

Appendix B : Exhibits Referenced in Text

Exhibit 5-1: National and State Resource Concerns and Planning Criteria

National and State Resource Concerns and Planning Criteria
10/1/2013

Resource Concern - Cause	Description of Concern	Land Use	Resource Concern Component	Planning Criteria		Measurement & Assessment Tools
<p>A resource concern (RC) is an expected degradation of the soil, water, air, plant, or animal resource base to an extent that the sustainability or intended use of the resource is impaired. Because NRCS quantifies or describes resource concerns as part of a comprehensive conservation planning process that includes client objectives, human and energy resources are considered components of the resource base. The "Cause" is the specific reason or threat to the resource that results in the resource concern.</p>		<p>* Required Assessment</p>	<p>For planning purposes, Some resource concerns are divided into components where there is a clear distinction in the causal factors, the mitigating actions, and the anticipated environmental effect.</p>	<p>A planning criterion is a quantitative or qualitative method to assess the existing condition of the natural resources on a site to determine whether additional treatment is needed to address a specific potential resource concern. Planning Consideration - A planning consideration is a description of potential actions or activities that should be considered to help address an identified resource concern and/or to address unintended consequences of an action. Planning considerations are identified for resource concerns when it is not appropriate or technologically feasible to identify specific criteria or a threshold for treatment.</p>		<p>Description of the technology or process for determining if assessment criteria are met.</p>
				<p>Screening Level Screening level criteria are defined, when appropriate, to identify sites with conditions that have little or no probability of needing additional treatment to address the specific resource concern. If the site meets the screening level criteria, then no other assessment is needed to document that planning criteria are met on this site. States can delete or edit nationally identified screening criteria to address localized conditions.</p>	<p>Basic Assessment Level Basic assessment level criteria are used when a site does not meet screening level criteria, or when no screening level criteria are defined. Assessment levels are also used when formulating and evaluating alternatives. National criteria establish the minimum for all sites. States may add state-specific criteria to address local conditions.</p>	

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SOIL	Description	Land Use	Component	Screening	Assessment Level	Assessment Tools	
SOIL EROSION - Sheet, rill, & wind erosion	Detachment and transportation of soil particles caused by rainfall runoff/splash, irrigation runoff or wind that degrades soil quality.	<ul style="list-style-type: none"> • Crop* • Developed Land* • Farmsteads* • Associated Ag Land* • Designated Protected Area* • Other Rural Land* • Pasture* 	Sheet & Rill	Permanent ground cover > 90% and slope < 10%	Water erosion rate ≤ T	RUSLE2	
			Wind		Wind erosion rate ≤ T	WEPS	
		• Range*	Sheet & Rill	Soil surface organic residue cover > 80%	State established criteria.	Site is stable and without visible signs of erosion	Visual Inspection
			Wind				
SOIL EROSION – Concentrated flow erosion	Untreated classic gullies may enlarge progressively by head cutting and/or lateral widening. Ephemeral gullies occur in the same flow area and are obscured by tillage. This includes concentrated flow erosion caused by runoff from rainfall, snowmelt or irrigation water.	• Crop*	Ephemeral gullies	Ephemeral gullies are not occurring	Conservation practices and managements are in place to prevent or control ephemeral gullies	Field measurements / observations	
			Classic gullies	Classic gullies are not present	Classic gully management is adequate to stop the progression of head cutting and widening and are offsite impacts are minimized by vegetation and/or structures		
		<ul style="list-style-type: none"> • Forest* • Farmsteads* • Pasture* • Range* • Developed Land* • Associated Ag Land* • Designated Protected Area* • Other Rural Land* 	Classic gullies	Classic gullies are not present	Classic gully management is adequate to stop the progression of head cutting and widening and are offsite impacts are minimized by vegetation and/or structures		
SOIL EROSION– Excessive bank erosion from streams shorelines or water conveyance channels	Sediment from banks or shorelines threatens to degrade water quality and limit use for intended purposes.	<ul style="list-style-type: none"> • Crop* • Forest • Range* • Developed Land* • Associated Ag Land* • Designated Protected Area* • Water* • Other Rural Land* • Farmsteads* 		Streams, shoreline or channels are not adjacent to site	For shorelines and water conveyance channels; banks are stable or commensurate with normal geomorphological processes? AND If bank erosion is present, it is beyond the client’s control or commensurate with normal geomorphological processes?	SVAP2	
					• Pasture*		For streambanks; SVAP2 bank condition element score ≥ 5? AND Bank erosion is it beyond the client’s control or commensurate with normal geomorphological processes? AND PCS - streambank / shoreline erosion element score ≥ 4?

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SOIL	Description	Land Use	Component	Screening	Assessment Level	Assessment Tools
SOIL QUALITY DEGRADATION - Subsidence	Loss of volume and depth of organic soils due to oxidation caused by above normal microbial activity resulting from excessive water drainage, soil disturbance, or extended drought. This excludes karst / sinkholes issues or depressions caused by underground activities.	<ul style="list-style-type: none"> • Crop • Forest • Associated Ag Land • Designated Protected Area • Pasture 		<p>Histisol soils are not present</p> <p>OR</p> <p>Histisols soils are not exhibiting subsidence</p>	Subsidence is adequately managed to meet client's objectives	Client input / planner observation
SOIL QUALITY DEGRADATION – Compaction	Management induced soil compaction resulting in decreased rooting depth that reduces plant growth, animal habitat and soil biological activity.	<ul style="list-style-type: none"> • Crop • Forest • Associated Ag Land • Designated Protected Area • Other Rural Land • Pasture 		Soil compaction is not a problem	Compaction is managed to meet Client's production and management objectives	Observation of soil and/or plant condition Client input / planner observation
		• Range		AND	PCS – compaction element score ≥ 4	PCS - Pasture Condition Score
				Activities do not cause soil compaction problems	RHA - soil site stability - slight to moderate or less OR Compaction is managed to meet Client's production and management objectives	RHA - Rangeland Health Assessment Observation of soil and/or plant condition
SOIL QUALITY DEGRADATION – Organic matter depletion	Soil organic matter is not adequate to provide a suitable medium for plant growth, animal habitat, and soil biological activity.	• Crop*		Permanent ground cover > 80%	SCI > 0	RUSLE2 WEPS
		• Pasture			SCI > 0 OR [PCS - plant cover element score ≥ 4 AND PCS - plant residue element score ≥ 4]	PCS - Pasture Condition Score RUSLE2
		• Range		Soil organic matter depletion is not a problem	[RHA - soil site stability slight to moderate or less AND RHA – biotic integrity attribute rating slight to moderate departure or less] OR Rangeland Planned Trend positive	RHA - Rangeland Health Assessment Rangeland Trend Worksheet
		• Forest		Activities do not cause soil organic matter depletion	Ground cover meets state criteria specific to ecological site OR Soil organic matter is managed to meet Client objectives	Client input / planner observation

