

TECHNICAL NOTES

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Agroforestry for Farms and Ranches

A new Agroforestry Technical Note has been developed by agency agroforestry scientists.

Agroforestry is the intentional growing of trees and shrubs in combination with crops or forage for a number of diverse purposes. These include protecting crops, increasing crop production and protecting the soil and water resources. Other purposes include conserving energy, improving ecosystem richness, creating wildlife habitat, providing forest products and increasing landscape diversity.

Agroforestry is a set of tools to consider for use when developing the capabilities of each unit when developing a plan. It focuses on natural systems and ecological processes to assist in achieving sustainable agriculture. Besides providing planning considerations for adaptation of agroforestry systems, this technical note provides attributes by agroforestry system.

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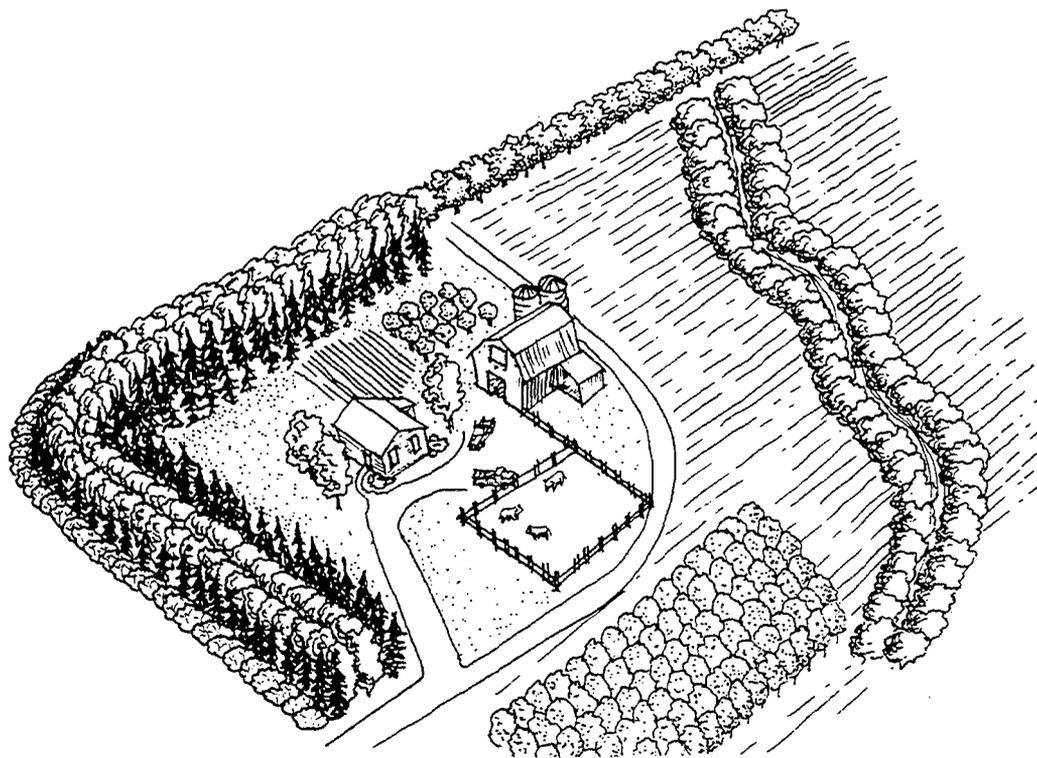
Natural
Resources
Conservation
Service

AGROFORESTRY
TECHNICAL NOTE NO. 1

July 1, 1996

Agroforestry for Farms and Ranches

**An introduction to using tree and
shrub practices in sustained agricul-
tural systems**



Agroforestry for Farms and Ranches^{1/}

An introduction to using tree and shrub practices in sustained agricultural systems.

Agroforestry Defined

Agroforestry is the intentional growing of trees and shrubs in combination with crops or forage. Agroforestry also includes tree and shrub plantings on the farm or ranch that improve habitat value or access by humans and wildlife, or that provide woody plant products in addition to agricultural crops or forage. Agroforestry is distinguished from traditional forestry by having the additional aspect of a closely associated agricultural or forage crop.

Diverse Purposes of Agroforestry Systems

Properly designed agroforestry systems protect crops and forage, increase their production, protect soil and water resources, conserve energy, improve ecosystem "richness," create additional wildlife habitat, and increase landscape diversity. They also provide additional farm or ranch products: timber, pulpwood, firewood, posts, fruit, nuts, and fodder to name a few. Agroforestry represents a collection of multi-purpose practices that are enduring and help achieve a sustainable agriculture. These practices can form the major part of a "Resource Management System" for a particular field or treatment unit. The matrix below provides some examples of how practices might be combined into agroforestry systems in cropland and pasture/hay settings.

Potential Agriculture Problems				
Wind impacts (erosion, crop loss, inefficient water use)	Water erosion	Degraded or unbuffered stream/riparian areas	Limited crop diversity (lack of tree/wood products integrated with agricultural crops)	Fragmented wildlife habitat or low biodiversity of perennial plants
Sustainable Agroforestry Systems (A + B or A + C)				
A. Principal Tree/Shrub Practices:				
<ul style="list-style-type: none"> • Windbreak/ Shelterbelt Establishment 	<ul style="list-style-type: none"> • Contour Buffer Strips (woody species) • Tree/Shrub Establishment 	<ul style="list-style-type: none"> • Riparian Forest Buffer • Filter Strip (woody species) 	<ul style="list-style-type: none"> • Alley Cropping • Multistory Cropping 	<ul style="list-style-type: none"> • Tree/Shrub Establishment
B. Principal Agronomic Practices -- Cropland Settings				
<ul style="list-style-type: none"> • Conservation Crop Rotation • Residue Management • Cross Wind Stripcropping • Herbaceous Wind Barrier • Irrigation Water Management 	<ul style="list-style-type: none"> • Conservation Crop Rotation • Stripcropping, Contour • Contour Farming • Residue Management • Terrace 	<ul style="list-style-type: none"> • Streambank and Shoreline Protection • Critical Area Planting • Use Exclusion • Nutrient and Waste Management 	<ul style="list-style-type: none"> • Conservation Crop Rotation • Residue Management 	<ul style="list-style-type: none"> • Conservation Crop Rotation • Residue Management • Use Exclusion
C. Principal Grazing Management Practices -- Pasture/Hay Settings				
<ul style="list-style-type: none"> • Irrigation Water Management • Prescribed Grazing • Fencing 	<ul style="list-style-type: none"> • Pasture and Hay Planting • Prescribed Grazing • Fencing 	<ul style="list-style-type: none"> • Prescribed Grazing • Fencing • Pasture and Hay Planting • Nutrient/Waste Management 	<ul style="list-style-type: none"> • Pasture and Hay Planting • Prescribed Grazing • Fencing 	<ul style="list-style-type: none"> • Pasture and Hay Planting • Prescribed Grazing • Fencing

^{1/} This technical note was developed by Gary Kuhn, James Robinson, and Bruce Wight, NRCS Agroforesters, National Agroforestry Center, and Lyn Townsend, Forest Ecologist, NRCS Watershed Science Institute.

Guidance on System Design

What practices work together? What are the design elements used for an agroforestry system? Tables 1 and 2 provide an overview of individual agroforestry systems to help answer these questions and provide a link to the National Handbook of Conservation Practices (NHCP) and the Field Office Technical Guide (FOTG). The NHCP and FOTG are maintained by the USDA, Natural Resources Conservation Service. Specific systems within a table may be found by referring to the list below.

Table 1. Row-Types:	Page:	Table 2. Block-Types:	Page:
• Field Windbreak	6	• Multistory Cropping	22
• Livestock Windbreak	8	• Wood Fiber Plantation	24
• Farmstead Windbreak	10	• Water-Waste Management Planting	26
• Living Snowfence	12		
• Alley Cropping	14		
• Contour Buffer Strips	16		
• Riparian Forest Buffer	18		
• Filter Strip	20		

The NHCP establishes official names for all conservation practices and sets national standards for each practice's design. The FOTG further refines each practice standard for use in a particular state. The agroforestry types listed in the tables are named by the predominant tree/shrub practice in the "system."

Planning Considerations for Systems

For a farmer or rancher to adopt an agroforestry system, he or she must be both able and willing to incorporate rows or blocks of trees and/or shrubs in individual fields or units. The landowner must understand the new system, concur with its relative advantage to the operation, and be able to incrementally install and maintain the required practices. The landowner must also be aware of the time it takes for the trees and shrubs to grow and their silvicultural or management requirements. Interim systems to achieve objectives may be necessary for the first 5 to 10 years while trees and shrubs become functional. The use of equipment and chemicals (particularly herbicides) may require a greater level of control to prevent harm to crowns, stems and roots. For woody plants that will be harvested or yield products, the landowner will most likely have to acquire special marketing information and techniques. Properly designed agroforestry systems offer many benefits to farmers, ranchers and the public.

Some Definitions

Block-Types (Agroforestry System): Types of agroforestry systems consisting of agronomic or forage practices with an integral tree or shrub practice that is arranged in a block or rectangular pattern (the width or short axis of the block typically greater than 100 feet).

Row-Types (Agroforestry System): Types of agroforestry systems consisting of agronomic or forage practices with an integral tree or shrub practice that is arranged in a row-type or strip pattern (the width of the individual strips typically less than 100 feet).

Density (windbreaks and row-type plantings): Density refers to the percentage of the "background" scene that is blocked from view when standing away from the planting and looking perpendicular through it. "H" refers to the expected height of the tallest tree or shrub row in the planting at a specified or base age, usually 20 years in temperate climates and 10 years in tropical areas. The term "5H," for example, refers to the calculation of multiplying the constant, 5, times the expected height at the base age.

