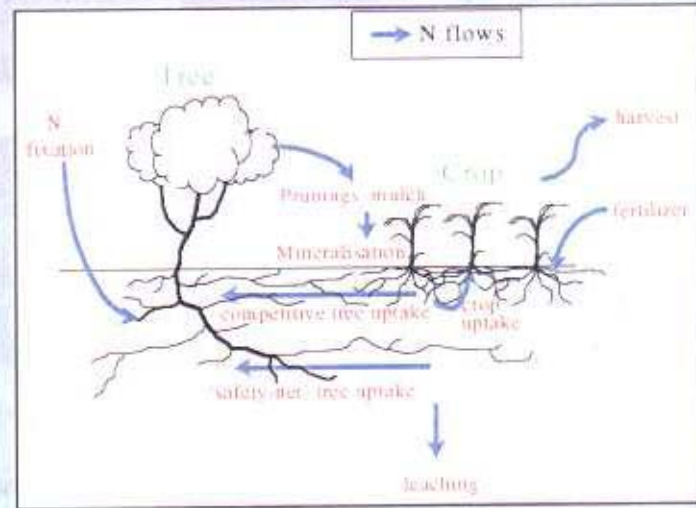


The tree root safety-net in agroforestry

In the humid tropics, available nitrogen in soil is easily leached down to depths where it cannot be reached by crop roots, reducing farm profitability and potentially causing pollution downstream. Crop roots are shallow during early growth stages, and on many acid soils crop roots are restricted to the surface soil. Intercropping with deep rooting trees can increase fertilizer use efficiency - deep tree roots can act as a safety-net, intercepting and recycling nitrogen. However, not all trees are suitable, and mixing trees and crops has other consequences as well.

Trees benefit soil structure and long term fertility by producing biomass which increases or maintains soil organic matter, and by improving nutrient cycling efficiency. Tree roots increase soil macroporosity and thus reduce the leaching effect of water flowing through soil. However, agroforestry associations (e.g. hedgerow intercropping) have not been successful where trees competed strongly with crop plants. Designing and managing successful agroforestry associations depends on minimising the competition from trees as much as on maximising their fertility benefit.



- The best trees for closely integrated agroforestry associations are likely to be slow growing during the period of crop growth, which also reduces the labour needed for pruning during times of peak farm activity. Ideally this should be combined with good growth during the dry season on residual soil moisture.

- Crop growth in hedgerow intercropping systems is maximised if hedgerows are kept pruned short during the growth of the crop but are allowed to produce lots of biomass during fallow periods. Pruning very frequently, however, is likely to increase tree mortality and costs a lot of labour.

- Nitrogen fixation by trees in hedgerows spaced 4 m apart can maintain sufficient N without supplements, provided only moderate amounts of N are exported in crop products. To boost system productivity and sustainability, N_2 fixing crops should be included in rotations.

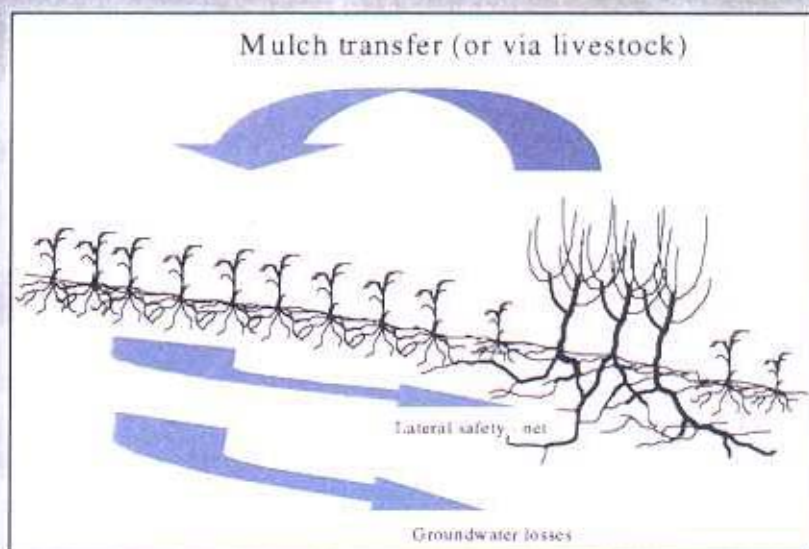


Peltophorum dasycarpum / maize hedgerow intercropping in Lampung, Indonesia, producing consistently positive effects on maize yield.

Recent research¹ has tested the safety-net hypothesis, quantifying the effect in a case study and helping to formulate a tree-soil-crop interaction model² which can be used to extrapolate to other soils, climates, trees or crops.

Lateral flows

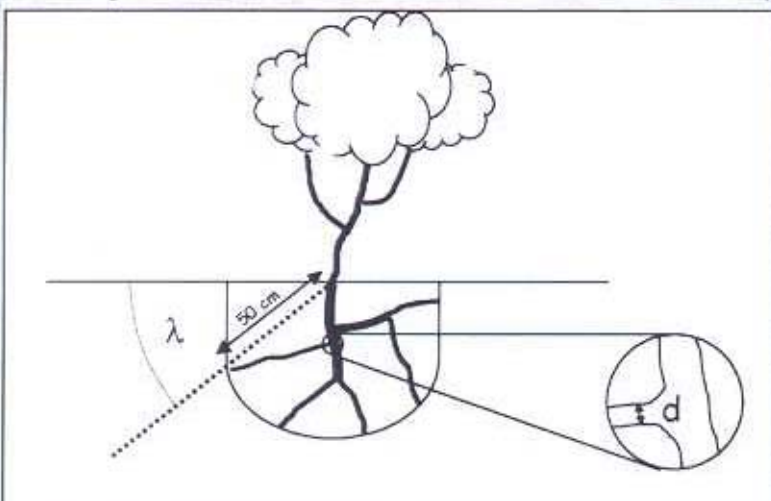
Even on slight slopes (e.g. 5 %), N leaching takes place laterally down the slope as well as vertically through the soil. Widely spaced hedgerows arranged as filters to intercept laterally flowing N compete less strongly with crops than hedgerows spaced 4 m apart, but still provide 'safety-net' benefits. Mulch transfer systems are very labour intensive. Livestock can be used to move and increase the availability of nutrients. However, manure must be managed carefully to avoid losses.



