UMass
Extension

CHECKLIST
SOIL CONSERVATION

Field Nurseries

Minimizing Soil Loss

- ✓ After harvest, incorporate composted manure, straw, or other organic materials. This practice adds stable forms of organic matter which enhances native soil fertility, soil structure, water holding capacity, and resistance to erosion.
- ✓ Plant cover crops between rows to protect against winter erosion. This practice also adds considerable amounts of organic matter to the soil. Cover crop roots also help to develop soil structure.
- ✓ Always plant cover crops in any field that is out of production.
- ✓ Plant crops along the contours of the land to reduce erosion. Planting along the contour produces a series of dams that will intercept overland water flow and thus reduce soil erosion. The feasibility of contour planting will be based on the ability of farm equipment to safely traverse the slope of the land.
- ✓ Install subsurface drainage systems in upland soils to reduce soil saturation and to minimize the presence of surface water, thereby reducing surface runoff and erosion.
- ✓ Use the largest feasible pot size when planting container nursery stock out into the field. This practice educes the amount of native soil lost during harvest.
- ✓ Practice root pruning for all B&B plant material to keep root balls as small as possible.
- ✓ Dedicate a minimum of one year of rest between nursery crop cycles in a field with a seeded cover crop. At least one planting of a cover crop should be seeded and then worked into the soil after it has grown. This practice will trap nutrients and provide more organic matter to the soil.

Animal Manure

- ✓ Use composted manures, not fresh manure.
- ✓ Avoid using manures on newly planted fields.
- ✓ Early spring to early summer is the best time to apply composted manures.

Organic Matter Spreading Techniques to Prevent Water Contamination

Contact EPA and local authorities for rules before spreading organic matter.

Organic matter, in the form of manure or compost should *not* be spread:

- ✓ On steep slopes where erosion and/or surface runoff is likely to occur.
- ✓ On saturated soils, where manures will not infiltrate into the soil.
- ✓ Within the high water mark of field depressions during times of the year when there is a high risk of direct surface runoff to an open watercourse.
- ✓ In excess winds where drift can occur.
- ✓ On frozen or snow-covered ground where runoff of snowmelt to open watercourses might occur.
- ✓ On areas having standing water.

Cover crops

- ✓ Grow cover crops to maintain vegetative cover on soils instead of leaving them bare. Cover crops protect the soil from erosion by water and wind, reduce competition from weeds, and improve soil tilth and soil fertility.

Field Storage of Manure and Compost

- ✓ Field storage should not exceed two weeks in duration.
- ✓ Field storage should not be located in natural drainage ways or where runoff will reach waterways.
- ✓ Field storage should not be located on coarse-textured or gravelly soils.
- ✓ Field storage should not take place at times of high rainfall or high water tables.
- ✓ If rainfall occurs, storage piles must be immediately covered to keep rainfall from entering the piles.

Container Nurseries

Soil Conservation

- ✓ Do not use native topsoil (field soil) as growth medium inside pot-in-pot culture, or in above-ground pots.
- ✓ Do not strip and stockpile native topsoil (field soil) to accommodate production.

SOIL CONSERVATION

Field Nurseries

Field nursery production involves the use of unique soil management practices. Soil conservation practices such as grassed waterways, water and sediment control basins, contour farming, nutrient management, planting cover crops, and crop rotation are all important to maintain good soil and water quality. Many of these conservation practices will also improve soil structure, fertility, and organic matter that ultimately produce high quality nursery crops.

Minimizing Soil Loss

Growers recognize that soil loss is a normal part of agricultural production. If this soil is not replaced, the field is losing the soil that, over time, may reduce it productive capacity. It is estimated that the harvesting of 44-inch diameter balled-and-burlapped stock can result in the loss of 470 tons of soil per acre. This is an average of 94 tons of soil lost per acre over a five-year rotation or 2.8 inches of topsoil lost in five years.

Many field growers have begun using compost to replace some of the topsoil that is lost. Aged compost with a lower organic content could be applied at high rates if thoroughly incorporated into the soil; some composts that are two to three years old have only ~20% organic matter and could be classified as organic soils. Another option for rejuvenating depleted soils is applying large quantities (6 to 9 inches over the surface of the field) of wood chips and/or bark mulch; this process requires at least one year of fallow management (growing green manure cover crops such as buckwheat or oats) to allow the huge volume of material to decompose. To speed decomposition, the organics must be thoroughly soil-incorporated.