Practices (code numbers in parentheses)

ALLEY CROPPING (new): An agroforestry practice consisting of growing trees or shrubs in rows or corridors with alleys of agronomic crops or forage between.

CONSERVATION CROP ROTATION (328): Growing crops in a recurring sequence on the same field.

CONTOUR BUFFER STRIPS (new): Plantings consisting of tree/shrub rows or strips of herbaceous vegetation on the contour or cross-slope.

CONTOUR FARMING (330): Farming sloping land in such a way that preparing land, planting, and cultivating are done on the contour. (This includes following established grades of terraces or diversions.)

CROSS WIND RIDGES (589A): Ridges formed by tillage or planting and aligned across the prevailing wind erosion direction.

CROSS WIND STRIPCROPPING (589B): Growing crops in strips established across the prevailing wind erosion direction, and arranged so that strips susceptible to wind erosion are alternated with strips having protective cover that is resistant to wind erosion.

CROSS WIND TRAP STRIPS (589C): Herbaceous cover resistant to wind erosion, established in one of more strips across the prevailing wind erosion direction.

DIVERSION (362): A channel constructed across the slope with a supporting ridge on the lower side.

FENCE (382): Enclosing or dividing an area of land with a suitable permanent structure that acts as a barrier to livestock, big game, or people (does not include temporary fences).

FILTER STRIP (393): A strip or area of vegetation for removing sediment, organic matter, and other pollutants from runoff and waste water.

GRASSED WATERWAY (412): A natural or constructed channel that is shaped or graded to required dimensions and established in suitable conveyance of runoff.

HERBACEOUS WIND BARRIERS (422A): Herbaceous vegetation established in rows or narrow strips across the prevailing wind direction.

IRRIGATION SYSTEM, TRICKLE (441): A planned irrigation system in which all necessary facilities are installed for efficiently applying water directly to the root zone of plants by means of applicators (orifices, emitters, porous tubing, perforated pipe) operated under low pressure. The applicators can be placed on or below the surface of the ground.

IRRIGATION WATER MANAGEMENT (449): Determining and controlling the rate, amount, and timing of irrigation water in a planned and efficient manner.

MULCHING (484): Applying plant residues or other suitable materials not produced on the site to the soil surface. (Used for moisture conservation around newly planted trees and shrubs.)

MULTISTORY CROPPING (new): An agroforestry practice consisting of growing an overstory of trees or shrubs with an understory of agronomic crops or forage.

NUTRIENT MANAGEMENT (590): Managing the amount, form, placement, and timing of applications of plant nutrients.

PASTURE AND HAY PLANTING (512): Establishing and reestablishing long-term stands of adapted species of perennial, biennial, or reseeding forage plants.

PEST MANAGEMENT (595): Managing agricultural pest infestations (including weeds, insects, and diseases) to reduce adverse effects on plant growth, crop production, and environmental resources.

PRESCRIBED GRAZING (528A): The controlled harvest of vegetation with grazing or browsing animals, managed with the intent to achieve a specified objective.

RESIDUE MANAGEMENT: Managing the amount, orientation and distribution of crop and other plant residues on the soil surface year-round, while growing crops....

- **NO TILL AND STRIP TILL (329A):** ...in narrow slots or tilled strips in previously untilled soil and residue.
- **MULCH TILL (329B):** ...where the entire field surface is tilled prior to planting.
- **RIDGE TILL (329C):** ...on preformed ridges alternated with furrows protected by crop residues.

RESIDUE MANAGEMENT, SEASONAL (344): Managing the amount, orientation and distribution of crop and other plant residues on the soil surface during part of the year, while growing crops in a clean tilled seedbed.

RIPARIAN FOREST BUFFER (391): An area of trees and/or shrubs located adjacent to and up-gradient from water bodies.

STREAMBANK AND SHORELINE PROTECTION (580): Using vegetation or structures to stabilize and protect banks of streams, lakes, estuaries, or excavated channels against scour and erosion.

STRIPCROPPING, CONTOUR (585): Growing crops in a systematic arrangement of strips or bands on the contour to reduce water erosion. The crops are arranged so that a strip of grass or close-growing crop is alternated with a strip of clean-tilled crop or fallow or a strip of grass alternated with a close-growing crop.

TERRACE (600): An earth embankment, channel, or a combination ridge and channel constructed across the slope.

TREE/SHRUB ESTABLISHMENT (612): To establish woody plants by planting or seeding.

USE EXCLUSION (472): Excluding animals, people or vehicles from an area.

WASTE UTILIZATION (633): Using agricultural waste or other waste on land in an environmentally acceptable manner while maintaining or improving soil and plant resources.

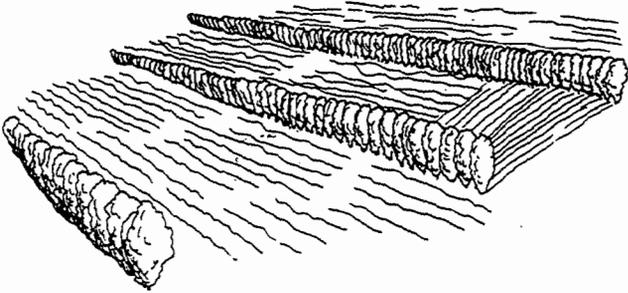
WINDBREAK/SHELTERBELT ESTABLISHMENT (380): Linear plantings of single or multiple rows of trees or shrubs established for environmental purposes.

Figure 1. *Field Windbreak.*

Field A:
Without
Windbreak

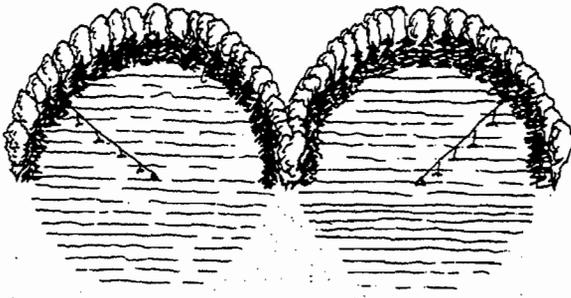
•Hot summer winds
cut crop yields

•Topsoil windblown



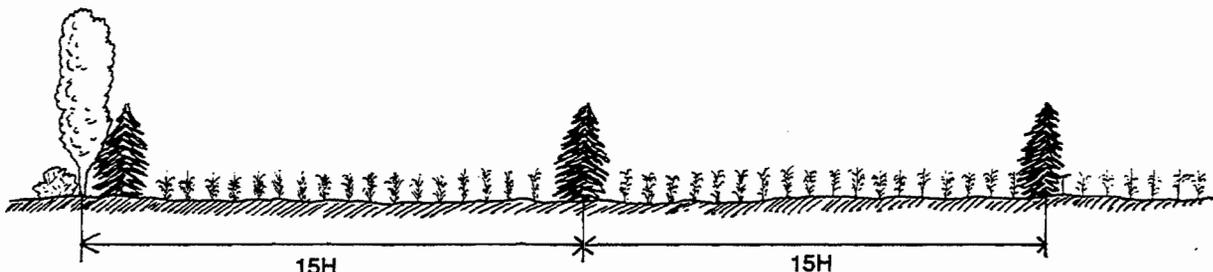
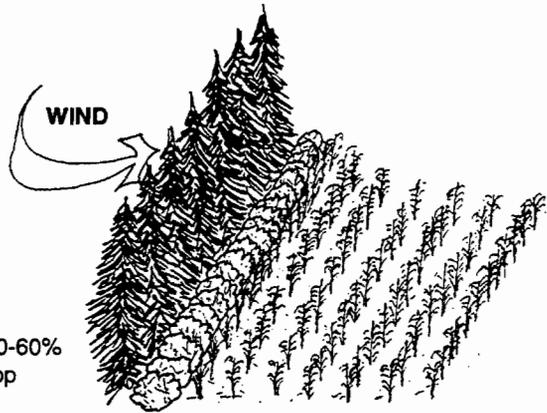
Field B:
With
Windbreak

•Yield will be up to 20% more
than Field A, compensating
for yield lost at and near
windbreak.



CENTER PIVOTS WITH WINDBREAKS

Windbreak densities of 40-60%
are optimum for soil & crop
protection

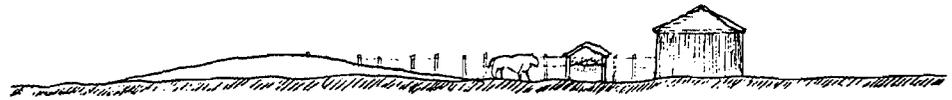
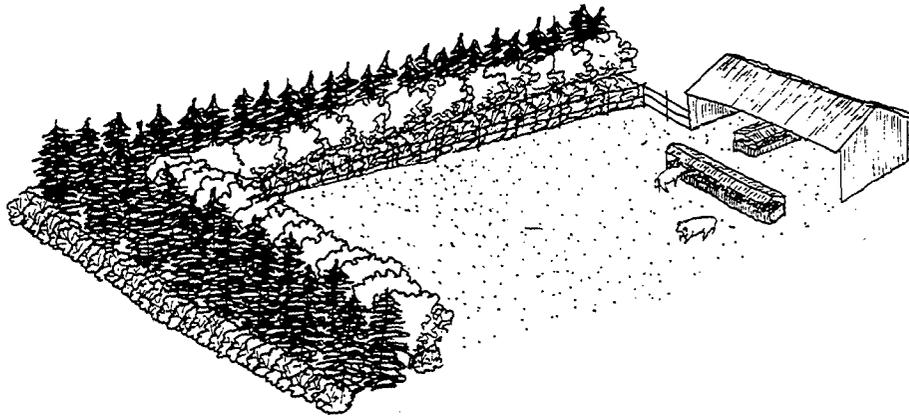


Windbreak spacing depends on windbreak height (h), soil erodibility,
crop sensitivity, crop residues, crop rotation, and climate.