Observing tree roots at the stem base reveals which ones are deep.

- Any soluble fertilizer should be split between an application just before crop establishment and an application at the time of maximum crop growth.

- Trees should be selected after trials on local soils. Deep rooted trees are likely to be less competitive and to recycle N more efficiently than shallow rooted trees.



The depth of tree rooting can easily be assessed by excavating main roots and measuring their angles of descent. The mean vertical angle of main roots, weighted by their cross-sectional area, gives a quick measure of rooting depth and potential safety-net role.

$$\text{Area-weighted mean vertical angle} = \frac{\sum d^2 \lambda}{\sum d^2}$$

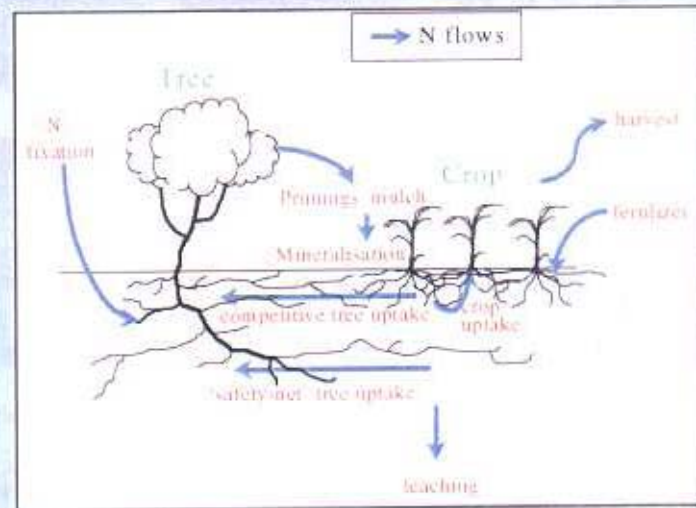
1. These recommendations resulted from a collaboration between Wye College, ICRAF SE-Asia and Brawijaya University. For further information contact <g.cadisch@wye.ac.uk>, <m.van-Noordwijk@cgiar.org>, or <soilub@wasantara.net.id>. This publication is an output from a research project funded by the Department for International Development of the United Kingdom. However, the Department for International Development can accept no responsibility for any information provided or views expressed. (R6523, Forestry Research Programme).

2. For info on the WaNuLCAS model of water, nutrient and light capture in agroforestry system, see <http://www.icse.org/id/wanulcas/>

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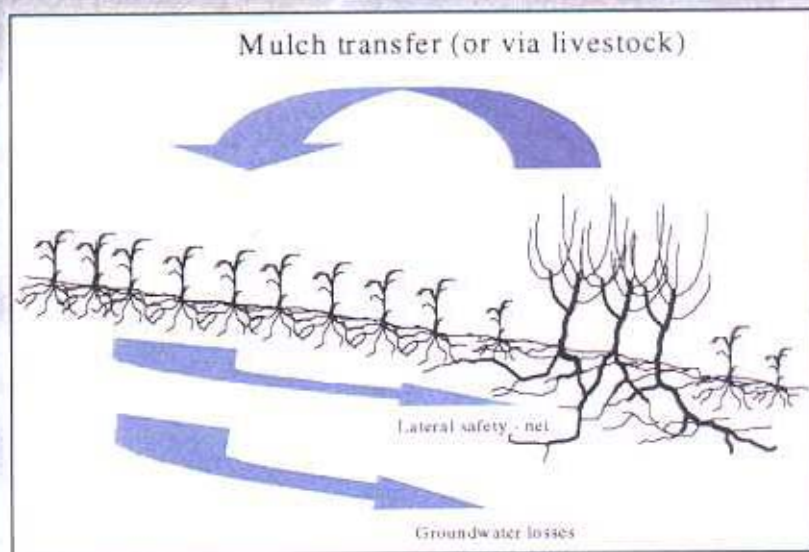


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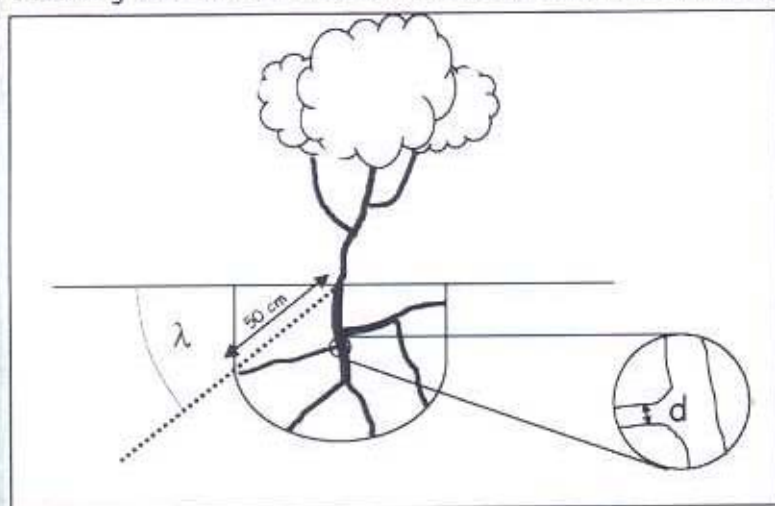
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