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SOIL	Description	Land Use	Component	Screening	Assessment Level	Assessment Tools
SOIL QUALITY DEGRADATION – Concentration of salts or other chemicals	Concentration of salts leading to salinity and/or sodicity reducing productivity or limiting desired use, or concentrations of other chemicals impacting productivity or limiting desired use.	<ul style="list-style-type: none"> • Crop • Pasture • Range • Associated Ag Land • Farmsteads 		Activities do not cause salinity/sodicity problems	Conservation practices and managements are in place to mitigate on-site effects	Soil diagnostic evaluations
WATER	Description	Land Use	Component	Screening	Assessment Level	Assessment Tools
EXCESS WATER – Ponding, flooding, seasonal high water table, seeps, and drifted snow	Surface water or poor subsurface drainage restricts land use and management goals. Wind-blown snow accumulates around and over surface structures, restricting access to humans and animals.	<ul style="list-style-type: none"> • Crop • Forest • Farmsteads • Pasture • Range • Developed Land • Associated Ag Land • Designated Protected Area • Other Rural Land 	Ponding and Flooding	Ponding or flooding not a problem AND Activities do not cause ponding/flooding problems	Excess water is managed to meet Client’s objectives	Client input / planner observation
			Seasonal High Water Table	Seasonal high water table does not cause a problem		
			Seeps	Excess water from seeps does not cause a problem		
			Drifted Snow	Drifted snow does not cause a problem		
INSUFFICIENT WATER – Inefficient moisture management	Natural precipitation is not optimally managed to support desired land use goals or ecological processes.	<ul style="list-style-type: none"> • Crop • Developed Land • Forest • Associated Ag Land • Designated Protected Area 		Moisture management is not a problem AND Activities do not cause inefficient moisture management problems	Runoff and evapotranspiration levels are minimized to meet Client’s management objectives	Client input / planner observation
					RHA - hydrologic function attributes slight to moderate or less	RHA - Rangeland Health Assessment
					PCS – compaction element score ≥ 4 AND PCS - plant cover element score ≥ 4	PCS - Pasture Condition Score
INSUFFICIENT WATER – Inefficient use of irrigation water	Irrigation water is not stored, delivered, scheduled and/or applied efficiently. Aquifer or surface water withdrawals threaten sustained availability of ground or surface water. Available irrigation water supplies have been reduced due to aquifer depletion, competition, regulation and/or drought.	• All*		PLU is not irrigated	The irrigation system components and management meet state specific efficiency criteria	State identified measurement and assessment tools - Farm Irrigation Rating Index (FIRI), State Version

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WATER	Description	Land Use	Component	Screening	Assessment Level	Assessment Tools
WATER QUALITY DEGRADATION: Excess nutrients in surface and ground waters	Nutrients - organic and inorganic - are transported to receiving waters through surface runoff and/or leaching into shallow ground waters in quantities that degrade water quality and limit use for intended purposes.	• Crop*	Excess nutrients in surface water	Organic or inorganic nutrients are not applied	Nutrient and amendment applications are based on soil or tissue tests and nutrient budgets for realistic yields AND Conservation practices and managements are in place to minimize surface water impacts	Client input / planner observation Nutrient budget
			Excess nutrients in groundwater	AND PLU is not grazed	Nutrient and amendment applications are based on soil or tissue tests and nutrient budgets for realistic yields AND Conservation practices and managements are in place to minimize groundwater impacts	
		• Pasture*	Excess nutrients in surface water		PCS - streambank / shoreline erosion element score ≥ 4 AND PCS - livestock concentration areas element score	PCS – Pasture Condition Score Nutrient budget
			Excess nutrients in groundwater			
		• Developed Land	Excess nutrients in surface water	Organic or inorganic nutrients are not applied	Nutrients if applied, are based on a soil test, tissue tests or nutrient budget AND Conservation practices and managements are in place to minimize surface water impacts	Nutrient Budget Client input / planner observation
			Excess nutrients in groundwater		Nutrients if applied, are based on a soil test, tissue tests or nutrient budget AND Conservation practices and managements are in place to minimize groundwater impacts	
		• Other Rural Land • Associated Ag Land • Designated Protected Area • Water • Forest • Range	Excess nutrients in surface water	Organic or inorganic nutrients are not applied AND PLU is not grazed AND There are no confined livestock areas	Nutrients if applied, are based on a soil test, tissue tests or nutrient budget AND Conservation practices and managements are in place to minimize surface water impacts	Nutrient Budget Client input / planner observation
			Excess nutrients in groundwater		Nutrients if applied, are based on a soil test, tissue tests or nutrient budget AND Conservation practices and managements are in place to minimize groundwater impacts	

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WATER	Description	Land Use	Component	Screening	Assessment Level	Assessment Tools
WATER QUALITY DEGRADATION: Excess nutrients in surface and ground waters (continued)	Nutrients - organic and inorganic - are transported to receiving waters through surface runoff and/or leaching into shallow ground waters in quantities that degrade water quality and limit use for intended purposes.	<ul style="list-style-type: none"> • Farmsteads* 	Excess nutrients in surface water	Organic or inorganic nutrients are not applied AND PLU is not grazed AND	Conservation practices and managements are in place to minimize surface water impacts AND Surface waters are protected from contamination due to runoff and leaching from storage sites, spill and other concentrated sources	Nutrient Budget Client input / planner observation
			Excess nutrients in groundwater	There are no confined livestock areas AND	Conservation practices and managements are in place to minimize groundwater impacts AND Groundwater is protected from contamination due to runoff and leaching from storage sites, spill and other concentrated sources	
WATER QUALITY DEGRADATION – Pesticides transported to surface and ground waters	Pest control chemicals are transported to receiving waters in quantities that degrade water quality and limit use for intended purposes.	<ul style="list-style-type: none"> • All 	Pesticides transported to surface water	Pest control chemicals are not applied AND	Pesticides are stored, handled, disposed and managed to prevent runoff, spills, leaks and leaching AND Conservation practices and managements are in place to minimize surface water impacts	Client input / planner observation WinPST
			Pesticides transported to groundwater	Pest control chemicals are not applied AND	Pesticides are stored, handled, disposed and managed to prevent runoff, spills, leaks and leaching AND Conservation practices and managements are in place to minimize groundwater impacts	
WATER QUALITY DEGRADATION – Excess pathogens and chemicals from manure, bio-solids or compost applications	Pathogens, pharmaceuticals, and other chemicals carried by land applied soil amendments are transported to receiving waters in quantities that degrade water quality and limit use for intended purposes. This resource concern also includes the off-site transport of leachate and runoff from compost or other organic materials of animal origin.	<ul style="list-style-type: none"> • Crop* • Farmsteads* • Forest • Developed Land • Associated Ag Land • Other Rural Land • Designated Protected Area • Water • Pasture* • Range 	Pathogens and chemicals from manure, bio-solids, or compost applications transported to surface water	Potential sources of pathogens or pharmaceuticals are not applied on the land AND	Organic materials are applied, stored, and/or handled to mitigate negative impacts to surface water sources	Client input / planner observation
			Pathogens and chemicals from manure, bio-solids, or compost applications transported to groundwater	Potential sources of pathogens or pharmaceuticals are not applied on the land AND	Organic materials are applied, stored, and/or handled to mitigate negative impacts to groundwater sources	

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WATER	Description	Land Use	Component	Screening	Assessment Level	Assessment Tools
WATER QUALITY DEGRADATION – Excessive salts in surface and ground waters	Irrigation or rainfall runoff transports salts to receiving water in quantities that degrade water quality and limit use for intended purposes.	• All	Excessive salts in surface water	Excess salt is not a problem AND Activities do not contribute to excess salt problem	Salt concentrations are managed to mitigate off-site transport to surface waters	Client input / planner observation
			Excessive salts in groundwater	Salt concentrations are managed to mitigate off-site transport to groundwater		
WATER QUALITY DEGRADATION – Petroleum, heavy metals and other pollutants transported to receiving waters	Heavy metals, petroleum and other pollutants are transported to receiving water sources in quantities that degrade water quality and limit use for intended purposes.	• All	Petroleum, heavy metals, and other pollutants transported to surface water	Activities do not present the potential for contamination by petroleum, heavy metals and other pollutants	Petroleum, heavy metals or other potential pollutants are stored and handled to avoid runoff to surface water	Client input / planner observation
			Petroleum, heavy metals, and other pollutants transported to groundwater	Activities do not present the potential for contamination by petroleum, heavy metals and other pollutants	Petroleum, heavy metals or other potential pollutants are stored and handled to avoid leaching to groundwater	
WATER QUALITY DEGRADATION – Excessive sediment in surface waters	Off-site transport of sediment from sheet, rill, gully, and wind erosion into surface water that threatens to degrade surface water quality and limit use for intended purposes.	• Crop* • Developed Land* • Farmsteads* • Other Rural Land • Associated Ag Land • Designated Protected Area • Water • Pasture*		Permanent ground cover > 90% and slope < 10% AND Classic gullies are not present AND Streams or shoreline are not on or adjacent to site	Upslope treatment and buffer practices address concentrated flows to water bodies AND SVAP2 - bank condition ≥ 5 AND Livestock and vehicle water crossings are stable AND Water erosion rate ≤ T AND Wind erosion rate ≤ T	RUSLE2 WEPS Client input / planner observation SVAP2
		• Forest*		There are no untreated sources of erosion AND Streams or shoreline are not on or adjacent to site	Upslope treatment and buffer practices address concentrated flows to water bodies AND Heavy use areas are stable AND SVAP2 - bank condition ≥ 5	Client input / planner observation SVAP2
		• Range*		RHA - hydrologic function attribute - slight to moderate or less AND SVAP2 - bank condition ≥ 5	RHA - Rangeland Health Assessment SVAP2	