Table 1. Row-Types

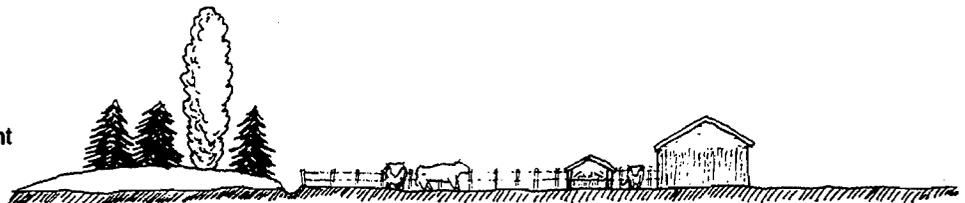
Agroforestry System	Attributes	
Field Windbreak	Description:	<i>One or more windbreaks or shelterbelts of closely spaced trees and/or shrubs planted perpendicular to the prevailing troublesome winds. "Wind shadows" created to the leeward side of these barriers achieve desired purposes. A single windbreak may consist of one to many rows to insure adequate density of branches, stems and leaves.</i>
	Some Primary FOTG Practices for this System:	<ul style="list-style-type: none"> • <i>Conservation Crop Rotation (328)</i> • <i>Residue Management (329, 344)</i> • <i>Cross Wind Ridges (589A)</i> • <i>Cross Wind Stripcropping (589B)</i> • <i>Cross Wind Trap Strips (589C)</i> • <i>Herbaceous Wind Barrier (422A)</i> • <i>Windbreak/Shelterbelt Establishment (380)</i> • <i>Mulching (484)</i> • <i>Irrigation System (441), Irrigation Water Management (449)</i> • <i>Nutrient Management (590)</i> • <i>Pest Management (595)</i>
	Primary Purposes:	<ul style="list-style-type: none"> • <i>Reduce wind velocity in the wind shadow area to: 1) control wind erosion, 2) deposit snow uniformly, 3) increase crop quality and production, and 4) improve water use efficiency.</i>
	Key Design Elements:	<ul style="list-style-type: none"> • <i>35-60% density barriers (during the erosion period) with the windbreaks at intervals across a field from 5H to 20H (agricultural fields between windbreaks are generally greater than 200 feet wide).</i>
	Tree/Shrub Species Requirements:	<ul style="list-style-type: none"> • <i>Adapted to the soil and climate of the planting site.</i> • <i>Low to moderate root and crown spread to minimize competition with adjacent crops.</i> • <i>Resistance to pests and herbicides.</i> • <i>Resistance to stem and branch breakage from high winds, ice, snow.</i>

Figure 2. *Livestock Windbreak.*



Benefits:

- Reduced feed requirements
- Reduced livestock stress
- Reduced mortality
- Increased health
- Increased profits
- Improved working environment



BE CAREFUL WHERE WATER DRAINS

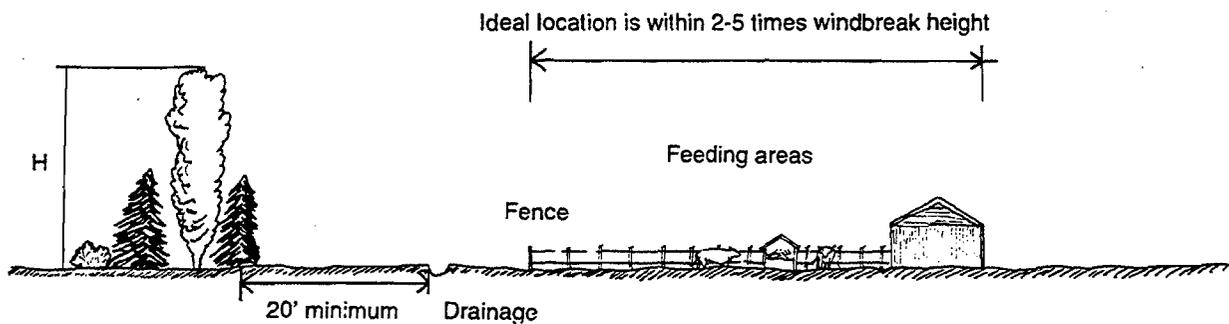
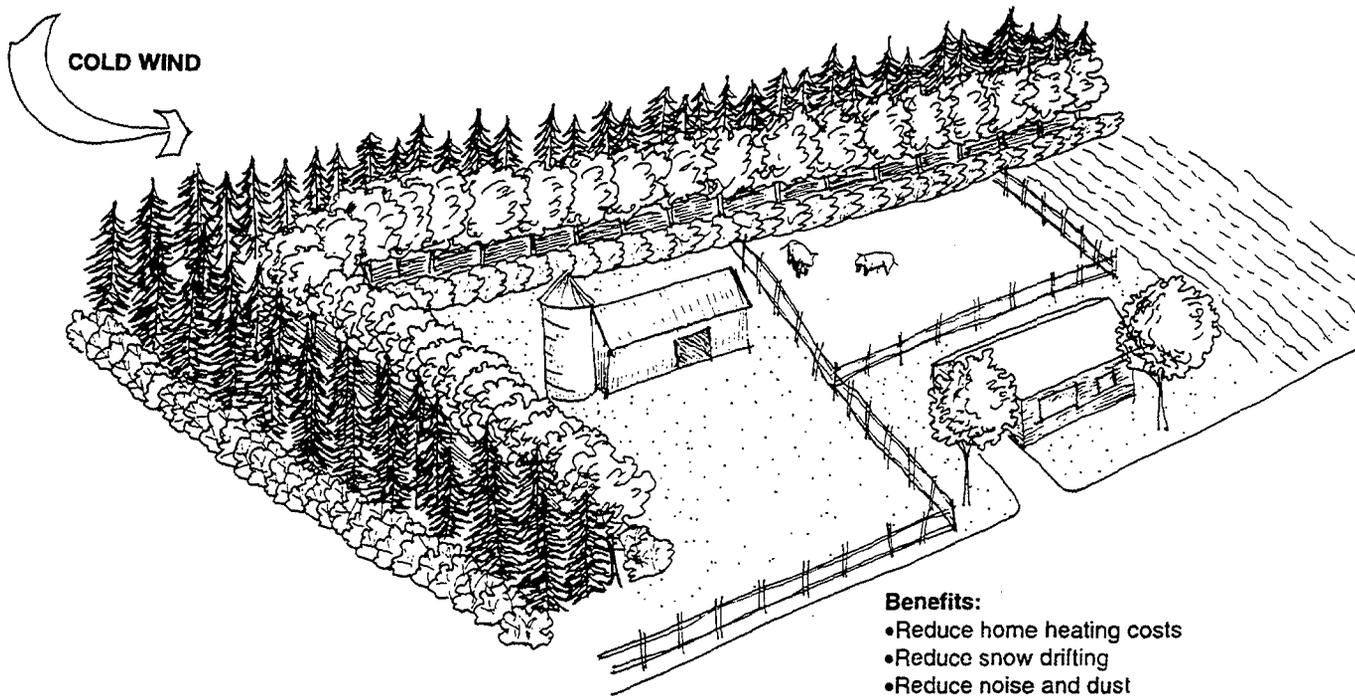


Table 1. Row-Types

Agroforestry System	Attributes	
Livestock Windbreak	Description:	<i>A windbreak or shelterbelt of closely spaced trees and/or shrubs planted perpendicular to the prevailing troublesome winds and adjacent to livestock areas. Areas are generally settings where livestock naturally concentrate or are confined such as a feedlot. The "wind shadow" created to the leeward side of this barrier achieves desired purposes. The windbreak may consist of one to many rows to insure adequate density of branches, stems and leaves.</i>
	Some Primary FOTG Practices for this System:	<ul style="list-style-type: none"> • <i>Windbreak/Shelterbelt Establishment (380)</i> • <i>Mulching (484)</i> • <i>Use Exclusion (472)</i> • <i>Fencing (382)</i> • <i>Irrigation System (441), Irrigation Water Management (449)</i>
	Primary Purposes:	<ul style="list-style-type: none"> • <i>Reduce wind velocity to: 1) control energy loss and feed intake by livestock, and 2) reduce snow drifting in the livestock concentration area.</i>
	Key Design Elements:	<ul style="list-style-type: none"> • <i>60-80% density barrier (year-round) with primary livestock areas within 5H of the barrier.</i>
	Tree/Shrub Species Requirements:	<ul style="list-style-type: none"> • <i>Adapted to the soil and climate of the planting site.</i> • <i>Tolerance of nitrogen and phosphorus concentrations from manure.</i> • <i>Resistance to pests.</i> • <i>Some resistance to stem/branch breakage from high winds, ice, snow.</i>

Figure 3. *Farmstead Windbreak.*

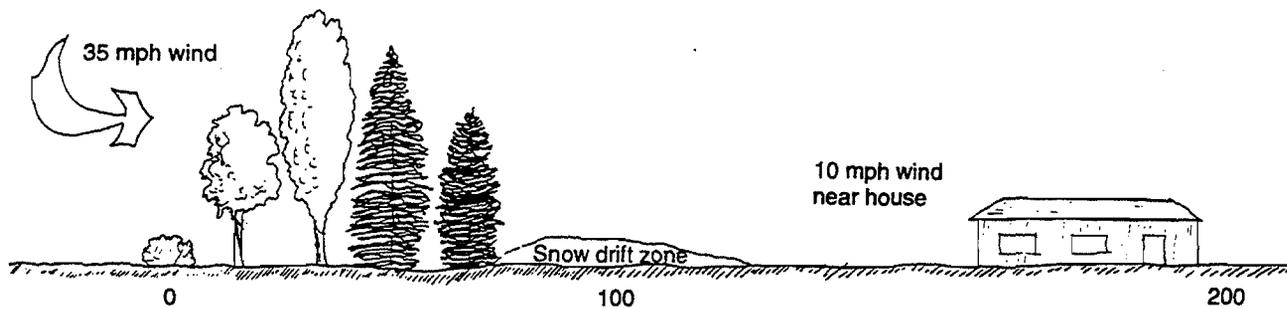


Benefits:

- Reduce home heating costs
- Reduce snow drifting
- Reduce noise and dust
- Reduce home maintenance and damage
- Moderate summer heat and winds
- Improve working and recreation environment
- Attract wildlife
- Beautify farmstead -- increases property value

SNOW AND WIND PROTECTION

Windward row 100-200 feet from area or building needing protection



WIND PROTECTION ONLY

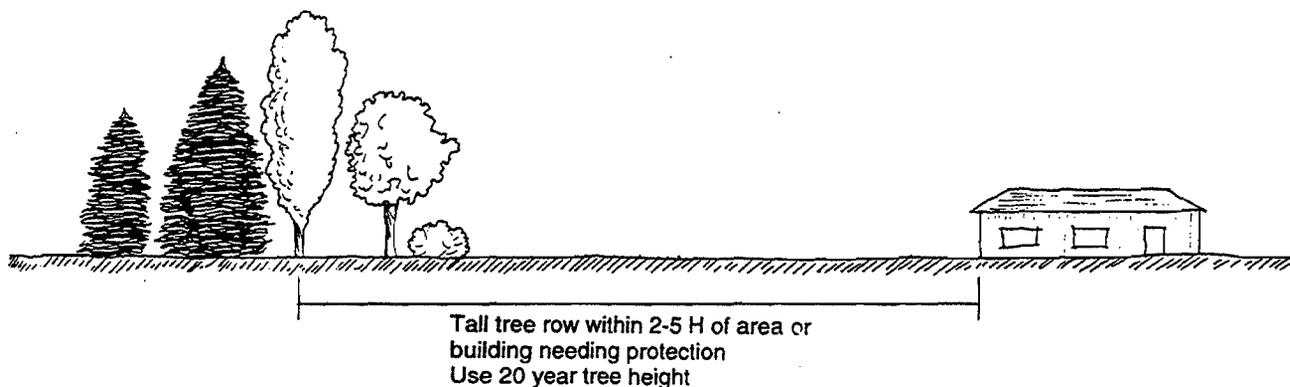
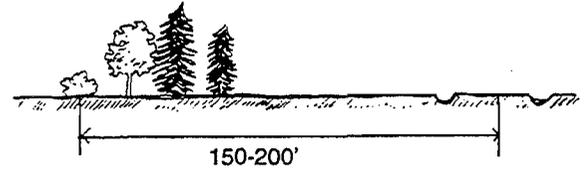
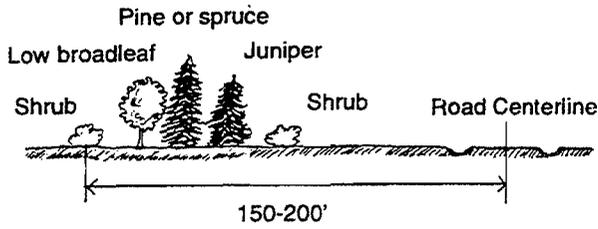


Table 1. Row-Types

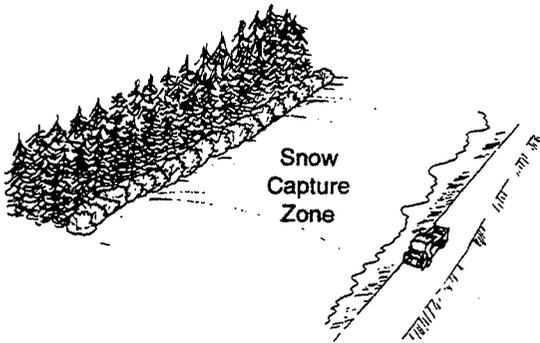
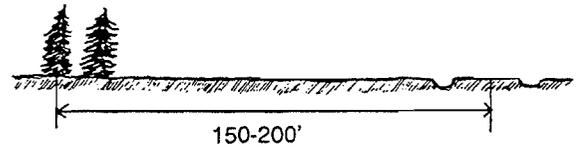
Agroforestry System	Attributes	
Farmstead Windbreak	Description:	<i>A windbreak or shelterbelt of closely spaced trees and/or shrubs planted perpendicular to the prevailing troublesome winds and adjacent to the farmstead home, buildings and work areas. The "wind shadow" created to the leeward side of this barrier achieves desired purposes. The windbreak may consist of one to many rows to insure adequate density of branches, stems and leaves.</i>
	Some Primary FOTG Practices for this System:	<ul style="list-style-type: none"> • <i>Windbreak/Shelterbelt Establishment (380)</i> • <i>Mulching (484)</i> • <i>Irrigation System (441), Irrigation Water Management (449)</i> • <i>Diversion (362)</i> • <i>Use Exclusion (472)</i> • <i>Fencing (382)</i>
	Primary Purposes:	<ul style="list-style-type: none"> • <i>Reduce wind velocity to: 1) reduce energy loss, 2) trap snow away from buildings, roads, etc. and 3) protect and improve human habitat.</i>
	Key Design Elements:	<ul style="list-style-type: none"> • <i>60-80% density barrier (year-round) with primary buildings/area within 2 - 5H of the barrier but at least 100' from the windward row in snow country. Animal waste runoff needs to be diverted away from the windbreak.</i>
	Tree/Shrub Species Requirements:	<ul style="list-style-type: none"> • <i>Adapted to the soil and climate of the planting site.</i> • <i>Aesthetically pleasing to increase farmstead value.</i> • <i>When utility lines are present, low to moderate root and crown spread to reduce conflicts.</i> • <i>Resistance to pests and herbicides.</i> • <i>Resistance to stem and branch breakage from high winds, ice, snow.</i>

Figure 4. *Living Snowfence.*



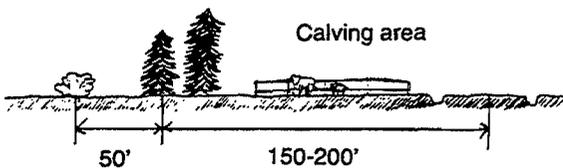
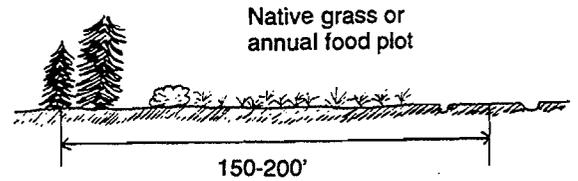
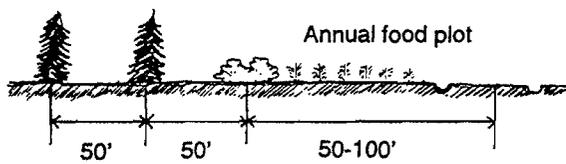
Density:

Ideal densities between 60-80% are desired for living snowfences. Evergreens and shrubs are ideal in living snowfence designs.



Benefits:

- Decreased annual snow removal costs -- money, time, and equipment
- Decreased road damage from snow removal equipment
- Safer winter travel for motorists
- Greater snow storage and longer snow control than slatted snow fences
- Wildlife food and cover
- Enhanced aesthetic appeal of landscape



Twin row high density

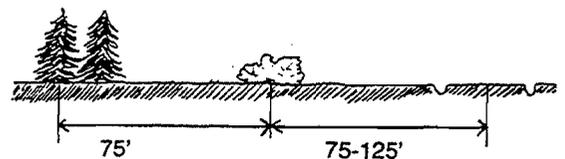
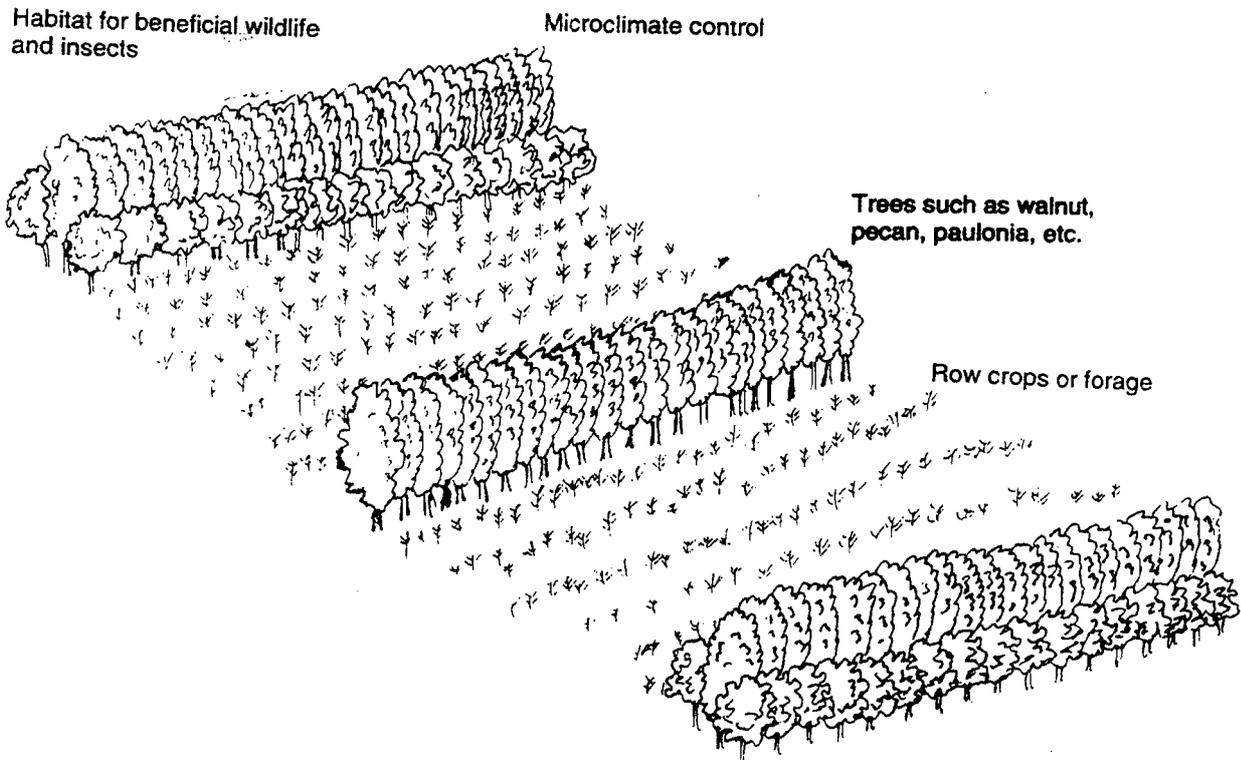


