buffer zone should be defined based on local conditions. For concentrated flow, mitigation measures such as retention ponds should be focused at the point where the runoff enters the water body or buffers should be placed along the line of descent along which concentrated flow collects (buffers in 'cascade').

3.5.4 Research needs

There is a need for further research into the efficacy of vegetated buffer zones in reducing transport of pesticides via surface runoff. The most urgent requirement is for studies investigating the impact of runoff received as channelled flow and of the effect of soil moisture status within the buffer. Further work is also recommended on (i) the fate of pesticide infiltrated in the buffer (e.g. sorption may not reach equilibrium when large volumes of water infiltrate the upper soil layers over short periods) and particularly clarification of the mechanisms for removal of pesticides from runoff and erosion as a function of chemical properties; and (ii) the development of models to simulate in a dynamic way the efficacy of buffers for the removal of pesticides from runoff and erosion. There is little information specific to European conditions on measures such as conservation tillage and conservation landscape management that target control of pesticide transport on eroded sediment. Further work is recommended on these topics.

Revised text (changes marked in red):

3.5.2 Mitigation Options for Annex I Registrations

Three mitigation options that are suited to regulatory assessments are:

1. A reduction in the application rate, giving a similar reduction in losses to surface waters via surface runoff or erosion;
2. A restriction in the application window, normally to avoid application during or immediately before periods when the risk of runoff is greatest.
3. The application of a vegetated buffer zone (or filter strip) to intercept runoff water and eroded sediment prior to entry into surface water.

For the first two options, the principles are similar to approaches applied in many Member States to mitigate the risk of leaching to groundwater. Both options should thus be broadly acceptable. The FOCUS surface water scenarios provide a harmonised approach to investigate the impact of the mitigation on pesticide exposure in surface waters. The SWAN software is now freely available to support Step 4 calculations (contact: gerhard.goerlitz@bayercropscience.com). The user can manually enter values for reduction in runoff water, pesticide fluxes and eroded sediment and the system will document the inputs and calculate refined outputs from the FOCUS surface water scenarios.
For the third option, there are already good examples of such approaches being successfully applied at Member State level, where label restrictions are applied to limit runoff input at the point of entry (i.e., next to the water body). For example, in Germany, 5 m and 10 m buffer strips are respectively considered to provide 50% and 90% reduction in runoff inputs (i.e. both water and pesticide load). These measures have been tested in several field studies over recent years and have been found to be effective.

The scientific literature indicates that the main actions of vegetated buffer zones (i.e. those comprised of relatively dense vegetation like grass at the soil surface) in reducing pesticide load transported to surface waters are (1) through an equivalent reduction in the volume of runoff water and (2) through sedimentation of particulate material. The efficacy of vegetated buffer zones depends on many inter-related factors (see Section 1.4.2 of Volume 2) and deriving generalised relationships is difficult at present. Furthermore, the experimental conditions of typical runoff studies may not be directly comparable to those in the field as they tend to be undertaken on small plots, often include artificial rainfall at high intensity and normally only consider sheet flow. The current literature data only apply to situations where: (i) surface runoff enters the buffer as sheet flow (rather than as channelled flow), and (ii) the soil in the buffer is not saturated and the infiltration capacity of the buffer is not reduced by soil surface sealing. A straight-forward analysis of these data is difficult because of the different experimental conditions and the measured variation in buffer efficacy for buffer zones of different sizes. There are also some references where the efficacy of the buffer can only be approximated.

Despite the difficulty of quantifying the runoff reduction efficiency of vegetated buffer zones of a specific size, the view of the majority of the Work Group was that some broad recommendations can be used to guide appropriate mitigation measures to apply to EU Annex I registrations (in the absence of channelled flow, saturated or capped soil). These pragmatic recommendations have been developed with due consideration that the aim of the EU Annex I risk assessment is to demonstrate that a major safe use of the compound in the EU is possible (i.e. not necessarily to be protective of every individual set of circumstances). However, the principles are also applicable at Member State level for national approvals, albeit that more detailed consideration of the local conditions should be applied. In some cases, smaller buffers may be appropriate to achieve the necessary mitigation (as has been demonstrated in Germany, e.g. with 90% reduction for 10-m strips), and elsewhere larger buffers may be required.

Reichenberger et al. (2007) have recently reviewed data on efficiency of vegetated buffer strips in reducing loadings of pesticide in aqueous and sediment phases. A limited amount of additional data have become available subsequent to this review (see Table 1.7, Volume 2). It is difficult to determine whether or not data generated outside of Europe are relevant to European conditions, so an initial screen of the data selected only those results generated in Europe. If the European data are pooled by buffer width and by transport mode (aqueous vs. sediment) then a reasonably consistent pattern emerges.

Table provides 90th percentile worst-case values for efficiencies of vegetated buffer zones in reducing the loading of pesticide transported in the aqueous and sediment phases of runoff. The 90th percentile was selected as it has been accepted in analogous cases as providing a sufficient degree of conservatism. The values were calculated assuming a Weibull distribution (cumulative relative frequency = rank/n+1) with linear interpolation between the two measured datapoints surrounding the 90th percentile. Measurements were combined into width intervals (e.g. 18-20 m) to provide a more robust estimate of the 90th percentile. Further information on the statistical analysis is provided in Volume 2, Table 1.10 and associated text. Values for reduction efficiencies proposed in Table 7 below are rounded for ease of use. The efficiency of a given width of vegetated buffer is greater in reducing mass of eroded sediment and associated pesticide than in reducing volume of runoff water and associated mass of pesticide in the aqueous phase.

