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Interactive comment on "Can we manipulate root system architecture to control soil erosion?" *by* A. Ola et al.

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Reviewer 2 makes a number of interesting observations which we will take into account in the revised version of the paper. In this response we are dealing with the comments, where we feel further clarification may be needed.

1. It is a review about effect of plant roots (not only architecture) on soil properties andhydrology regarding erosion, and the main hypothesis is that, as plants can form densemats of roots at the soil surface which may block soil pores and therefore limit infiltration, deeper placement of fertilizer would decrease soil erosion through concentrated flow by inducing a proliferation of fine and thin roots in deeper horizons (at 10 cm depth? we don't know) at the expense of shallow roots. The title do therefore not

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really correspond to the content.

The reviewer's point here seems to be that the title is not a clear indicator of the paper's content. On reflection we agree that it may indicate an experimental rather than a 'progress' style paper. Therefore we have changed the title to 'Is there potential to manipulate root system architecture to control erosion?'

2. The most recent review I know on this subject is not cited in this manuscript!: "The role of fine and coarse roots in shallow slope stability and soil erosion control with a focus on root system architecture: a review (2007) Bert Reubens Jean Poesen Frederic Danjon Guy Geudens Bart Muys Trees 21:385–402 DOI 10.1007/s00468-007- 0132-4 " It was cited 97 times, it is therefore probably not a bad paper, I'm therefore very surprised that it was not cited in the manuscript.

We are aware of this paper, but we did not cite it because of its focus on woody roots of trees, while our manuscript focuses on arable land, as mentioned in the introduction. However, we do agree that it is an important paper with some general information about root system architecture, that our readers may be interested in, so we will cite it in the revised paper.

In the same way, the manuscript deals mainly with annuals crops, but there are several references to forest and to natural areas. You should better define which ecosystems you will address, mainly on annual crop plants or all plants.

The focus of our manuscript is arable land and thus, mainly annual crops. Occasionally we may have referred to other plants, which should be acceptable depending on the point to be made e.g. studies using grass roots to demonstrate that roots do contribute to the erosion reducing effect associated with vegetative covers (page 268). It is also worth noting that according to the definition by FAO arable land may also refer to temporary pastures (Ramankutty, N. and Foley, J.A. (1999). Estimating historical changes in global land cover: Croplands from 1700 to 1992, Global Geochemical Cycles, 13, 997-1027). Nevertheless, we will reassess the use of these examples during

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the revision.

3. There is a big problem in this paper, it is difficult to understand how the main hypothesis is built. It may come from Archer et al. (2002) “lolium perenne and agrostis capillaris form fibrous and rhizomous mats, respectively, at shallow depth, and have low hydraulic conductivity. Densely growing fibrous and rhizomous roots could occupy more pore space at the soil surface , reducing macropore space available for water movement”. From what I know, grazing lands in fairly wet zones are not so much prone to erosion if the plant cover is continuous, not disturbed by trampling of hikers, including natural zones like mountain pastures. Because hydraulic conductivity is not the sole parameter determining erosion rate.

We found the reviewers comment a little unclear. We will take a careful look at how we develop our hypothesis in the revised paper, but we are not really clear what point is being made.

I’m not convinced that wheat or hordeum or zea can really block heavily water infiltration by the shallow root mat they could form at the end of the growing season.

There is evidence (Mannering and Johnson, 1969 in Archer et al. 2002) that roots of some crop species (Zea mays and Glycine max) initially block soil pores and flow paths are created upon decomposition of the roots towards the end of the growing season. Moreover, the hypothesis rely also on work of Drew and co-workers on annuals crops growing short time in well watered artificial and oxygenated media showing that fine roots proliferate in the area where nutrients are more abundant. I’m not sure grass species such as lolium perenne and agrostis capillaris will really completely change their architectural model by setting most of their fine and thin roots at 20 cm depth if fertilizer is provided there. The focus of our paper is arable crops. However, several studies reported proliferation of roots of grasses in nutrient enriched zones including: Fransen, B.; de Kroon, H. and Berendse, F. (1998). Root morphological plasticity and nutrient acquisition of perennial grass species from habitats of different nutrient

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availability, Oecologia, 115, 351 – 358.

4. Rooting in the soil is much more complex than the rhizotron 2D experiments on young plants and artificial media from Drew. Rooting is dynamic, there is and interaction and feed-back through depletion between root growth and water content of the soil (work of e.g. Glyn Bengough), and also with biomechanics (last paper on interaction between slope and mechanical perturbation of shoot : Danjon F, Khuder H, Stokes A (2013) Deep Phenotyping of Coarse Root Architecture in R. pseudoacacia Reveals That Tree Root System Plasticity Is Confined within Its Architectural Model. PLoS ONE 8(12): e83548. doi:10.1371/journal.pone.0083548). Moreover, water content and root distribution are dynamic, especially in annual crops.

We completely agree and we have drawn our examples form a wide range of work, discussing studies based on lab experiments (i.e. rhizotrons, artificial media etc.) and field experiments (page 276 line 26).

5. Reading the manuscript, I conclude that there are certainly much more way to decrease erosion rate in slopes covered with natural vegetation, forests, perennial or annual crop by manipulating root architecture, it is certainly much more easier by using genetic variability, at the species, provenance or variety level, favouring for example mixtures of shrubs and grasses.

The reviewer may be correct, but we are not principly concernered with forested landscapes. Rather the focus of our review is arable agriculture and mixtures of shrubs and grasses are not really suitable in monoculture agricultural systems. Furthermore, we discussed the possibility to specifically select and breed for plant traits to reduce soil erosion rates (page 274 line 10).

6. . . . specific root parameter (rld) whereas other root parameter exist (RAR biomass, RLD, angle to vertical, branching parameters). A subchapter about all usable root parameter would be needed.

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We focused on RLD as it has been frequently used in soil erosion studies (concentrated flow erosion). For further details please see reply to Comment #3 from Referee 1.

Interactive comment on SOIL Discuss., 2, 265, 2015.