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WATER	Description	Land Use	Component	Screening	Assessment Level	Assessment Tools
WATER QUALITY DEGRADATION – Elevated water temperature	Surface water temperatures exceed State/Federal standards and/or limit use for intended purposes.	• All		Water courses on or adjacent to the site are not designated by a State Agency as a temperature impairment OR Water course temperature is not a client concern	[SVAP2 - riparian area quality element score \geq 5 AND SVAP2 - riparian area quantity quality element score \geq 5 AND SVAP2 - canopy cover element score \geq 6] OR Existing conservation practices are in place to address water temperature	Client input / planner observation SVAP2
PLANT	Description	Land Use	Component	Screening	Assessment Level	Assessment Tools
DEGRADED PLANT CONDITION – Undesirable plant productivity and health	Plant productivity, vigor and/or quality negatively impacts other resources or does not meet yield potential due to improper fertility, management or plants not adapted to site. This includes addressing pollinators and beneficial insects.	• Crop • Farmsteads • Developed Land • Designated Protected Area • Associated Ag Land • Other Rural Land		Plant production and health is not a client concern	Plants are adapted to the site, meet production goals and do not negatively impact other resources AND Plant damage from wind erosion is below Crop Damage Tolerance levels	Client input / planner observation Crop Tolerance Table
		• Range*		Vegetation meet similarity index or range condition score of 60 or greater for desired plant community and has a positive trend OR RHA – biotic integrity attribute rating - slight to moderate departure or less	RHA - Rangeland Health Assessment Rangeland Trend Worksheet Similarity Index Worksheet	
		• Pasture*		Plant production and health is not a client concern	PCS - 30 or above Plants are adapted to the site, meet production goals and do not negatively impact other resources	PCS - Pasture Condition Score
		• Forest		Plant production and health is not a client concern	Forest species are adapted to site AND Composition and stand density meets the Client's objectives and production goals	Forest Inventory plots and/or transects

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PLANT	Description	Land Use	Component	Screening	Assessment Level	Assessment Tools
DEGRADED PLANT CONDITION – Inadequate structure and composition	Plant communities have insufficient composition and structure to achieve ecological functions and management objectives. This includes degradation of wetland habitat, targeted ecosystems, or unique plant communities.	<ul style="list-style-type: none"> • Forest • Designated Protected Area • Associated Ag Land • Water • Pasture 		Plant communities support the intended land use and desired ecological functions	Plant communities contain adequate diversity, composition and structure to support desired ecological functions	Ecological Site Descriptions
		<ul style="list-style-type: none"> • Range* 		Plant communities support the intended land use and desired ecological functions	Plant communities contain adequate diversity, composition and structure to support desired ecological functions OR RHA – biotic integrity attribute rating slight to moderate departure or less OR Vegetation meet similarity index of 60 or greater for desired plant community and has a positive trend	Ecological Site Descriptions RHA - Rangeland Health Assessment Rangeland Trend Worksheet
DEGRADED PLANT CONDITION – Excessive plant pest pressure	Excessive pest damage to plants including that from undesired plants, diseases, animals, soil borne pathogens, and nematodes. This concern addresses invasive plant, animal and insect species.	<ul style="list-style-type: none"> • Crop • Forest* • Farmsteads • Range* • Developed Land • Associated Ag Land • Designated Protected Area • Water • Other Rural Land 		Plant productivity is not limited from pest pressure	Pest damage to plants are below economic or environmental thresholds or client-identified criteria AND Plant pests, including noxious and invasive species are managed to meet client objectives	Client input / planner observation
		<ul style="list-style-type: none"> • Pasture* 		Plant productivity is not limited from pest pressure	PCS - insect and disease pressure element score \geq 4 AND PCS - site adaptation element score \geq 4	PCS - Pasture Condition Score
DEGRADED PLANT CONDITION– Wildfire hazard, excessive biomass accumulation	The kinds and amounts of fuel loadings - plant biomass - create wildfire hazards that pose risks to human safety, structures, plants, animals, and air resources.	<ul style="list-style-type: none"> • All 		Wildfire hazard is not a concern	Fuel loads and fuel ladders are managed to provide defensible space and meet client objectives	Client input / planner observation

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ANIMAL	Description	Land Use	Component	Screening	Assessment Level	Assessment Tools
INADEQUATE HABITAT FOR FISH AND WILDLIFE – Habitat degradation	Quantity, quality or connectivity of food, cover, space, shelter and/or water is inadequate to meet requirements of identified fish, wildlife or invertebrate species.	All with “wildlife” modifier - (Required when Land Use has a wildlife modifier)	Quantity, quality of food is inadequate to meet requirements of identified fish, wildlife or invertebrate species		WHSI rating ≥ 0.5 AND (when surface stream present) [SVAP2 – fish habitat complexity element score ≥ 7 AND SVAP2 – aquatic invertebrate habitat element score ≥ 7] OR Conservation practices and management are in place that meet or exceed species or guild-specific habitat model thresholds OR Food is available in quality and extent to support habitat requirements for the species of interest	Species-specific wildlife habitat assessment tools SVAP2 Generalized WHS Index finalized by States, and detailed models by selected species and habitat type
			Quantity, quality of water is inadequate to meet requirements of identified fish, wildlife or invertebrate species		WHSI rating ≥ 0.5 AND (when surface stream present) SVAP2 – aquatic invertebrate habitat element score ≥ 7 OR Conservation practices and management are in place that meet or exceed species or guild-specific habitat model thresholds OR Water is available in quality and extent to support habitat requirements for the species of interest	
			Quantity, quality or cover/shelter is inadequate to meet requirements of identified fish, wildlife or invertebrate species		WHSI rating ≥ 0.5 AND (when surface stream present) [SVAP2 – barriers to movement element score ≥ 7 AND SVAP2 – fish habitat complexity element score ≥ 7 AND SVAP2 – aquatic invertebrate habitat element score ≥ 7] OR Conservation practices and management are in place that meet or exceed species or guild-specific habitat model thresholds OR Cover is of available quality and extent to support habitat requirements for the species of interest	

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ANIMAL	Description	Land Use	Component	Screening	Assessment Level	Assessment Tools
INADEQUATE HABITAT FOR FISH AND WILDLIFE – Habitat degradation (continued)	Quantity, quality or connectivity of food, cover, space, shelter and/or water is inadequate to meet requirements of identified fish, wildlife or invertebrate species.	All with “wildlife” modifier - (Required when Land Use has a wildlife modifier)	Habitat continuity and/or space is inadequate to meet requirements of identified fish, wildlife or invertebrate species		WHSI rating ≥ 0.5 AND (when surface stream present) [SVAP2 – barriers to movement element score ≥ 7 AND SVAP2 – aquatic invertebrate habitat element score ≥ 7] OR Conservation practices and management are in place that meet or exceed species or guild-specific habitat model thresholds OR The connectivity of habitat components are adequate to support stable populations of targeted species	Species-specific wildlife habitat assessment tools SVAP2 Generalized WHS Index finalized by States, and detailed models by selected species and habitat type
LIVESTOCK PRODUCTION LIMITATION – Inadequate feed and forage	Feed and forage quality or quantity is inadequate for nutritional needs and production goals of the kinds and classes of livestock.	• All with “grazed” modifier (Applicable when Land Use is grazed)			Livestock forage, roughage and supplemental nutritional requirements addressed.	Client input / planner observation GRAS - Grassland Resource Analysis System
LIVESTOCK PRODUCTION LIMITATION – Inadequate livestock shelter	Livestock lack adequate shelter from climatic conditions to maintain health or production goals.	• All with “grazed” modifier (Applicable when Land Use is grazed)			Artificial or natural shelters meet animal health needs and client objectives.	Client input / planner observation
LIVESTOCK PRODUCTION LIMITATION – Inadequate livestock water	Quantity, quality and/or distribution of drinking water are insufficient to maintain health or production goals for the kinds and classes of livestock.	• All with “grazed” modifier (Applicable when Land Use is grazed)			Water of acceptable quality and quantity adequately distributed to meet animal needs.	Client input / planner observation GRAS - Grassland Resource Analysis System - Tool for water distribution