Table 1. Row-Types

Agroforestry System	Attributes	
Living Snowfence	Description:	<ul style="list-style-type: none"> • <i>A planting of closely spaced trees and/or shrubs placed perpendicular to the prevailing troublesome winds and adjacent to roads, buildings and work areas. The "wind shadow" created to the leeward side of this barrier achieves desired purposes by depositing snow in deep drifts. A living snowfence may consist of one to many rows to insure adequate density of branches, stems and leaves.</i>
	Some Primary FOTG Practices for this System:	<ul style="list-style-type: none"> • <i>Windbreak/Shelterbelt Establishment (380)</i> • <i>Mulching (484)</i> • <i>Use Exclusion (472)</i> • <i>Fencing (382)</i>
	Primary Purposes:	<ul style="list-style-type: none"> • <i>Concentrate snow deposition away from roads, buildings and other areas to improve farm access or habitat.</i>
	Key Design Elements:	<ul style="list-style-type: none"> • <i>50-100% density barrier (snow season) with windward row at 100-200 feet from road/area to be protected.</i>
	Tree/Shrub Species Requirements:	<ul style="list-style-type: none"> • <i>Adapted to the soil and climate of the planting site.</i> • <i>Evergreens or densely branched trees and shrubs are preferred.</i> • <i>Low to moderate root and crown spread to reduce conflicts with adjacent crops and utility lines.</i> • <i>Resistance to pests and herbicides.</i> • <i>Resistance to stem and branch breakage from high winds, ice, snow.</i>

Figure 5. Alley Cropping.



3 row tree strip with training trees for high-value hardwoods

Single row tree strip

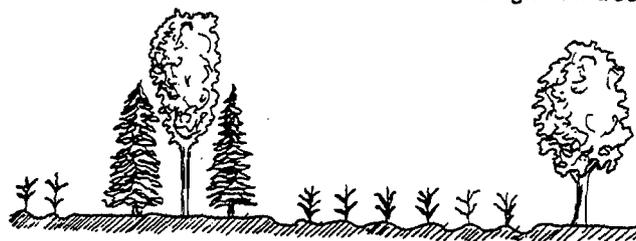


Table 1. Row-Types

Agroforestry System	Attributes	
Alley Cropping	Description:	<i>Plantings consisting of trees or shrubs in rows or corridors with alleys of agronomic crops or forage between. Plantings are placed at intervals across a field or unit that, depending on purpose, are perpendicular to the prevailing troublesome winds, on the contour, or at multiples of the widest field equipment width. The products derived from the trees or shrubs or the protected or climatically influenced zones of these plantings achieve desired purposes. Trees or shrubs planted along the edges of "alleys" may consist of one to many rows to insure adequate density of branches, stems, foliage and roots.</i>
	Some Primary FOTG Practices for this System:	<ul style="list-style-type: none"> • <i>Alley Cropping (new)</i> • <i>Filter Strip (393), Conservation Crop Rotation (328)</i> • <i>Stripcropping, Contour (585), Contour Farming (330)</i> • <i>Residue Management (329, 344)</i> • <i>Diversion (362), Terrace (600), Grassed Waterway (412)</i> • <i>Use Exclusion (472), Fencing (382), Prescribed Grazing (528A)</i> • <i>Pasture and Hay Planting (512)</i> • <i>Mulching (484)</i> • <i>Irrigation System (441), Irrigation Water Management (449)</i> • <i>Nutrient Management (590), Pest Management (595)</i>
	Primary Purposes:	<ul style="list-style-type: none"> • <i>1) To produce wood or tree products in addition to agronomic crops or forage, 2) To improve crop or forage quality and quantity by enhancing microclimatic conditions, 3) To improve utilization and recycling of soil nutrients for crop or forage use, 4) To reduce excess subsurface water or control water table depths, 5) To provide favorable habitat for species beneficial to crops or forage.</i>
	Key Design Elements:	<ul style="list-style-type: none"> • <i>30-100% density barriers with rows at intervals across field to achieve intended purpose and tailored to equipment widths. Intervals are wide enough to allow sufficient light to agronomic crops in the alleys.</i>
	Tree/Shrub Species Requirements:	<ul style="list-style-type: none"> • <i>Adapted to the soil and climate of the planting site.</i> • <i>Produce wood, fruit or fodder suited to the purpose of planting.</i> • <i>Resistance to pests and herbicides.</i> • <i>Tolerant of sediment deposition and pollutant-laden runoff</i> • <i>Resistance to stem/branch breakage from winds, ice, snow.</i>

Figure 6. *Contour Buffer Strips.*

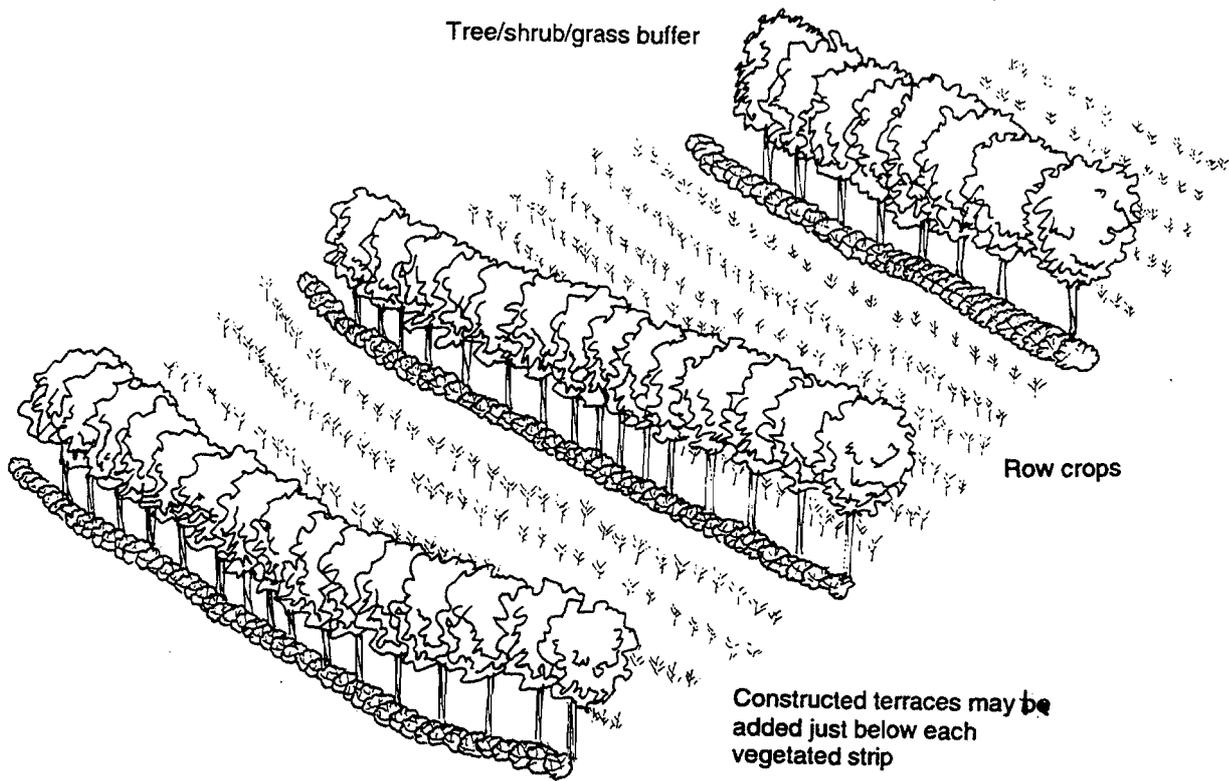
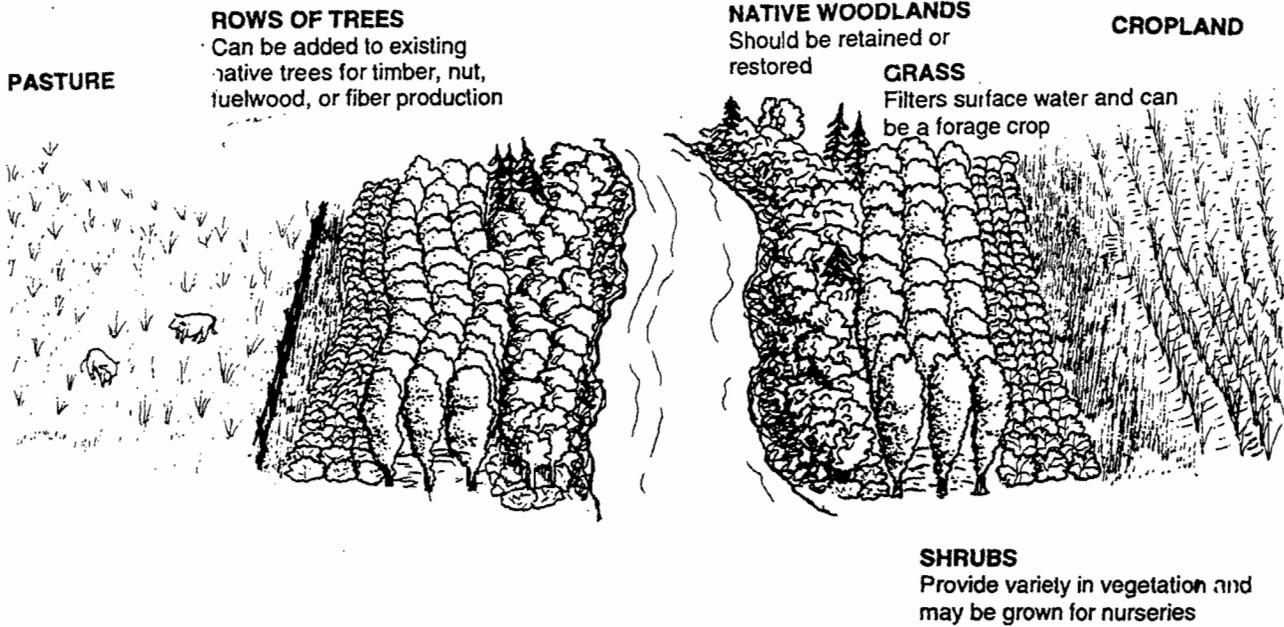


