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Policy Brief

Fighting against soil erosion and improving the sustainability of Mediterranean rainfed agriculture

In order to reverse the economic and social environmental issues affecting vast areas of dryland farming systems in Central Chile, we provide to the authorities of the Government of Chile, a set of technologies and soil conservation tools, developed in the framework of the EU-funded DESIRE project. Specifically the new knowledge consists of using no-tillage with subsoiling, which allows dramatic decrease in soil losses and enhanced availability of water for crops. In addition, the project has developed new crop rotations incorporating legumes into de sequence of the crops that can improve soil fertility and increase the productivity of the whole system. Finally, suitable technologies are available for the plantation of multipurpose trees and seeding legume pastures, for the implementation of silvopastoral systems. This new knowledge will combat against the erosion and desertification of this vast area of Chile and improve the quality of the soils. In spite of the auspicious results obtained in 5 years of participatory research, the implementation of these technologies needs the subsidiary help of the government of Chile, because the problems of degradation and impoverishment of the land users are of such magnitude that make it impossible that they can adopt them otherwise.

Based on experience in Chile

Erosion in the Secano interior and 0 tillage as a solution for land degradation, @Inia

Local degradation, regional consequences

Mediterranean dryland areas of central Chile have been subjected for more than four centuries to a heavy destruction and degradation of natural resources. Most of this 2 millions ha is occupied by a traditional agricultural system that combines livestock activities with the production of cereals, on soils with steep slopes. As a result of the prevailing land use systems, about two thirds of "Secano interior" soils are badly eroded (IREN, 2010), and soil organic matter and fertility are very low in many places. At macro regional level, the erosion has provoked environmental imbalances, like siltation of rivers and ports, and serious problems of floods, as much at rural level as in the cities. As a result of this historical process there are strong environmental, economic and social imbalances. Indeed, these are the areas of the country with the greatest concentration of rural poverty and the worst quality of life and social inequity.

DESIRE Project

The DESIRE Project, designed and implemented in a participatory manner with farmers in dry land areas of the regions of Maule and Bío of Chile, has successfully evaluated and tested a set of new technologies that allow farmers to significantly reduce soil and water losses and help to improve the fertility of these depleted soils.

Here we present three successful technologies:

Technology 1 : No-tillage

No-tillage with subsoiling is done with a subsoiler at 40 cm depth. This technology mitigates water erosion compared to the traditional tillage. In heavy rainfall events, no-tillage reduced soil loss by more than 72% compared to conventional tillage. In addition, the runoff coefficient during the rainy period was 70% lower. These results show the importance of conservation tillage and crop stubble management to decrease erosion, especially in years when extreme precipitation presents a high potential for soil erosion.

In relation to soil compaction, comparing the resistance to penetration in the soil profile, the traditional tillage system showed a strongly compacted layer at a depth of 10cm (>1300 kPa), which increased to over 2000 kPa between 15 and 20 cm. In contrast, no-tillage + subsoiling showed less compaction, beyond 20 cm below the threshold of 2000 kPa, defined by several authors as the critical threshold for root penetration and growth. Moreover, cereal production showed higher biomass and grain yield.

It is concluded that no-tillage + subsoiling with stubble retained on the surface is the best option to mitigate soil erosion.

Sowing of wheat with 0 tillage in Ninhue commune, in the secano Interior . @Inia

No-tillage seed planter pulled by oxen, to grow lentils on the rainfed soils of Ninhue County . @Inia

Technology 2 : New crop rotation system

A new system of crop rotation benefits the capacity of the legumes to fix nitrogen (N) from the atmosphere, and utilize this N in cereals. The rotation is 1 or 2 years of legumes follow by one year of wheat.

