Removing unwanted macro, micro and nanoplastics from fresh produce production

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Project Description: Global plastics production in 2019 was 359 million tonnes. Of the 62 million tonnes produced in Europe, only 9.2 million tonnes was collected for recycling, leaving the remainder to be disposed of on land or in marine environments, to the detriment of those ecosystems. Recent work has demonstrated that macro plastics, e.g. plastic bags, break down over time into micro- or nano-plastic particles. These microscopic plastics have been investigated in the marine environment and it has been found that marine wildlife, such as scallops and mussels ingest these, and they become distributed throughout the body of the organism. However, to date, no work has been done on terrestrial environments to find out whether nano-plastics can be taken up by plant roots and potentially enter the human food chain. Since plant roots are designed to absorb nutrients and small molecules from the soil it seems likely that this could occur. *This project will characterize the abundance and distribution of macro, micro and nano plastics in a crop cultivation environment using Scanning Electron Microscopy. You will also use ^{14}C radiolabelled spherical nanopolymers in a hydroponic experimental set up that will investigate whether plants can take up these particles and find out where in the plant they are subsequently distributed, using liquid scintillation counting and phosphorimaging.*

We have chosen to focus on the leafy salad industry as the environment in which to investigate plastic contamination, since businesses depend heavily on it to preserve the quality of the crops they grow. Much of the European supply of vegetables and fruit is produced in a region of southern Spain called Almeria, where 2,700,000 metric tons per year of produce is harvested over a region covering 30,000 hectares, nearly all of which is covered in plastic. Standard practice in Almeria is to cover the crops in plastic tunnels or plastic mulch which is then ploughed into the soil when the crop is harvested. The mulch is used to keep the soil temperature warm enough for plant growth, to prevent evaporative water loss, to suppress weed growth instead of using herbicide, and to reduce soil erosion. Nanoplastics (<1000nm) are expected to be generated by repeated cultivation of land containing waste plastic mulching material. Leafy salads also use plastics throughout the supply chain, in order to maintain freshness of the crop, to prevent microbial contamination, and to extend shelf

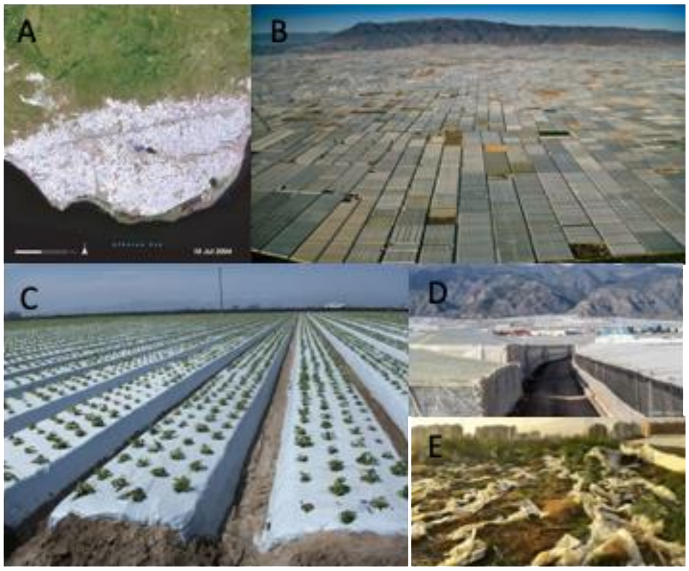

Figure 1. Plastics in use for fruit and vegetable cultivation, Almeria, Spain. A: satellite image of the Almeria region. B: aerial image of Almeria greenhouses and field cultivation. C: plastic mulch used for field production. D. Plastic greenhouses used for indoor production. E: plastic debris from disused cultivation systems

life. Almeria produces the major proportion of conventionally and organically grown salads consumed in the UK between September and March. Disposable plastics are used throughout the supply chain for crate liners, wrapping pallets and product packaging. In the case of crate liners and pallet wrappers, waste management streams are well controlled, enabling most UK fresh produce businesses to claim zero waste to landfill. However, packaging used for bagged baby and cut salad leaves does not have a good waste management stream and companies are starting to explore alternatives including biodegradable and compostable packaging. Although these concepts are good, research has indicated that degradation of these materials is often poor. *More work is required to develop bio-based packaging materials that are truly biodegradable. You will evaluate the potential for bio-based packaging to preserve leafy salad quality and shelf life, alongside assessing the ability of these types of packaging to degrade in different environments that reflect possible disposal routes.*

Finally, there is a need to undertake a structured life cycle analysis (LCA) of all plastics, and their alternatives, used in the fresh produce supply chain. *You will evaluate the sustainability of different production and supply chain practices in relation to plastic use and ensure that alternative materials to hydrocarbon polymers represent a real improvement in sustainability.* LCA will also highlight key points when alternative waste management streams should be innovated in order to prevent plastics contaminating the environment.

References:

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