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ENERGY	Description	Land Use	Component	Screening	Assessment Level	Assessment Tools
INEFFICIENT ENERGY USE – Equipment and facilities	<p>Inefficient use of energy in the Farm Operation increases dependence on non-renewable energy sources that can be addressed through improved energy efficiency and the use of on-farm renewable energy sources.</p> <p>As an example, this concern addresses inefficient energy use in pumping plants, on-farm processing, drying and storage.</p>	<ul style="list-style-type: none"> • All 		<p>Client is not interested in improving equipment and facilities energy efficiency</p>	<p>A USDA approved energy audit been implemented that address equipment and facilities to meet client objectives OR On-farm renewable energy and/or energy conserving practices have been implemented to meet client objectives</p>	<p>Client input / planner observation USDA approved Energy Audit NRCS Energy Estimator</p>
INEFFICIENT ENERGY USE – Farming/ranching practices and field operations	<p>Inefficient use of energy in field operations increases dependence on non-renewable energy sources that can be addressed through improved efficiency and the use of on-farm renewable energy sources.</p>	<ul style="list-style-type: none"> • All 		<p>Client is not interested in improving energy use in farm and ranch field operations</p>	<p>A USDA approved energy audit been implemented that address field operations to meet client objectives OR On-farm renewable energy and/or energy conserving practices have been implemented to meet client objectives</p>	<p>Client input / planner observation USDA approved Energy Audit NRCS Energy Estimator Conservation on the Farm Checklist</p>

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AIR	Description	Land Use	Component	Screening	Assessment Level	Assessment Tools
AIR QUALITY IMPACTS - Emissions of Particulate Matter - PM - and PM Precursors	Direct emissions of particulate matter - dust and smoke -, as well as the formation of fine particulate matter in the atmosphere from other agricultural emissions - ammonia, NOx, and VOCs - cause multiple environmental impacts, such as: - The unintended movement of particulate matter - typically dust or smoke - results in safety or nuisance visibility restriction. - The unintended movement of particulate matter and/or chemical droplets results in unwanted deposits on surfaces. - Increased atmospheric concentrations of particulate matter can impact human and animal health and degrade regional visibility.	<ul style="list-style-type: none"> • Crop • Pasture • Range • Forest • Other Rural Land • Associated Ag Land • Designated Protected Areas • Developed Land • Farmsteads 		Activities are not present that contribute to agricultural source PM or PM precursor emissions PM Producing Activity Examples: <ul style="list-style-type: none"> • Prescribed Burn is conducted • Travel ways unpaved or untreated with binding agents • Engines (combustion source) • Tillage • Pesticides are applied • Fertilization (manure/commercial) • CAFO/manure management) AND Episodes or complaints of emissions of PM (dust, smoke, exhaust, etc.), or chemical drift have not occurred	PM and PM Precursor emissions are managed to meet client objectives	Client input / planner observation
AIR QUALITY IMPACTS - Emissions of Greenhouse Gases - GHGs	Emissions increase atmospheric concentrations of greenhouse gases.	<ul style="list-style-type: none"> • All 		Activities are not present that produce GHGs emissions GHG Producing Activities: <ul style="list-style-type: none"> • Fertilization (manure/commercial) • CAFO/manure management • Engines (combustion source) • Tillage AND GHGs are not regulated in this planning area	Greenhouse gas emissions are managed to meet client objectives	Client input / planner observation

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AIR	Description	Land Use	Component	Screening	Assessment Level	Assessment Tools
AIR QUALITY IMPACTS - Emissions of Ozone Precursors	Emissions of ozone precursors - NOx and VOCs - resulting in formation of ground-level ozone that cause negative impacts to plants and animals.	<ul style="list-style-type: none"> • All 		Operations are not present that produce ozone or precursor emissions Ozone Producing Activities: <ul style="list-style-type: none"> • Engines (combustion source) • Pesticide application • Burning • CAFO/manure management • Fertilization (manure /commercial) 	Ozone precursor emissions are managed to meet client objectives	Client input / planner observation
AIR QUALITY IMPACTS - Objectionable odors	Emissions of odorous compounds - VOCs, ammonia and odorous sulfur compounds - cause nuisance conditions.	<ul style="list-style-type: none"> • Crop • Pasture • Farmsteads • Other Rural Land 		Activities are not present that contribute to nuisance air quality conditions Nuisance Producing Activities: <ul style="list-style-type: none"> • Pesticide application • CAFO / manure management • Composting is conducted AND Odor sources are not regulated in this planning area AND Episodes or complaints of emissions of PM (dust, smoke, exhaust, etc.), or chemical drift have not occurred	Odors are managed to meet client objectives	Client input / planner observation

Exhibit 5-2: Wind Erodibility Group (WEG) and Wind Erodibility Index (from the National Soil Survey Handbook)

Part 618 – Soil Properties and Qualities

Subpart B – Exhibits

618.95 Wind Erodibility Groups (WEG) and Index

WEG 1,3,4,5,7	Properties of Soil Surface Layer	Dry Soil Aggregates More Than 0.84 mm (wt.%)	Wind Erodibility Index (I) (tons/ac/yr)
1	Very fine sand, fine sand, sand, or coarse sand ²	1	310
		2	250
		3	220
		5	180
		7	160
2	Loamy very fine sand, loamy fine sand, loamy sand, and loamy coarse sand; very fine sandy loam and silt loam with 5 or less percent clay and 25 or less percent very fine sand; and sapric soil materials (as defined in Soil Taxonomy), except Folists.	10	134
3	Very fine sandy loam (but does not meet WEG criterion 2), fine sandy loam, sandy loam, and coarse sandy loam; noncalcareous silt loam that has greater than or equal to 20 to less than 50 percent very fine sand and greater than or equal to 5 to less than 12 percent clay.	25	86
4	Clay, silty clay, noncalcareous clay loam that has more than 35 percent clay and noncalcareous silty clay loam that has more than 35 percent clay; all of these do not have sesquic, parasesquic, ferritic, ferruginous, or kaolinitic mineralogy (high iron oxide content).	25	86
4L	Calcareous ⁶ loam, calcareous silt loam, calcareous silt, calcareous sandy clay, calcareous sandy clay loam, calcareous clay loam, and calcareous silty clay loam.	25	86
5	Noncalcareous loam that has less than 20 percent clay; noncalcareous silt loam with greater than or equal to 5 to less than 20 percent clay (but does not meet WEG criterion 3); noncalcareous sandy clay loam; noncalcareous sandy clay; and hemic soil materials (as defined in Soil Taxonomy).	40	56
6	Noncalcareous loam and silt loam that have greater than or equal to 20 percent clay; noncalcareous clay loam and noncalcareous silty clay loam that have less than or equal to 35 percent clay; silt loam that has parasesquic, ferritic, or kaolinitic mineralogy (high iron oxide content).	45	48
7	Noncalcareous silt; noncalcareous silty clay, noncalcareous silty clay loam, and noncalcareous clay that have sesquic, parasesquic, ferritic, ferruginous, or kaolinitic mineralogy (high content of iron oxide) and are Oxisols or Ultisols; and fibric soil materials (as defined in Soil Taxonomy).	50	38
8	Soils not susceptible to wind erosion due to rock and pararock fragments at the surface and/or wetness; and Folists.	--	0

