

## Biobeds: on-farm biopurification for environmental protection

Biobeds, also called biofilters, are facilities intended to retain and degrade as well as facilitate microbial breakdown of on-farm pesticides. Point sources of pollution, especially when filling spraying equipment for pesticides in farmer's field can be minimized using biobeds. A major point source of contamination is spills during filling and cleaning of spraying equipment. These activities often are performed at particular on-farm sites due to the convenience of water supply<sup>1</sup>. Spraying equipment is normally filled in the same place on the farm every time, often in the farmyard near water sources. Due to these activities, high concentrations of pesticide residues have been found at on-farm sites. A low-cost system known as the biobeds can minimize the risks of such pollution. Biobeds consists of three components in a 60 cm deep pit in the ground having 50 cm biomixture layer (straw, peat, and soil @ 2 : 1 : 1 with good absorption capacity and high microbial activity), a 10 cm clay layer at the bottom (low permeability and high sorption), and grass cover (hydrophilic) on the surface. Biomixture stimulates growth of lignin-degrading fungi and formation of ligninolytic enzymes, which degrade different pesticide residues. Biotechnological interventions, i.e. augmentation with pesticide-degrading microbes or pesticide-primed matrices have resulted in enhanced biodegradation of on-farm biopurification systems. The clay layer provides sorption capacity. The grass layer indirectly contributes to the degradation by regulating water balance for biological processes and directly, by phytoremediation processes in the biomixture. The moisture in the biobeds should be high enough to promote microbial processes and solubilization of pesticides, but still leave enough pore space for oxygen to support aerobic processes<sup>2</sup>.

Small modification in the composition of biomixture (straw, peat and soil) can increase the efficiency of the system.

Ideally the biomixture should be allowed to stand outside in a windrow for 30–90 days before being added to the biobeds. This allows the composting process to start breakdown of straw materials and then makes it easier to create a homogeneous mixture. Most pesticides have strong affinity to organic matter; therefore, when the run-off water contaminated with pesticides is directed through the biobeds, the pesticides adhere to the organic material. The pesticides held in the biobeds are then broken down by the microorganisms. Straw or some other lignin-rich component should be present in the biomixture. If straw is not available, other lignocellulosic materials like lignin-rich maize or rice residues may be used. The lignocellulosic materials are useful as they are persistent, and slow in degradation, which allows continuous supply of carbon, energy, and nutrients to microorganisms<sup>3</sup>. The biobeds are also equipped with a ramp to allow the sprayer to be driven and parked over them.

There are two types of biobeds: lined and unlined. The former are lined by a synthetic impermeable layer that isolates them from the ground. This design allows the collection of drainage water in special wells that are built at the side of the biobeds. Drainage layers are usually placed below the clay. The unlined biobeds have no impermeable synthetic layer that isolates them from the ground. The biobeds should be located in a secure place at least 10 m away from any surface water source, 50 m from any well, spring or borehole and 250 m from any environmentally sensitive area. They should also be away from major access routes to prevent the trafficking of potential contaminants. The design of biobeds must be in an impermeable area, with sealed/zero drainage system on which pesticide mixing and equipment wash-down activities take place. The retention time of the pesticides in the biobeds can be increased by increasing the depth of

the biobeds or using a more effective adsorptive layer at the bottom of the bed. Total volume of the biomixture should be replaced completely after 5 years. The exhausted biomixture should be stored securely for at least 12 months, but not more than 36 months prior to land-spreading<sup>4</sup>. Biobeds should not be covered with any material as this will affect their ability to degrade pesticides. Soil having high pH should not used in biobeds, because it contains high amounts of bacteria which suppress the fungal activity. Very wet clay soil is not used for the preparation of good biomixture because it is difficult to make a homogeneous mixture.

On-farm biobeds offer an attractive solution for prevention of contamination of natural water resources by pesticides use. At the global scale much emphasis has been given to decontamination of pesticides; biobeds in farmer's field will be able to save our environment from hazardous chemical pesticides use.

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