Table 7. 90th percentile worst-case values for reduction efficiencies for different widths of vegetated buffers and different phases of surface runoff

Buffer width (m)	10-12	18-20
Reduction in volume of runoff water (%)	60	80
Reduction in mass of pesticide transported in aqueous phase (%)	60	80
n (for aqueous phase)	*36*	*30*
Reduction in mass of eroded sediment (%)	85	95
Reduction in mass of pesticide transported in sediment phase (%)	85	95
n (for sediment phase)	*19*	*11*

The values provided in

Table 7 are recommended as reasonable worst-case assumptions for efficacy of vegetated buffer zones in good condition. **It should be noted that the reductions apply both to the volume of runoff water and the loading of dissolved-phase or sediment-bound pesticide in that runoff. Thus, for example, a 60% reduction in dissolved pesticide load will result in a significantly smaller reduction in the predicted environmental concentration because the volume of runoff water (and thus part of the dilution capacity) is also reduced by 60%.** The values in Table 7 for reduction in water volume and sediment load are not calculated from measured data, but are set to the same values as for reduction in pesticide load for consistency and ease of use. Variability in the data is greater for narrower buffers (Reichenberger et al., 2007) and for this reason it is not recommended that a buffer of less than 10 m width be considered for Annex I listing. The proposed reduction values represent 90th percentiles from measured distributions; their use in combination with Step 3 exposure values that are themselves realistic worst-case is expected to yield conservative values for use in risk assessment. The possibility for lower or higher efficacy under some conditions cannot be excluded and needs to be considered on a case-by-case basis at Member State level. The availability of experimental data should be considered when determining suitable buffer zones, and values different from those above may be appropriate depending on the results of studies on specific compounds.

3.5.3 Implementation of runoff mitigation into exposure assessment

The reduction in pesticide load for compounds dissolved in runoff results from a corresponding decrease in the volume of water moving as surface runoff. An example of how this relationship can be included into the calculation of predicted environmental concentrations is provided in Section 2.1.2.2 of Volume 2. For some compounds, it may be necessary to consider the fate of pesticide infiltrating into the vegetated buffer zone. It is recommended that appropriate literature citations or experimental data be provided to support the claimed mitigation effect of buffer zones for a specific chemical in recognition of the influence of sorption behaviour on soluble runoff *versus* erosion as key transport mechanisms.

When considering the implementation of runoff mitigation for national authorisations, Member States should also take the following considerations into account. The mitigating effect of buffer zones is reduced or negated for pesticide losses with runoff water when soils become saturated (this does not apply for highly sorptive compounds that are primarily transported with soil particles) or if a significant component of runoff reaches the buffer as concentrated flow. Experimental or literature data should consider these effects. Vegetated buffer zones have been shown to be an efficient measure to reduce soil erosion in agricultural landscapes and are therefore likely to reduce particle-bound pesticide losses to a great extent. It may be necessary to have additional restrictions on use of a pesticide during periods when the buffer is expected to be saturated. At Member State level, the appropriate width of the buffer zone should be defined based on local conditions. For concentrated flow, mitigation measures such as retention ponds should be focused at the point where the runoff enters the water body or buffers should be placed along the line of descent along which concentrated flow collects (buffers in 'cascade').

3.5.4 Research needs

There is a need for further research into the efficacy of vegetated buffer zones in reducing transport of pesticides via surface runoff. The most urgent requirement is for studies investigating the impact of runoff received as channelled flow and of the effect of soil moisture status within the buffer. Further work is also recommended on (i) the fate of pesticide infiltrated in the buffer (e.g. sorption may not reach equilibrium when large volumes of water infiltrate the upper soil layers over short periods) and particularly clarification of the mechanisms for removal of pesticides from runoff and erosion as a function of chemical properties; and (ii) the development of models to simulate in a dynamic way the efficacy of buffers for the removal of pesticides from runoff and erosion. There is little information specific to European conditions on measures such as conservation tillage and conservation landscape management that target control of pesticide transport on eroded sediment. Further work is recommended on these topics.

Short discussion of the virtual nature of the upstream catchment defined in the FOCUS surface water scenarios and the consequences for the reductions of runoff as implemented via the SWAN tool.

The EFSA peer review (that includes risk assessors from member state competent authorities) use the noted landscape and mitigation report, so accepts and uses the SWAN tool to implement runoff mitigation following the procedure outlined in this noted report. However, because of the virtual nature of the upstream catchment definition in the FOCUS surface water scenarios (that provide the flow rates (base flow and infiltration flux) in the different FOCUS water bodies), they cannot be considered spatially representative of any real catchment. Hence the implementation of runoff reduction in SWAN also has this 'virtual' aspect. This simplification means that the SWAN implementation does not incorporate any reduction to the volume of runoff water in the upstream catchments due to the presence of vegetation in uncultivated areas of the upstream catchment or the presence of vegetated buffer strips (that by definition are permanent features of the landscape) in cultivated areas. I.e. the dilution capacity of the upstream catchment is not reduced in the SWAN runoff reduction implementation. This is accepted due to the virtual nature of the FOCUS upstream catchment definition. As a consequence, there is uncertainty about whether the levels of mitigation predicted by the SWAN implementation will always be achieved in real catchments for substances present dissolved in the aqueous phase of runoff; this uncertainty is considered to be much smaller for more strongly sorbed substances. To a certain extent this uncertainty for more weakly sorbed substances can be considered counterbalanced by the FOCUS groups assessment of the literature considered by Reichenberger et al. (2007), that indicated that for substances that had a range of adsorption properties, runoff reductions were achieved, at least in the situations that had been investigated, in the publications included in this review.