The following footnotes are applied in the order listed:

- (i) For all WEGs except 1 and 2 (sands and loamy sand textures), if percent rock and pararock fragments (>2mm) by volume is 15-35, reduce "I" value by one group with more favorable rating. If percent rock and pararock fragments by volume is 35-60, reduce "I" value by two favorable groups except for sands and loamy sand textures which are reduced by one group with more favorable rating. If percent rock and pararock fragments is greater than 60, use "I" value of 0 for all textures except sands and loamy sand textures which are reduced by three groups with more favorable ratings. An example of more favorable "I" rating is next lower number: "I" factor of 160 to "I" factor of 134 or "I" factor of 86 to "I" factor of 56. The index values should correspond exactly to their wind erodibility group (e.g., "I" factor of 56 = WEG 5).
- (ii) The "I" values for WEG 1 vary from 160 for coarse sands to 310 for very fine sands. Use an "I" of 220 as an average figure.
- (iii) All material that meets criterion 3 in the required characteristics for andic soil properties as defined in the *Keys to Soil Taxonomy*, 11th edition. Such material is placed in WEG 2 regardless of the texture class of the fine-earth fraction.
- (iv) All material that meets criterion 2, but not criterion 3, in the required characteristics for andic soil properties as defined in the *Keys to Soil Taxonomy*, 11th edition. Such material is placed in WEG 6, regardless of the texture class of the fine-earth fraction. The only exception to this is for Cryic Spodosols which have a medial substitute class and a MAAT < 4 degrees C.; these soils are placed in WEG 2.
- (v) For surface layers or horizons that do not meet the required characteristics for andic soil properties but do meet Vitrandic, Vitritorrandic, Vitrixerandic, and Ustivitrandic subgroup criteria (thickness criterion excluded) move one wind erodibility group (WEG) with a less favorable rating.
- (vi) Calcareous is a strongly or violently effervescent reaction (class) of the fine-earth fraction to cold dilute (1N) HCL; a paper "Computing the Wind Erodible Fraction of Soils" by D. W. Fryear et.al (1994) in the *Journal of Soil and Water Conservation* 49 (2) 183-188 raises a yet unresolved question regarding the effect of carbonates on wind erosion.
- (vii) For mineral soils with thin 'O' horizons, the WEG is based on the first mineral horizon.

Exhibit 5-3: Resource Concern Guide, Soil Erosion - Wind

Arizona Planning Guide for Natural Resource Concerns

Soil Erosion - Wind

Resource Concern Description –
 Detachment and transport of soil particles caused by wind degrade soil quality and/or damage plants.



Planning Criteria – Land use and management do not cause accelerated wind erosion.

1. Wind erosion on cropland and pastureland does not exceed the established soil loss tolerance “T” for the soil.
2. On rangeland the soil site stability is slight to moderate or less.
3. On forestland the site is stable without visible signs of erosion.

Methods for evaluating resource condition

- Visual assessment (pedestals, blow-out areas)
- Rangeland Health Assessment
- Wind Erosion Prediction System (WEPS)

Conservation Practices that may be needed as part of a Conservation Management System to achieve Planning Criteria for this resource concern include those listed here.

- 314 Brush Management
- 327 Conservation Cover

- 328 Conservation Crop Rotation
- 340 Cover Crop
- 342 Critical Area Planting
- 588 Cross Wind Ridges
- 589C Cross Wind Trap Strips
- 324 Deep Tillage
- 382 Fence
- 386 Field Border
- 512 Forage and Biomass Planting
- 655 Forest Trails and Landings
- 666 Forest Stand Improvement
- 548 Grazing Land Mechanical Treatment
- 561 Heavy Use Area Protection
- 422 Hedgerow Planting
- 603 Herbaceous Wind Barriers
- 441 Irrigation System, Microirrigation
- 443 Irrigation System, Surface and Subsurface
- 447 Irrigation System, Tailwater Recovery
- 449 Irrigation Water Management
- 484 Mulching
- 528 Prescribed Grazing
- 550 Range Planting
- 562 Recreation Area Improvement
- 329 Residue and Tillage Management, No Till
- 345 Residue and Tillage Management, Reduced Till
- 557 Row Arrangement
- 610 Salinity and Sodic Soil Management
- 442 Sprinkler System
- 585 Stripcropping
- 609 Surface Roughening
- 612 Tree/Shrub Establishment
- 645 Wildlife Upland Habitat Management
- 380 Windbreak/Shelterbelt Establishm

Exhibit 5-4: Resource Concern Guide, Air Quality Impacts - Emissions of Particulate Matter (PM) and PM Precursors

Arizona Planning Guide for Natural Resource Concerns

Air Quality Impacts – Emissions of Particulate Matter (PM) and PM Precursors

Resource Concern Description – Direct emissions of particulate matter such as dust and smoke, as well as the formation of fine particulate matter in the atmosphere from other agricultural emissions - ammonia, NOx, and VOCs - cause multiple environmental impacts, including but not limited to:

- The unintended movement of particulate matter - typically dust or smoke - results in safety or nuisance visibility restriction.
- The unintended movement of particulate matter and/or chemical droplets results in unwanted deposits on surfaces.
- Increased atmospheric concentrations of particulate matter can impact human and animal health and degrade regional visibility.

Planning Criteria –PM and PM Precursor emissions are managed to meet client objectives.

Methods for evaluating resource condition

- Visual Assessment
- Client Interview
- EPA Air Quality Guidelines
- State and County Air Quality Guidelines
- NRCS Agricultural Air Quality Conservation Measures Guide
- Emissions Calculator
- RUSLE2
- WEPS
- Manure Management Planner (MMP)
- Nutrient Budget
- Pesticide planning and mitigation worksheet

Conservation Practices that may be needed as part of a Conservation Management System to achieve Planning

Criteria for this resource concern include those listed here.

- 309 Agrichemical Handling Facility
- 371 Air Filtration and Scrubbing
- 591 Amendments for Treatment of Agricultural Waste
- 366 Anaerobic Digester
- 372 Combustion System Improvement
- 328 Conservation Crop Rotation
- 340 Cover Crop
- 375 Dust Control from Animal Activity on Open Lot Surfaces
- 373 Dust Control on Unpaved Roads and Surfaces
- 512 Forage and Biomass Planting
- 595 Integrated Pest Management
- 441 Irrigation System, Microirrigation
- 443 Irrigation System, Surface and Subsurface
- 449 Irrigation Water Management
- 590 Nutrient Management
- 338 Prescribed Burning
- 329 Residue and Tillage Management, No Till
- 345 Residue and Tillage Management, Reduced Till
- 442 Sprinkler System
- 633 Waste Recycling
- 632 Waste Separation Facility
- 313 Waste Storage Facility
- 634 Waste Transfer
- 629 Waste Treatment
- 359 Waste Treatment Lagoon

Exhibit 5-5: Example of a "T Chart"

Conservation Practice Effects

Conservation Cover (Ac) 327

Definition: Establishing and maintaining permanent vegetative cover

Major Resource Concerns Addressed: Soil Erosion and Water Quality.

Benchmark Condition: Annually tilled highly erodible low productivity cropland.