The objective of all field production operations should be to minimize all forms of soil removal. This can be accomplished through minimizing soil erosion, adding mineral and organic matter during the growing cycle, and using operational practices designed to minimize soil loss during harvest. The following guidelines should be followed in all field operations:

- After harvest, incorporate composted manure, straw or other organic materials. This practice adds stable forms of organic matter which enhances native soil fertility, soil structure, water holding capacity, and resistance to erosion.
- Plant cover crops between rows to protect against winter erosion. This practice also adds considerable amounts of organic matter to the soil, and cover crop roots help to develop soil structure.
- Always plant cover crops in any field that is out of production.
- Plant crops along the contours of the land to reduce erosion. Planting along the contour produces a series of dams that will intercept overland water flow and thus reduce soil erosion. The feasibility of contour planting is based on the ability of farm equipment to safely traverse the slope of the land.
- Install subsurface drainage systems in upland soils to reduce soil saturation and minimize the presence of surface water, thereby reducing surface runoff and erosion.
- Use the largest feasible pot size when planting container nursery stock out into the field. This practice reduces the amount of native soil lost during harvest.

- Minimize rootball size by practicing root pruning for all B & B plant material. Rootballs should be kept as small as possible.
- Follow manufacturer directions for using root-containment bags to minimize rootball size.
- Dedicate a minimum of one year of rest between nursery crop cycles in a field with a seeded cover crop. At least one planting of a cover crop should be seeded and then worked into the soil after it has grown. This practice will trap nutrients and provide more organic matter to the soil.

Soil Conservation

The continual removal of large quantities of soil from field operations, especially balled and burlapped operations, represents a serious problem affecting the long-term viability of the land. Soil removal can be considered a form of erosion. Some erosion occurs naturally but is offset by processes of soil formation. Erosion occurring in excess of an acceptable level leads to soil degradation and loss of productivity.

To some extent, degraded soils can be managed to achieve reasonable productivity through fertilizer additions, but soil degradation jeopardizes the stability of the production system. Operations that are dependent on additions of chemical fertilizers for all their nutrient requirements may have greater problems, such as nutrient leaching and water quality concerns. In addition, degraded soils typically contain less organic matter which results in poor soil structure stability. This leads to erosion and compaction, lower available water storage capacity, and increased irrigation requirements. Soils with low organic matter content are also more susceptible to water and wind erosion, initiating a cycle of further degradation.

Soil removal generally affects the topsoil, or the A horizon of the native soil. The A horizon contains large quantities of organic matter and plant nutrients relative to the underlying B and C horizons (subsoil), but the mineral soil materials (sand, silt, and clay) are often similar throughout the soil profile. Natural processes of soil formation result in a slow but steady conversion of the upper A and B horizons. This occurs as small amounts of topsoil are lost to erosion and weathering under natural conditions. Similarly, parent materials at the upper boundary of the C horizon slowly take on the characteristics of the B horizon.

It is very expensive to replace lost topsoil. A better strategy is to encourage the development of a fertile surface horizon through the addition of composted residues or manures and the use of cover crops. Two benefits result:

- The fertility of the native topsoil will be enhanced and an "artificial" A horizon will be developed which will have most of the beneficial properties of the original A horizon.
- A greater proportion of the soil materials removed during harvest will consist of the added materials and their decomposition products, reducing the loss of native soil materials.

Soil Erosion From Rain

Protecting the soil surface from soil erosion is a serious concern for nursery operations because of the openness of the crops. If exposed, the soil surface is subjected to destructive forces

associated with raindrop impact. Upon impact, there is sufficient energy to break the bonds holding soil aggregates together. The result is that soil is broken down into its textural separates: sand, silt and clay.