These systems combine phases of legumes, in which N is fixed and accumulated in the soil, followed by phases of cereals where accumulated N is used up. In this new rotation for rainfed agricultural systems in Central Chile four legume-wheat rotations were compared to a monoculture crop rotation (wheat follow by oat). The legume species were: narrow-leaf lupin (*Lupinus angustifolium*), yellow lupin (*Lupinus luteus*), Peas (*Pisum sativum*) and a fodder mixture of vetch (*Vicia atropurpurea*) + oat). In the following year of the legume crop, wheat was seeded without N fertilisation on the incorporated residues of grain legumes and green manure (vetch+oat). BNF (Biological Nitrogen Fixation) in the grain legumes varies from 124 to 178 kg N ha-1, depending on the legume, with peas being the most efficient fixing crop. In the lupin - wheat (*L. angustifolius*) rotation without N application to the wheat after lupin, between 79 and 110% of the production of the wheat fertilised with N was produced. In the rotation peas- wheat a yield equivalent to 72 and 105% of the wheat fully fertilised with N was obtained.

Crop rotation experiments in the "Secano interior" of Cauquenes.
Photo by Soledad Espinoza

Technology 3 : Agroforestry systems

Under a Mediterranean climate, water availability for woody species, especially in the first summer, is a key factor in the survival, growth and successful establishment of tree species. The use of conservation systems of soil and water management allows a more favourable water balance, increasing water infiltration into the soil and therefore water availability for the development of agroforestry species.

Agroforestry species such as cork oak (*Quercus suber*) and Quillaja (*Quillaja saponaria*), work well in establishing conservation structures, but a fodder tree called tagasaste (*Chamaecytisys proliferus*) is the species with the best growth in height, crown diameter and trunk diameter.

Among conservation structures, infiltration trenches favour the development of tree species, but these are expensive and less efficient in retaining water in the profile, compared to subsoiling with ridges. This structure has shown an increase in moisture content over the infiltration trench to a depth of 70cm.

Multi-purpose system of planting trees on infiltration trenches. Photo by Carlos Ruiz

Multi-purpose system planting trees on subsoil tillage ridge. Photo by Carlos Ruiz

Policy recommendations

In the framework of the DESIRE Project, and after five years of research that included the participation of land users, those responsible for the implementation of soil conservation policies in the country and the administration and scientific communities, we are able to recommend:

a) In soils on slopes from 5 to 15% it is urgent to replace the traditional cropping system currently used by the farmers

b) No-tillage may replace the conventional farming system that includes fallow, tillage with reversible ploughing and burning of crop residues. This will drastically reduce the runoff and sedimentation. However, although no-tillage decreases erosion, applying this technique by itself does not assure high yields of grain, because of the remaining problem of soil compaction

c) To address the problem of soil compaction, no-tillage ought to be applied in conjunction with subsoiling, using a chisel plough at a depth of 50 cm

d) Those soils on slopes of more than 15 to 20% should not be planted. Instead, an agroforestry system with the plantation of multipurpose trees appears to be the most suitable use for these lands. These trees should be planted with soil conservation management consisting of subsoiling with ridges. This structure has shown an increase in soil moisture content and a better growth of trees.

e) Financial subsidies should be paid to households to implement and maintain the soil and water conservation practices that are recommended by the DESIRE participatory research.

Set of pictures showing Experimental plots of the DESIRE project, where were obtained the results that today allow us to make these recommendations @Inia

What is required for effective transfer of new ideas so that the farmers will adopt the suggested technologies?

1. Include technologies developed in the DESIRE Project as part of the incentive programme for the recovery of degraded soils managed by the Agriculture and Livestock Service (SAG), by:
   - adjusting incentives according to timing of expenses and investments, and
   - conditioning incentives to the adoption of the technologies

2. Generating a participatory approach for further transfer and dissemination of the results, which implies considering the production systems and the goals of the farmers

3. Developing an adoption model with local leadership, - coordination between institutions, - and long-term institutional commitments

4. Training for technicians to support the adoption of the technologies

5. Evaluating the economic and social impact of the soil conservation practices

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