Date: October, 2016 **Developer/Location:** Hal Gordon, OR

Positive Effects	Negative Effects
<p>Soil</p> <ul style="list-style-type: none"> • Increased vegetation and cover will improve infiltration and decrease sheet and rill, wind, and gully erosion. • Streambank, shoreline, and channel erosion is reduced. • Organic matter will increase with residue and root establishment. • Compaction and subsidence is will decrease with fewer field operations. • Concentration of salts or other chemicals is reduced with permanent cover. <p>Water</p> <ul style="list-style-type: none"> • Runoff, flooding, ponding, seeps or seasonal high water table may be reduced with increased water use. • Permanent vegetation can trap snow. • Soil moisture will increase. • Reduced nutrient and pesticide use, less transport to surface and ground water. • Less runoff and infiltration of salts, pathogens and chemicals from manure. • Less sediment in surface water. <p>Air</p> <ul style="list-style-type: none"> • Fewer emissions of particulate matter, permanent vegetation reduces wind erosion and generation of fugitive dust. • Emissions of ozone precursors and CO2 will be reduced with less machinery use. <p>Plants</p>	<p>Land</p> <ul style="list-style-type: none"> • Land use will be changed or land taken out of production if cropland is converted to permanent cover. <p>Capital</p> <ul style="list-style-type: none"> • No additional field equipment required. • Materials, seedbed and planting costs. • Annual operation and maintenance costs to maintain vegetation and reduce pests. • Reduced farm income (forgone income). <p>Labor</p> <ul style="list-style-type: none"> • None. <p>Management</p> <ul style="list-style-type: none"> • None. <p>Risk</p> <ul style="list-style-type: none"> • Reduced whole farm flexibility and timing by taking land out of agricultural production. • Reduced or lost crop production. • Reduced cash flow. • Seeps may increase with deeper and more numerous roots and higher soil infiltration rates.

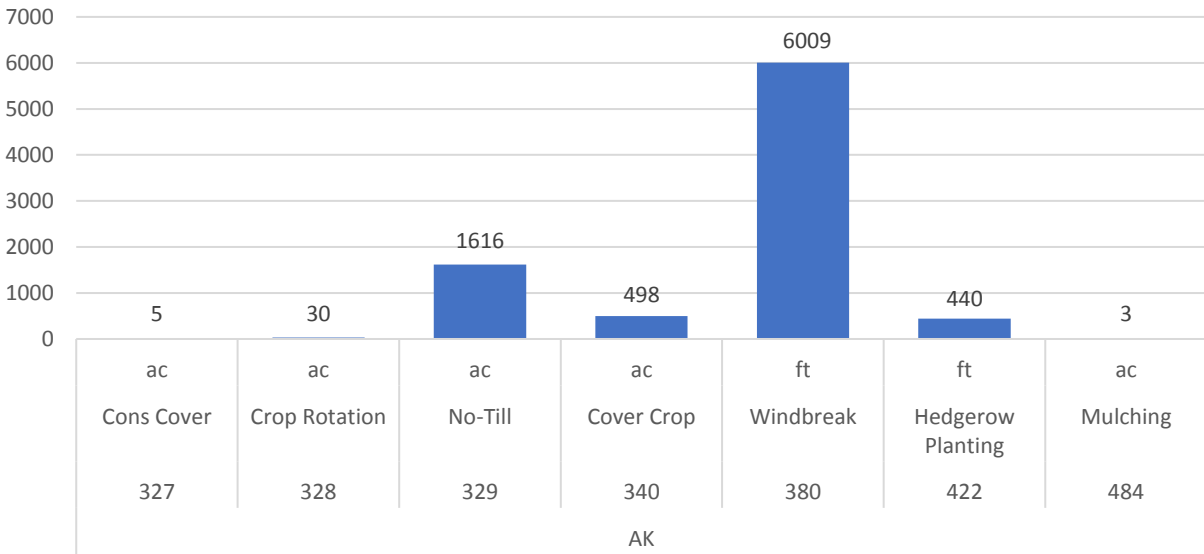
<ul style="list-style-type: none"> • Plant community productivity and health will increase. • Permanent vegetation may slow the spread of noxious weeds. <p>Animals</p> <ul style="list-style-type: none"> • Fish and wildlife habitat, food, cover and shelter will improve. • Fish and wildlife habitat continuity (space) will increase and may be used to connect other cover areas. <p>Energy</p> <ul style="list-style-type: none"> • Less fuel and oil will be used with reduced machinery use. <p>Human</p> <ul style="list-style-type: none"> • Cultural resources may be protected from erosion. • Labor, management and capital will decrease as land is taken out of production. • Reduced time cultivating previous crop. • Create sustainability of natural resources that support farm business. • Increase the property value (real estate). • Create open space and improve habitat for wildlife. • Conserve soil and water for periods of drought and future use. • Prevent off-site negative impacts. • Comply with environmental regulations. • Save time, money and labor. • Promote family health and safety. • Make land more attractive and promote good stewardship. • May be eligible for cost share. 	
<ul style="list-style-type: none"> • Net Effect: Soil health will improve, erosion will be reduced and water quality improved at a significant cost. Profitability will decrease as land is taken out of production. 	

Commonly Associated Practices: Brush Management, Critical Area Planting, Fence, Tree/Shrub Establishment, Upland Wildlife Habitat Management

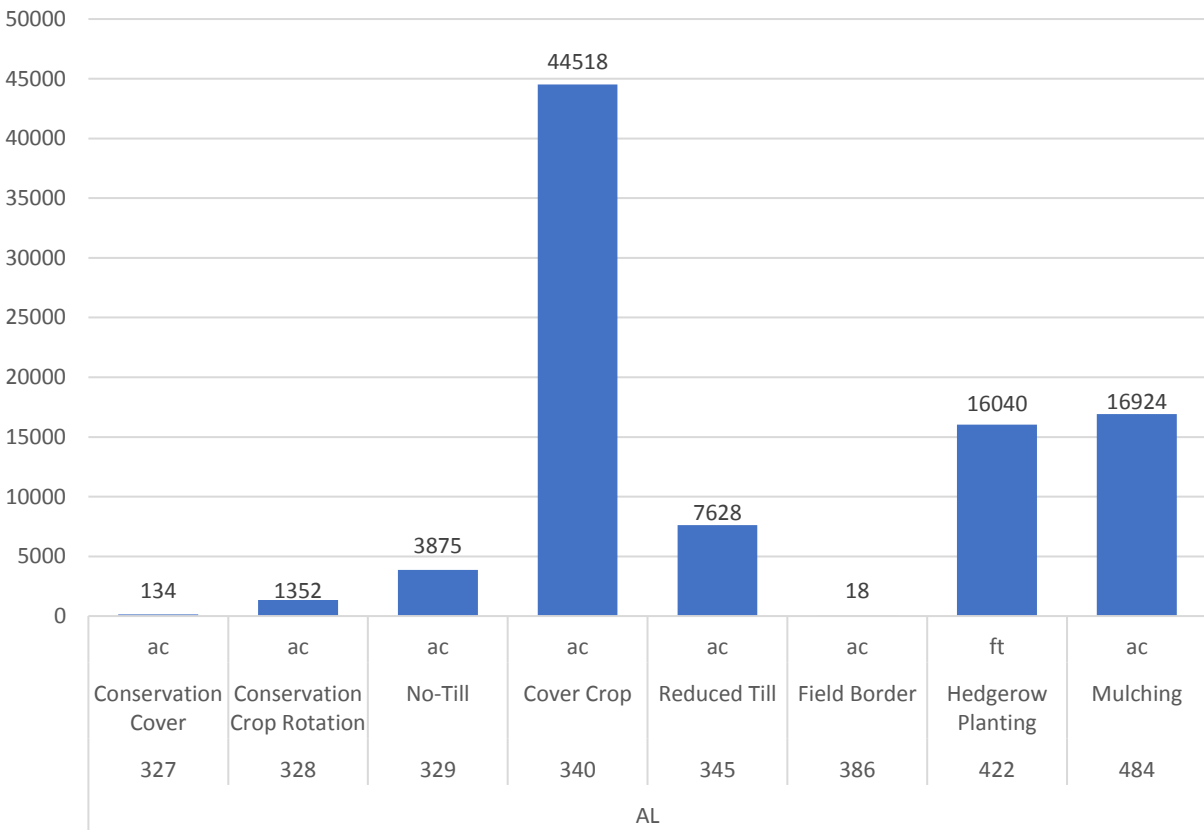
Note: This worksheet contains general talking points for the conservation planner to discuss with the land user. It is the first step towards an economic or financial analysis. The second step would include identifying a specific site for analysis at the farm or field level, editing the template for local conditions, and adding units and quantities of farm inputs and outputs. The third step in the economic analysis is to place a dollar value on as many variables as possible, and put all units in the same time frame using amortization (\$/Acres/Year) or net present value (\$/Acre), so that benefits and costs can be compared. The fourth and final step would be to combine several conservation practices into a conservation system, which is how most conservation practices are applied at the field level. Data for the worksheet comes from the land user, conservation planner, technical specialist, and local agricultural supply vendors and contractors. See Economics Technical Note: TN 200-ECN-1, Basic Economic Analysis Using T-Charts (August 2013) for more information.