Lynn Betts, USDA NRCS

Once separated, the soil particles can seal the soil surface and reduce its ability to conduct water. This seal or crust causes rainwater to pond or run off so it does not infiltrate into the soil. If this occurs on sloped fields, surface runoff will cause soil erosion. If a cover crop covers at least 30% of the exposed soil surface, some beneficial protection against raindrop impact is achieved. In addition, the roots of the cover crop help hold the soil together reducing erosion by runoff. In high or intense rainfall areas, the maximum percentage plant cover attainable is desirable.

Soil Erosion From Wind

Cover crops are also used to protect the soil surface from erosion by wind. Wind is a problem particularly on sandy soils. It is also a problem for loams previously impacted by raindrops whose aggregates have been broken down into their constituent sand, silt, and clay separates. In clay soils, stronger bonds generally produce more stable soil aggregates. This creates a rougher soil surface less susceptible to disintegration by raindrop impact. The tightly bound clays and silts are therefore less prone to erosion by wind. Cover crops form a protective layer of plant material that effectively dissipates the forces of wind. The taller and denser the crop, the better protected the soil.

Sandy soils erode by a process in which individual sand grains are lifted and return to the ground a short distance downwind, sort of "hopping" down the field. The smaller and lighter the sand grains, the higher the hop and the greater the distance the soil particles move. When the sand grains return to the ground, they do so with considerable force. By this process more and more sand grains are caused to jump, accelerating the soil erosion.

The windblown sand sandblasts the nursery crop causing physical damage to stems and leaves. The damaged plants are susceptible to disease, fungus, and pests. The sandblasting occurs on equipment and buildings as well. Other problems caused by windblown sand are sedimentation of perimeter ditches and surface levelling issues.

Strong winds can blow the clays and silts of unprotected loamy soils into dust clouds. The erosion of silts and clays represents a serious and permanent loss as these fine-textured soil constituents give fertility and structure to the soil.

Cover Crops

Traditional methods to increase organic matter in fields include the establishment of winter cover crops (to prevent late season erosion and capture nutrients before they hit the water table) and/or a green manure crop rotation. Since the primary concern with a green manure program is increasing organic matter levels in the soil, grasses and small grains are generally used in a double cropping system. Small grains are sown in the fall then killed with herbicide or plowed in before they produce seed in the spring. Sorghum-sudan hybrids are commonly used as summer cover crops sown in April or May. Sorghum-sudan hybrids should be mowed at least twice to prevent seed formation, and then they are generally plowed under in the fall.

To begin a green manure program, it is necessary to mix in previous crop stubble, fertilizer, lime, and soil amendments. Tall weeds should be mowed before seed dispersal then disked or plowed under. This permits more effective soil mixing during plowing and minimizes the problem of long, coarse stems becoming entwined in equipment.

Cover crops are grown to maintain vegetative cover on soils. Cover cropping is an important farm management practice that provides many immediate cultural benefits while sustaining, or very likely improving, the productivity of the soil. Cover crops protect the soil from erosion by water and wind and reduce competition from weeds. Equally as important, cover crops improve soil tilth and soil fertility. To optimize the benefits from cover cropping practices, practices must be integrated into each nursery grower's specific operation. By choosing between different types of cereals, grasses, legumes, and brassicas, and by seeding at appropriate times, the nursery grower selects an optimal strategy to get the desired benefits.

Cover crops can be grouped into the following categories:

- Dead mulches
- Live mulches
- N contributing cover crops
- Organic matter producing cover crops
- Interplanted cover crops
- Nutrient capture crops
- Erosion control cover crops

Table 3. Cover crop seeding rates and planting dates

Species	Seeding Rate (bushels [bu] or pounds [lb]/acre [A])	Weight (lb/bu)	Planting Date
Barley	2.0 bu/A	48.0	Aug.-Oct.
Cereal Rye	1.5 bu/A	56.0	Aug.-Oct.
Ryegrass(annual)	2.0 bu/A	24.0	Aug.-Oct.
Oats	1.5 bu/A	32.0	Aug.-Oct.
Buckwheat	1.5 bu/A	45.0	Aug.-Oct.
Wheat	25.0 lb/A	60.0	Aug.-Oct.
Sorghum-Sudan	25.0 lb/A	50.0	April-May

Cover crops can serve as living mulches planted in the aisles of the main crop to hold the soil, trap sediment that may have eroded from the row, provide equipment traction, increase water infiltration, and suppress weeds. Legume cover crops like clovers fix nitrogen and may be used to reduce the amount of N fertilizer applied each year. Cover cropping, although it protects the soil surface and improves soil tilth, has to be part of a total soil conservation plan.

