Sixty per cent of arable land in Chile is affected by erosion, the rate having increased by almost 50% during the past 30 years. In Central Chile, a shortage of flat land has increasingly compelled wine growers to plant vineyards on the hillsides. This has resulted in further soil erosion and degradation that already covers 20% of the region, equivalent to 90,500 ha. The sustainability of vineyard operations is further aggravated by the negative impact that this erosion has on downstream water quality, caused by herbicides and nutrients being carried down the hillsides by excess water runoff.

The central region of Chile has therefore placed priority on the challenge to develop and implement appropriate land management practices designed to improve water quality and minimise soil erosion in vineyards.

Through three consecutive IAEA technical cooperation projects1,2,3, the Agriculture Section of the Chilean Nuclear Energy Commission, in cooperation with the Faculty of Agricultural Sciences at the University of Chile and the Agriculture and Livestock Service, compared current soil management practices in vineyards in the Apalta valley 200 km south of Santiago de Chile. The fallout radionuclide, Beryllium-7 (7Be), was used as a tracer to estimate short-term (less than a month) soil erosion and deposition across agricultural landscapes. Herbicides labelled with the radioactive carbon-14 (14C) were used to determine the mobility of herbicides during erosion events and hence their influence on water quality. The projects compared planting on terraces with the traditional downslope rows, both with only scarce soil cover during the rainy season. Net annual rates of soil loss from the terraced site (76 t/ha) were only about 7% less than those from the downslope site (82 t/ha), indicating that soil losses were substantial on both terraces and downslopes. The lack of sufficient cover particularly during the first month of the rainy seasons could explain the severity of the observed soil losses.

Using 14C labelled material it was found that glyphosate, the only herbicide applied in vineyard management, is strongly bound to soil particles and hence the main pathway of herbicide transport was associated with the loss of soil particles.
The Technology

Beryllium-7 (\(^{7}\text{Be}\)) is a naturally occurring radioactive material in the atmosphere. Through rainfall it is deposited on the soil surface. Once deposited it binds strongly to the soil particles. When soil will be redistributed by soil erosion, this radioactive material will move with the soil. This material is therefore a good indicator of soil erosion and provides an accurate measure of the efficiency of soil conservation measures designed to control erosion processes.

By labelling herbicides with easily measurable radioactive markers, such as carbon-14 \((\text{\(^{14}\text{C}\)})\), the movement of these herbicides in the soil can be traced. This enables the determination of the capacity of soil to bind herbicides. The stronger the herbicide is bound to the soil, the less herbicide is available that can move to surface waters. However, where extensive soil erosion is taking place, pesticide-bonded soil particles can be transported in runoff to receiving waters where herbicides may then be desorbed into these waters. \(^{14}\text{C}\) is therefore a useful tool in determining the mobility of herbicides in agricultural landscapes.

The Impact

The huge erosion of up to 82 t/ha/year of soil from hillside vineyards, and the ensuing movement of herbicides and nutrients to downhill water reservoirs, has shown the untenability of current vineyard management practices. It has also shown that terracing of vines is only likely to reduce soil erosion on these sites by a mere 7%. The Agriculture Section of the Chilean Nuclear Energy Commission, in cooperation with the Faculty of Agricultural Sciences at the University of Chile, is therefore planning to investigate the use of permanent ground cover between vines to effectively minimise soil erosion and water runoff on such slopes and hence to improve the downstream water quality.

Since the start of the project, cover crops have been introduced in 13 vineyards in Apalta, covering 3,200 ha. The speed with which such cover crops are being adopted reflects the importance of close public-private collaborations between research organisations and wine growers.

“The vineyard associations have been open to embrace nuclear research techniques as it has been a win-win relationship for the farmers of the region. The obtained results will help improve soil conservation and water quality at least on our 65 hectares of vineyards.”

Mr. Emilio Sanchez, Representative of the La Robleria vineyard, Apalta

For further information, please visit:
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International Atomic Energy Agency, Wagramer Strasse 5, PO Box 100,
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www-naweb.iaea.org/nafa/swmn

2 RLAS050 on “Integrated analytical approaches to assess good agricultural practices (GAP)”, 2007-2009.
3 RLAS053 on “Implementation of a diagnosis system to assess the impact of pesticide contamination in food and environmental compartments at a catchment scale in LAC Region”, 2009-2011.