Exhibit 6-1: Cropland Wind Erosion Practices by State

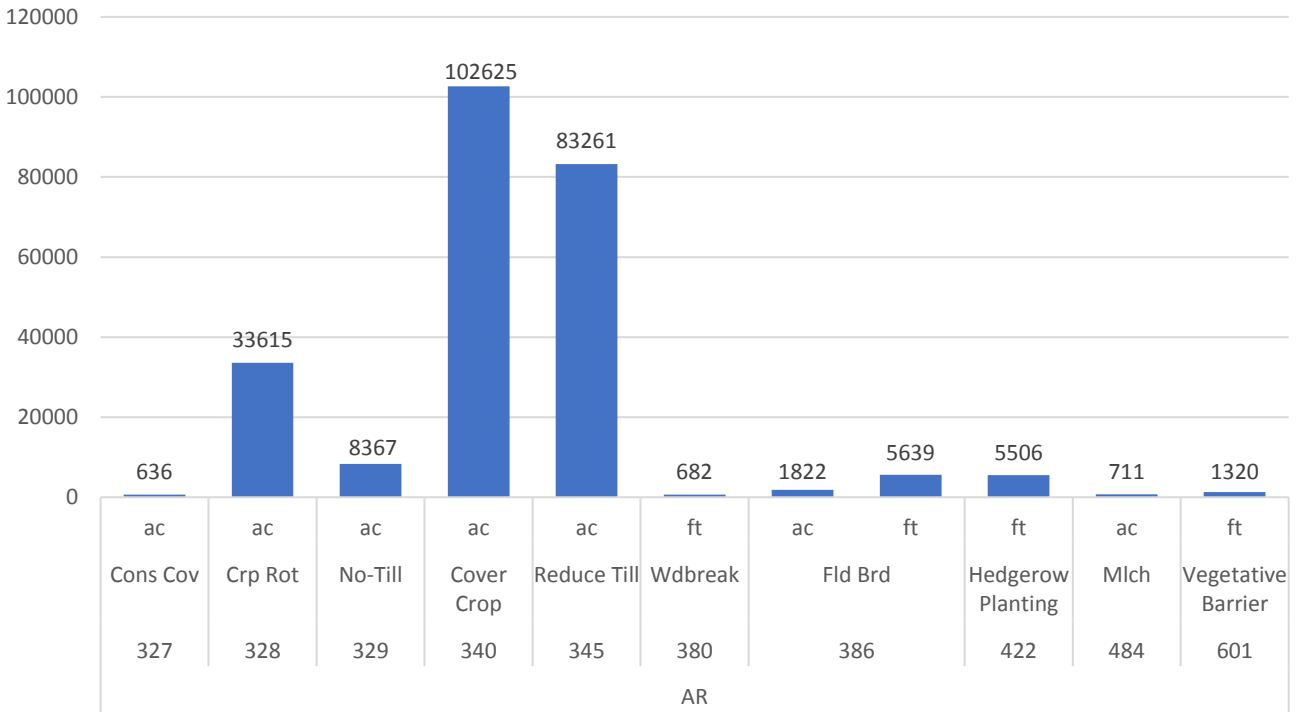
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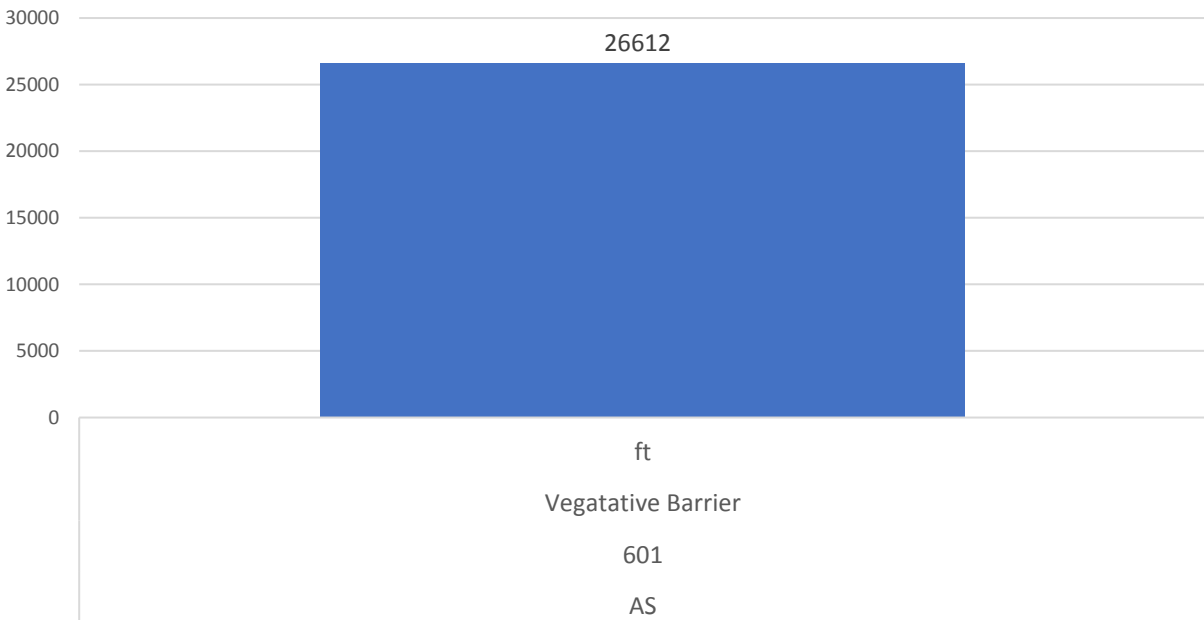
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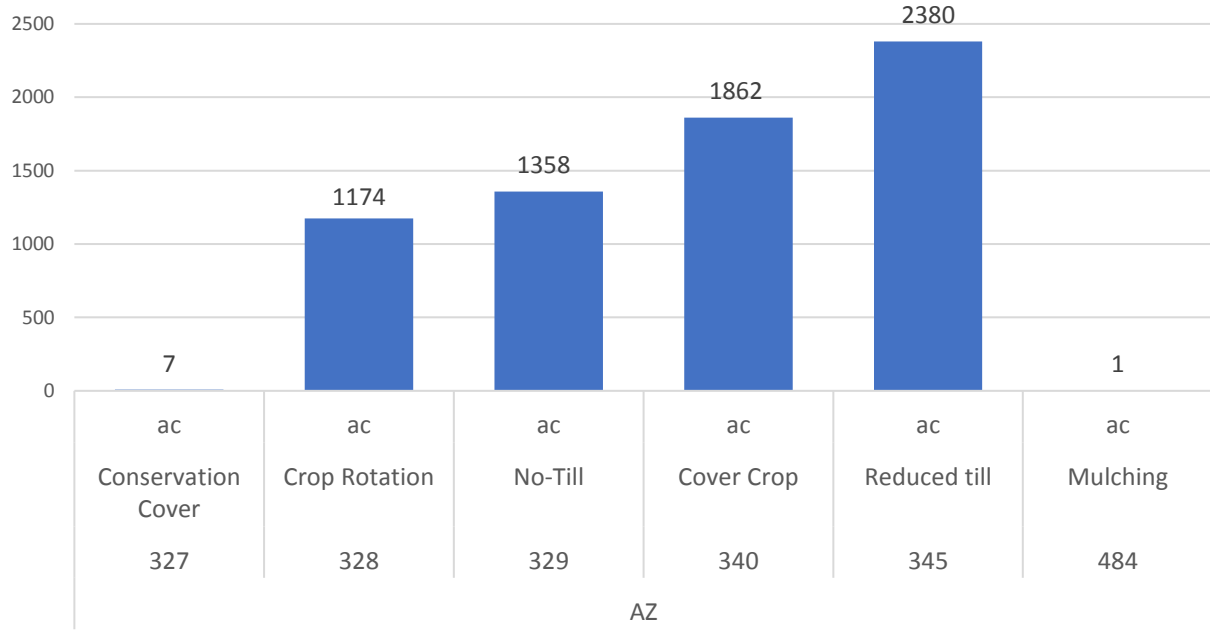