Table 1. Row-Types

Agroforestry System	Attributes	
Contour Buffer Strips (woody species)	Description:	<i>Plantings consisting of tree/shrub rows on the contour or cross-slope, and at multiples of the widest field equipment width. Tree or shrub strips typically consist of two or more rows to insure adequate root density and litter production, and are usually planted in conjunction with strips of herbaceous vegetation.</i>
	Some Primary FOTG Practices for this System:	<ul style="list-style-type: none"> • <i>Contour Buffer Strips (new)</i> • <i>Filter Strip (393), Conservation Crop Rotation (328)</i> • <i>Stripcropping, Contour (585), Contour Farming (330)</i> • <i>Residue Management (329, 344)</i> • <i>Diversion (362), Terrace (600), Grassed Waterway (412)</i> • <i>Use Exclusion (472)</i> • <i>Mulching (484)</i> • <i>Irrigation System (441), Irrigation Water Management (449)</i> • <i>Nutrient Management (590), Pest Management (595)</i>
	Primary Purposes: Key Design Elements:	<ul style="list-style-type: none"> • <i>Reduce sheet and rill water erosion, increase sediment deposition and convey excess water at a controlled grade.</i> • <i>Barriers of closely spaced trees/shrubs planted at intervals across the slope or on the contour and configured parallel with one another as practicable. Intervals are wide enough to allow sufficient light to agronomic crops between the strips. The spacing between barriers should be in multiples of the widest field equipment width and must not exceed the computations of spacings for constructed terraces (see Terrace, 600, in the FOTG or NHCP). Typically, suitable herbaceous vegetation is planted as part of the strip to the uphill side of the woody vegetation.</i>
	Tree/Shrub Species Requirements:	<ul style="list-style-type: none"> • <i>Adapted to the soil and climate of the planting site.</i> • <i>Resistance to pests and herbicides.</i> • <i>Tolerant of sediment deposition and pollutant-laden runoff.</i> • <i>Fast-growing and dispersed root system.</i>

Figure 7 *Riparian Forest Buffer.*



TRAP NUTRIENTS

Riparian forests retain significant amounts of nutrients in runoff from agricultural fields.

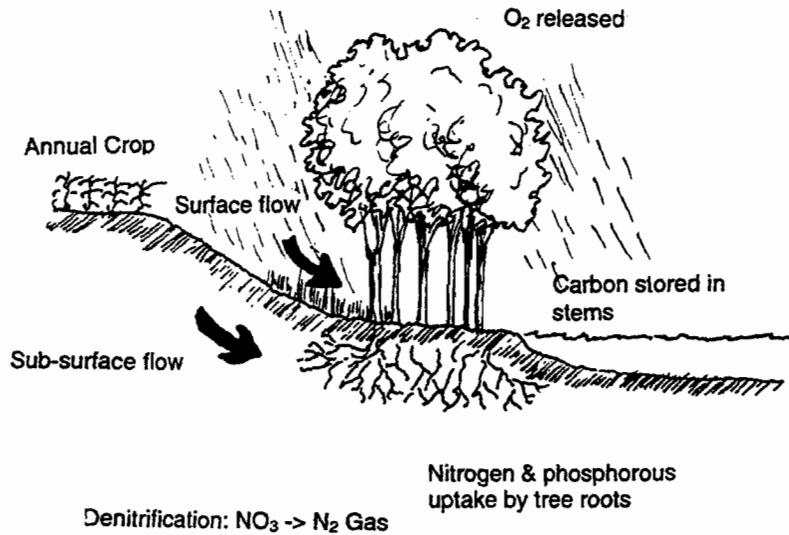


Table 1. Row-Types

Agroforestry System	Attributes	
Riparian Forest Buffer	Description:	<i>A corridor of trees and/or shrubs planted adjacent to a river, stream, wetland or water body. The planting is of sufficient width and up-gradient and near the water body to insure adequate functioning for the desired purpose.</i>
	Some Primary FOTG Practices for this System:	<ul style="list-style-type: none"> • <i>Riparian Forest Buffer (391)</i> • <i>Streambank and Shoreline Protection (580)</i> • <i>Use Exclusion (472)</i> • <i>Fencing (382)</i> • <i>Prescribed Grazing (528A)</i> • <i>Pasture and Hay Planting (512)</i>
	Primary Purposes:	<ul style="list-style-type: none"> • <i>Protect near-stream soils from over-bank flows, trap harmful chemicals or sediment transported by surface and subsurface flows from adjacent land uses, or provide shade, detritus and large woody debris for the in-stream ecosystem.</i>
	Key Design Elements:	<ul style="list-style-type: none"> • <i>Corridors are planted adjacent to and more-or-less parallel with the stream bank. They must be sufficiently wide to achieve primary purposes (usually 15 to 100 feet).</i>
	Tree/Shrub Species Requirements:	<ul style="list-style-type: none"> • <i>Adapted to the soil and climate of the planting site.</i> • <i>Tolerant of extended periods of flooding (depending on the width of the planting and distance from the streambanks).</i> • <i>Moderate to aggressive root and crown spread to occupy the site quickly and provide adequate litter fall.</i> • <i>Resistance to pests and herbicides.</i>

Figure 8. **Filter Strip.**

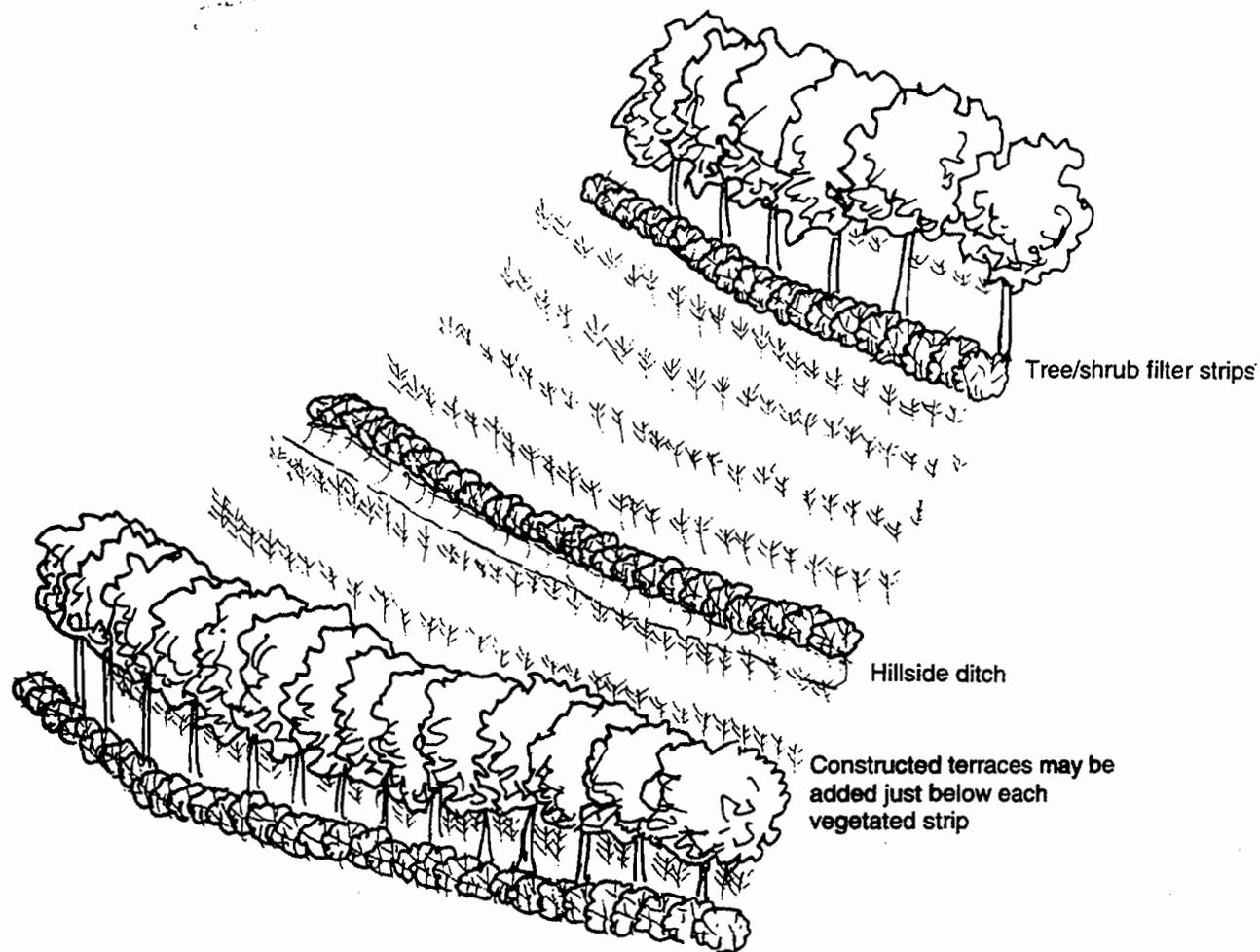
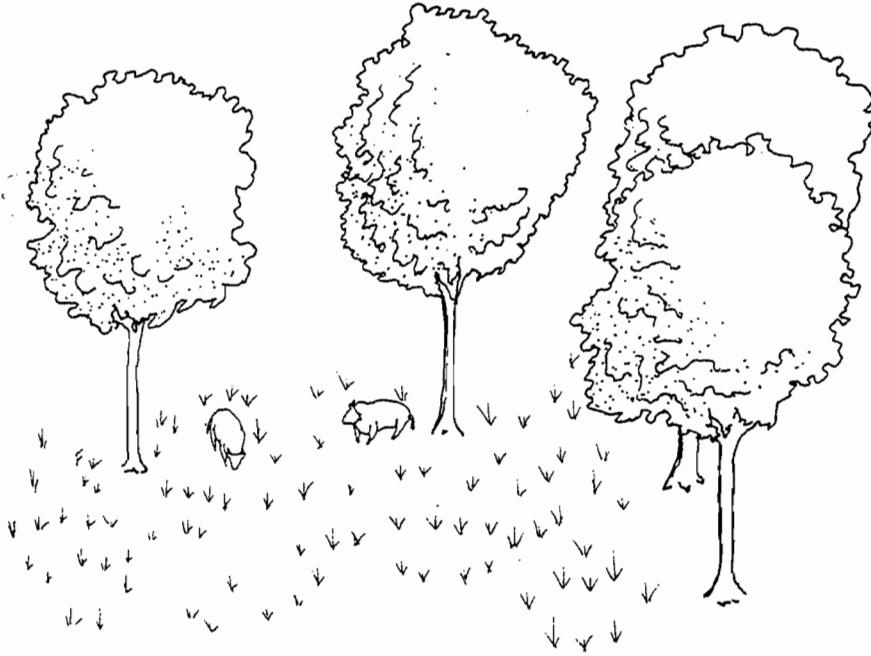