Prevention of Competition by Weeds

Preventing competition from weeds is an important benefit of using cover crops. If restricted to inter-row areas or outside the drip-lines, a cover crop will not compete significantly with the nursery stock for moisture or nutrients. A dead mulch cover crop can be sown closer because it takes up nutrients only late in the season and actually helps the nursery crop harden off for the winter. Planted in later summer and killed by frost, the dead mulch covers the soil, smothering out weed competition. If planted earlier, the cover crop can be flail-mowed to be kept under control, and the cuttings will contribute even more organic matter to the soil. If the dead mulch cover crop is seeded too late, or if there is a mild winter, the cover crop may not die. In this situation chemical controls can be used.

Ronald Kuiawski

A major benefit of using a dead mulch cover crop is that tillage in the spring for weed control is unnecessary. Without spring cultivation, nursery plants' outermost fine roots in the cultivation layer are still present to supply water and nutrients to the crop. Through the summer, the dead mulch also keeps dust down and off the nursery stock. Besides producing a cleaner stock, this practice may also help to suppress

mite populations on the plants. Be sure to use clean cover crop seed and a cover crop species that will not increase disease incidence in the nursery.

Soil Tilth and Reduction of Soil Compaction

Soil tilth represents the physical condition of soil described by its bulk density, porosity, soil structure, and soil aggregate characteristics. All these have an effect on the availability and movement of water, nutrients, air, heat, as well as on soil biological populations and their activity. Cover crop roots and the addition of organic matter loosen the soil, decreasing its soil bulk density and increasing its porosity. This soil loosening increases the ease with which water, nutrients, and air move into the soil to the plant roots. Cover crops also help to catch excess nutrients before they leach out of the soil. By contributing organic matter, cover crops enhance soil structure, surface roughness, soil aggregate stability, and soil biological populations. By improving soil tilth, cover crops contribute to sustained or increased productivity potential.

Compaction of soils (primarily from equipment traffic and personnel accessing growing areas when soils are wet) destroys soil tilth. Once compaction occurs and air pore spaces are reduced, root zones have less access to oxygen and less water percolates through the soil, creating more runoff losses from the field. Soil compaction is extremely difficult to mitigate; it is better to restrict traffic to designated lanes or headlands and minimize entry onto wet soils.

Animal Manures

The application of animal manure counters soil degradation because manure contains plant nutrients, organic matter, and a variety of organisms which add to the biological activity of soils. Animal waste should be applied during the field preparation process; using manure just after planting is not recommended. If not managed with sufficient care, manures can be major sources of pollution and can contribute to contamination of surface and groundwater.

K.A. Barbarick, , Bugwood.org

Animal wastes such as cow manure or poultry litter are best when composted first and then incorporated into the soil. The composting process reduces the amount of ammonium-N (NH_4-N) (particularly in poultry litter), which can cause damage to soil organisms and plants if it is applied at very high rates. All animal wastes contain two forms of N: NH_4-N, which is immediately available to plants and microorganisms; and organic-N, which is slowly available because it is tied up in plant or animal biomass.

If wastes are incorporated, 100% of the NH_4-N in the waste may be available the first year; however in most composted manures, the availability is usually very low, perhaps 1 to 2%. As the manure decays, 50% of the organic-N will be available in year one (if it was

incorporated), and as the decay process continues, 25 to 30% is available the second year, 8 to 10% in year 3, etc. The amount of manure applied to a crop should be governed by soil test recommendations and a nutrient analysis of the manure. If the amount of N exceeds crop needs, N losses to the environment will be excessive over time, and more importantly, P will have been over-applied and may cause even more environmental damage than the lost N. In wet environments, nutrients added in excess of crop requirements are subject to runoff into streams and lakes, and leaching to groundwater. In dry environments, the problems are reduced, but nutrients may still be carried to water bodies in irrigation runoff water and to ground water through normal percolation of water through the soil profile. Most of the leaching losses of N occur in the fall after most crops have ceased growing.