Table 1. Row-Types

Agroforestry System	Attributes	
Filter Strip	Description:	<i>A strip or area of vegetation for removing sediment, organic matter, and other pollutants from runoff and waste water.</i>
	Some Primary FOTG Practices for this System:	<ul style="list-style-type: none"> • <i>Filter Strip (393)</i> • <i>Conservation Crop Rotation (330)</i> • <i>Stripcropping, Contour (585)</i> • <i>Contour Farming (330)</i> • <i>Residue Management (329,344)</i> • <i>Diversion (362), Terrace (600), Grassed Waterway (412)</i> • <i>Use Exclusion (472)</i> • <i>Fencing (382)</i> • <i>Prescribed Grazing (528A)</i> • <i>Pasture and Hay Planting (512)</i>
	Primary Purposes:	<ul style="list-style-type: none"> • <i>To remove sediment and other pollutants from runoff by filtration, deposition, infiltration, or plant uptake.</i>
	Key Design Elements:	<ul style="list-style-type: none"> • <i>Strips are planted cross-slope or on the contour downhill from the source of sediment or pollutants. They must be sufficiently wide to achieve primary purposes.</i>
	Tree/Shrub Species Requirements:	<ul style="list-style-type: none"> • <i>Adapted to the soil and climate of the planting site.</i> • <i>Tolerant of sediment deposition and pollutant-laden runoff.</i> • <i>Moderate to aggressive development to occupy the site quickly.</i> • <i>Resistance to pests and herbicides.</i>

Figure 9. *Multistory Cropping.*

MULTI-STORY CROPPING: INTRODUCED FORAGE



Canopy does not exceed a planned percent cover

MULTI-STORY CROPPING: SPECIALTY CROPS

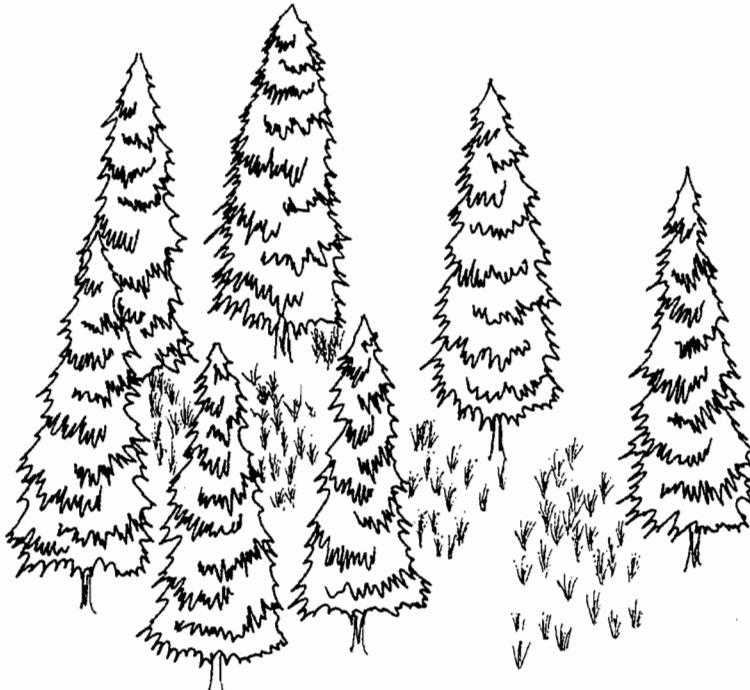
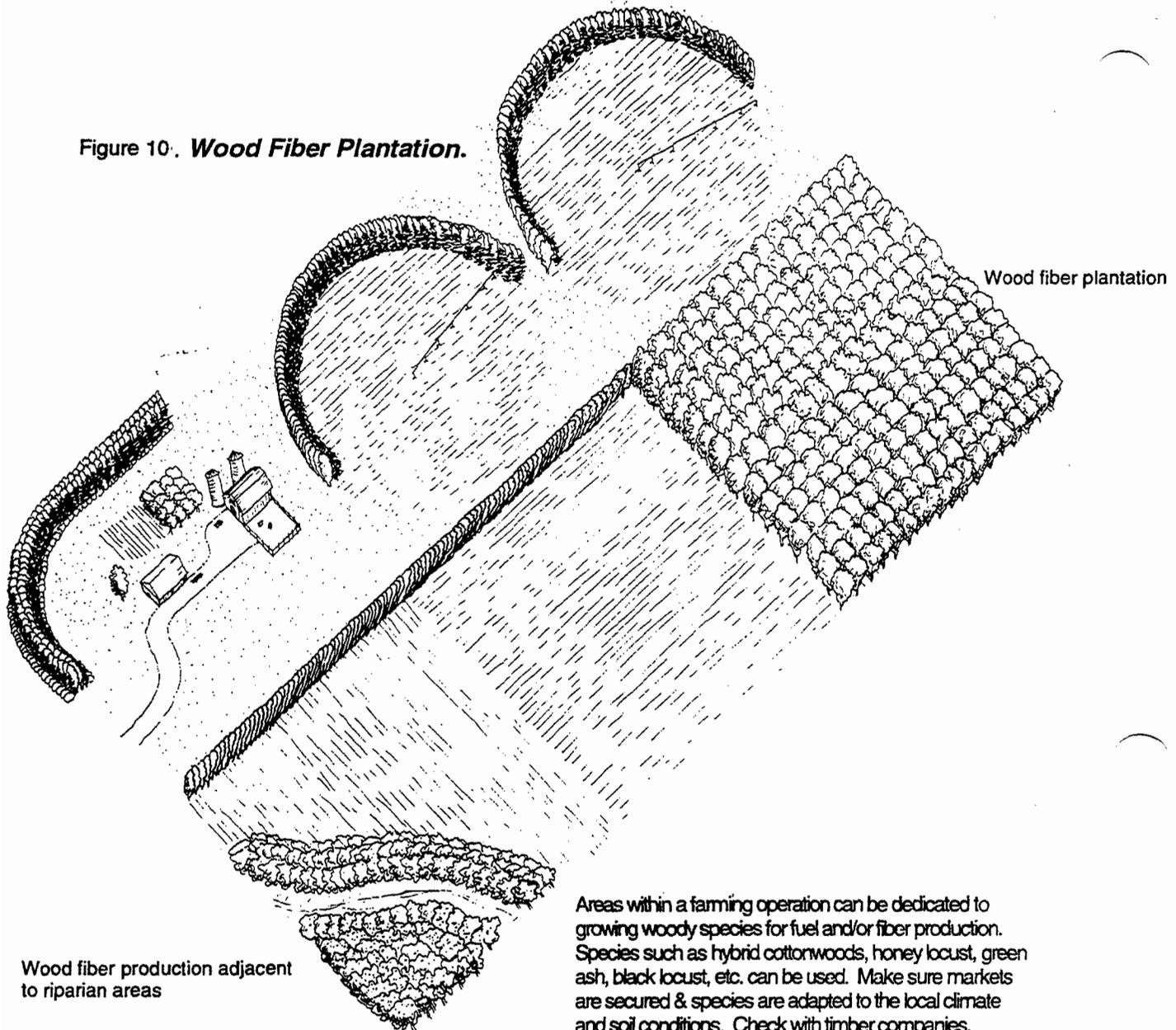