The nutrients present in raw manures are readily available to plants and microorganisms; however, if manure is over-applied, excess nitrates produced through the mineralization process and not taken up by plants may leach during wet weather. Composted manures have similar nutrient content, but the N is in a more stable form that is less susceptible to leaching; however, this form of N is also less available to the plants in the short term.

Fine-textured soils (clays) retain nutrients and prevent leaching losses to a greater extent than coarse-textured soils (sands), which have a very limited nutrient retention capacity. Also, since rain or irrigation water enters fine-textured soils slowly, surface runoff may contain more nutrients. Coarse-textured soils readily admit water and groundwater quality may be at risk.

Heavier application rates for composted manures than for raw manures may be acceptable since the nutrients are converted to more stable forms during composting. Heavy applications should only be made in the "rest" year of a cycle and in combination with an aggressive cover cropping program. Research in this area is ongoing.

The timing of manure application is important. Ideally, manure should be applied so that nutrients will be released from the manure at the same time plants are actively growing. Early spring to early summer is the best time to apply composted manures. This will ensure that the crop takes up more nutrients, and lesser amounts are susceptible to leaching. Manure application in the fall and early winter are to be avoided for this reason.

Composts

As water quality and solid waste disposal regulations become stricter, the amount of organic material being composted will increase. The landscape and nursery industries are prime candidates for using these products, but only if the materials produced meet high quality standards and can be used in an environmentally responsible manner. The incorporation of composted organic materials into soil and nursery media will provide environmental and economic benefits.

Composts from municipal yard wastes may become an affordable organic source for amending fields. Application rates of stabilized composted wastes can be 50 to 200 tons per acre since composted yard wastes may have only 0.2 to 0.5% N content and nutrient loss is of less concern. The 50 tons per acre application rate represents approximately ½-inch coverage over a 1-acre area, while the 200 tons per acre rate would cover approximately 2 inches over a 1-acre area.

Table 4. Suggested compost application rates for landscape beds and nursery field production

Type of Compost	Suggested Rate (tons or pounds [lbs]/square foot [sq ft])
Yard waste compost	2 to 3 inches incorporated (2 to 3 tons/1,000 sq ft)
Animal waste compost	½ to ¾ inch incorporated (880 to 1,300 lbs/1,000 sq ft)

Organic Matter Spreading Techniques to Prevent Water Contamination
Contact the Environmental Protection Agency (EPA) and local authorities for rules before spreading organic matter.

Organic matter, in the form of manure or compost should *not* be spread:

- On steep slopes where erosion and/or surface runoff is likely to occur.
- On saturated soils, where manures will not infiltrate into the soil.
- Within the high water mark of field depressions during times of the year when there is a high risk of direct surface runoff to an open watercourse.
- In excess winds where drift can occur.
- On frozen or snow-covered ground where runoff of snowmelt to open watercourses might occur.
- On areas having standing water.

An alternative to applying organic materials over the entire field is to incorporate the organic matter in planting rows only. If rows in the field are spaced 12 feet apart and the root zone area of plants is considered to be 2 feet on each side of the stem, a 4-foot strip would receive the organic matter, thus reducing the amount of organic matter applied in the field by two-thirds.

Field Storage of Manure and Compost
This BMP generally applies to solid manures or composted organic materials. If field storage of manures or other composted organic materials is necessary, the following guidelines should be adhered to:

- Field storage should not exceed two weeks in duration.
- Field storage should not be located in natural drainage ways or where runoff will reach waterways.
- Field storage should not be located on coarse-textured or gravelly soils.
- Field storage should not take place at times of high rainfall or high water tables.
- If rainfall occurs, storage piles must be immediately covered to keep rainfall from entering the piles.

Container Nurseries

Soil Conservation

Sound cultural practices should be included to conserve soil in above-ground production, as well as in field nurseries. For example, topsoil native to the nursery (field soil) should not be used as growing media inside pot-in-pot culture or above-ground pots. Growing media used in containers should be soilless mix or soil compost mix. Also, growing media should not come from sources that degrade other farmland areas. When selecting a site for container production, the site should be chosen to minimize the loss of quality native soils.