Table 2. Block-Types

Agroforestry System	Attributes	
Multistory Cropping	Description:	<i>Plantings consisting of an overstory of trees or shrubs with an understory of speciality or agronomic crops or forage. Tree-to-tree distance is wide enough to let sufficient light through to understory crops or forage. "Forest Farming" is a form of multistory cropping. Tree canopies of native forests would be managed to allow the production of such crops or forage.</i>
	Some Primary FOTG Practices for this System:	<ul style="list-style-type: none"> • <i>Multistory Cropping (new)</i> • <i>Tree/Shrub Establishment (612)</i> • <i>Conservation Crop Rotation (328)</i> • <i>Residue Management (329, 344)</i> • <i>Use Exclusion (472) or Prescribed Grazing (528A)</i> • <i>Pasture and Hay Planting (512)</i> • <i>Nutrient Management (590)</i> • <i>Pest Management (595)</i> • <i>Irrigation System (441), Irrigation Water Management (449)</i>
	Primary Purposes:	<ul style="list-style-type: none"> • <i>1) To produce wood or tree products in addition to agronomic crops or forage, 2) To improve crop or forage quality and quantity by enhancing microclimatic conditions, 3) To improve utilization and recycling of soil nutrients for crop or forage use, 4) To reduce excess subsurface water or control water table depths, 5) To provide favorable habitat for species beneficial to crops or forage.</i>
	Key Design Elements:	<ul style="list-style-type: none"> • <i>Trees are planted or native forests managed at a sufficiently wide spacing to allow adequate light to the understory crops or forage and permit passage of the widest field equipment width. Generally, mature tree canopy ranges from 5 to 40 percent crown cover.</i>
	Tree/Shrub Species Requirements:	<ul style="list-style-type: none"> • <i>High value species adapted to the soil/climate of the planting site.</i> • <i>Low to moderate root and crown spread to minimize competition with understory crops.</i> • <i>Tolerance of agricultural fertilizers and traffic on surficial roots.</i> • <i>Resistance to pests and herbicides.</i> • <i>High resistance to stem and branch breakage from high winds, ice and snow as applicable to the site.</i>

Figure 10. *Wood Fiber Plantation.*



Areas within a farming operation can be dedicated to growing woody species for fuel and/or fiber production. Species such as hybrid cottonwoods, honey locust, green ash, black locust, etc. can be used. Make sure markets are secured & species are adapted to the local climate and soil conditions. Check with timber companies, university extension services, and/or federal or state agencies for available species and varieties.



Table 2. Block-Types

Agroforestry System	Attributes	
Wood Fiber Plantation	Description:	<i>Trees are planted in a block as a separate field within an agricultural or livestock-production operating unit. Tree-to-tree distance is adjusted to produce optimum amounts of wood fiber during rotations generally less than 10 years.</i>
	Some Primary FOTG Practices for this System:	<ul style="list-style-type: none"> • <i>Tree/Shrub Establishment (612)</i> • <i>Use Exclusion (472)</i> • <i>Nutrient Management (590)</i> • <i>Forest Stand Improvement (666)</i> • <i>Irrigation System (441), Irrigation Water Management (449)</i>
	Primary Purposes:	<ul style="list-style-type: none"> • <i>To produce tree products or wood fiber in close proximity to agricultural or pasture areas to diversify the farm and ranch products.</i>
	Key Design Elements:	<ul style="list-style-type: none"> • <i>Trees are planted at a spacing to optimize wood fiber production. Generally, mature tree canopy cover ranges from 70 to 100 percent crown cover.</i>
	Tree/Shrub Species Requirements:	<ul style="list-style-type: none"> • <i>High value species adapted to the soil and climate of the planting site.</i> • <i>Tolerance of agricultural fertilizers and manure from adjacent fields.</i> • <i>Resistance to pests and herbicides.</i> • <i>Some resistance to stem and branch breakage from high winds, ice and snow as applicable to the site.</i>

Figure 11 . *Water-Waste Management Planting.*

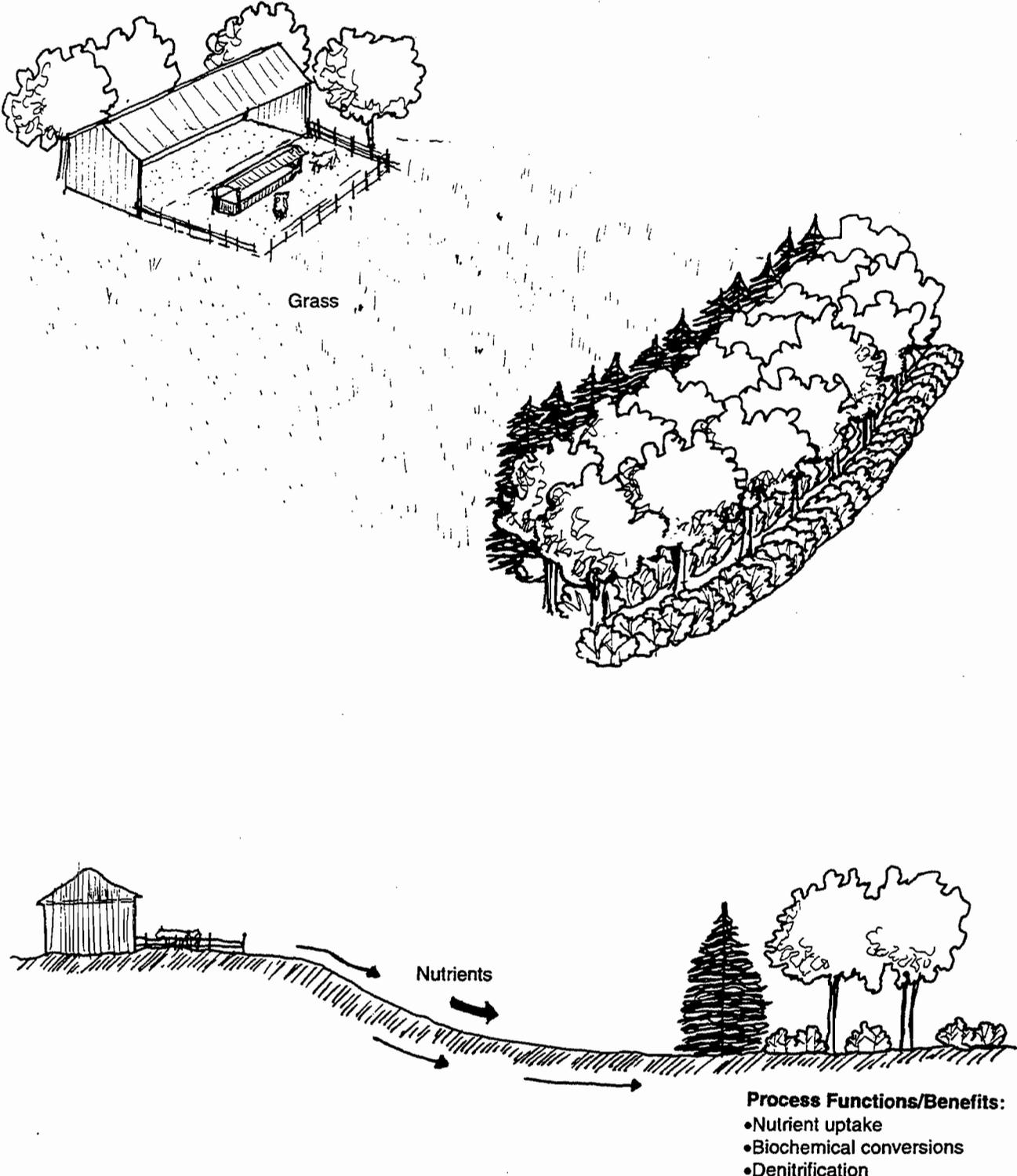


Table 2. Block-Types

Agroforestry System	Attributes	
Water-Waste Management Planting	Description:	<i>A block planting of closely spaced trees and/or shrubs placed downslope from agricultural water or waste sources. (For plantings immediately adjacent to streams or water courses, see Riparian Forest Buffer.) The dimension of the planting on its downhill axis and distance between individual plants insures the trapping of sediment or harmful chemicals from uphill land uses.</i>
	Some Primary FOTG Practices for this System:	<ul style="list-style-type: none"> • <i>Tree/Shrub Establishment (612)</i> • <i>Use Exclusion (472)</i> • <i>Prescribed Grazing (528A)</i> • <i>Pasture and Hay Planting (512)</i> • <i>Fencing (382)</i> • <i>Waste Utilization (633)</i> • <i>Irrigation Water Management (449)</i>
	Primary Purposes:	<ul style="list-style-type: none"> • <i>To use excess water by plant uptake, and/or intercept and utilize or sequester waste and other pollutants transported from uphill sources to and through a down-gradient block planting.</i>
	Key Design Elements:	<ul style="list-style-type: none"> • <i>Blocks are planted downhill from the source of water and/or waste. They must be sufficiently large (generally greater than 100 feet on its downhill axis) to achieve primary purposes and configured to fit the use of equipment and materials on adjacent fields. Application of water and/or waste shall not exceed the capability of the block planting to utilize such water/waste on a sustained basis. (For plantings less than 100 feet wide, see Filter Strips in the Alley Cropping System.)</i>
Tree/Shrub Species Requirements:	<ul style="list-style-type: none"> • <i>Adapted to the soil and climate of the planting site.</i> • <i>Tolerant of excess water, sediment deposition and waste-laden runoff.</i> • <i>Aggressive root and crown spread to occupy the site quickly.</i> • <i>Resistance to pests, herbicides and site pollutants.</i> 	