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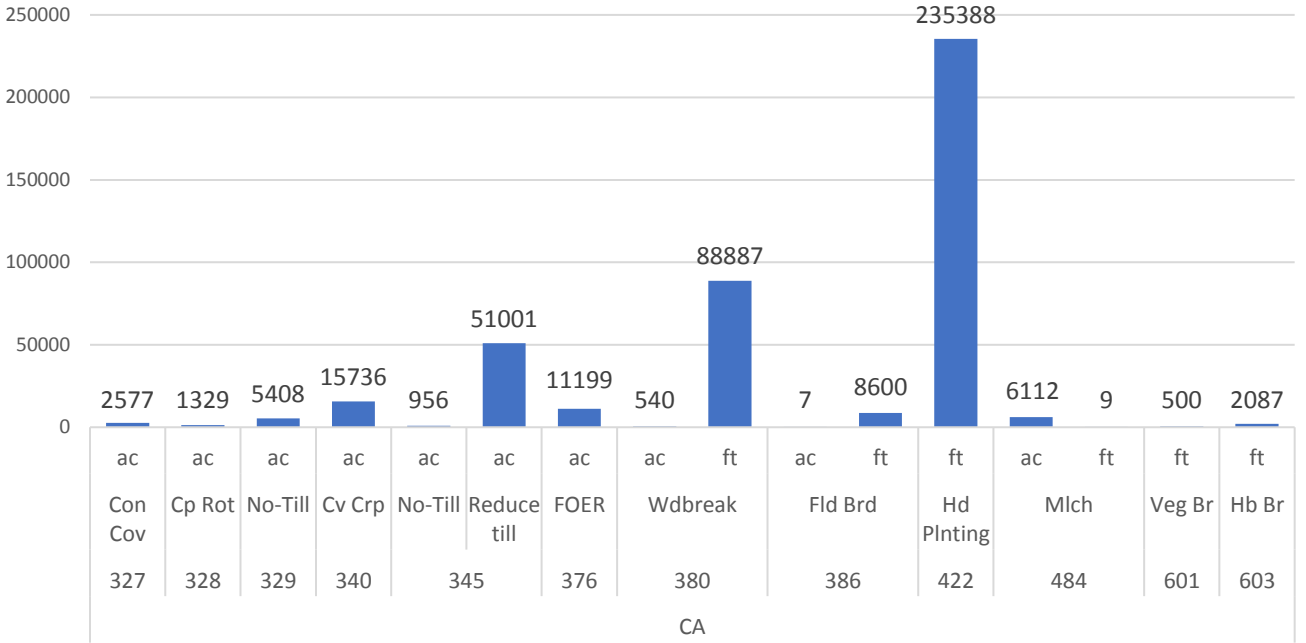
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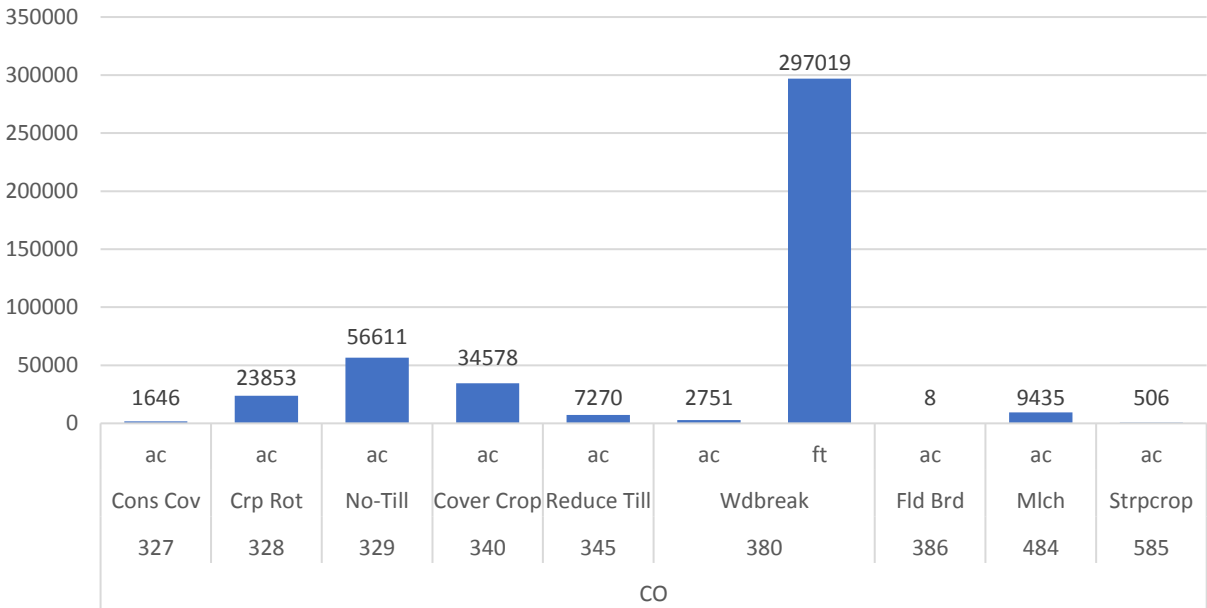
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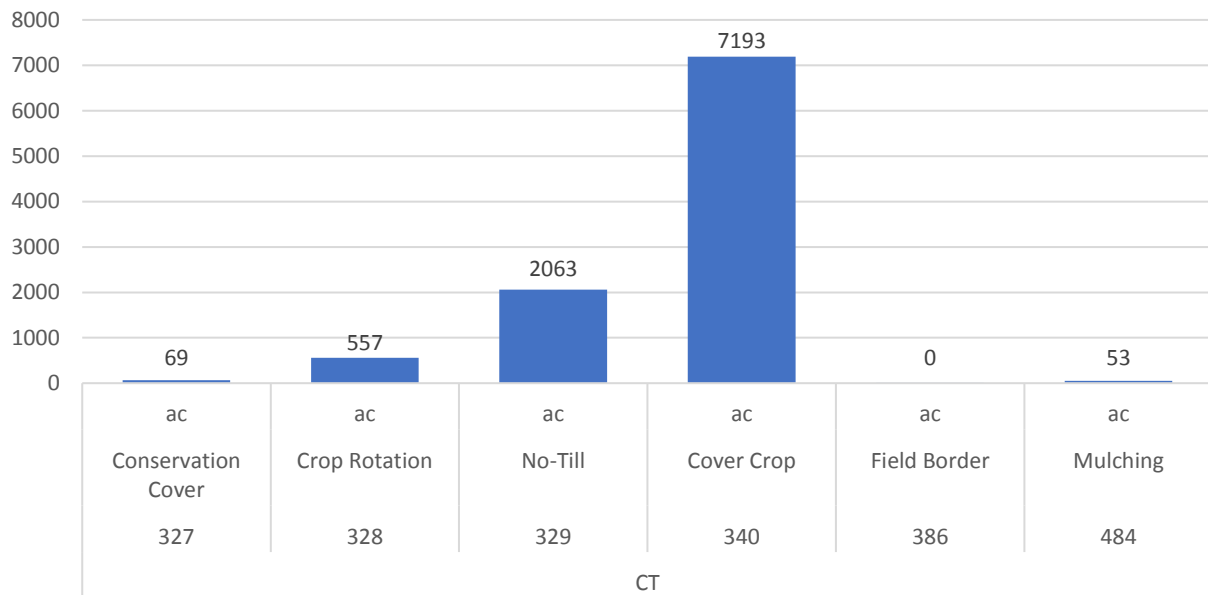
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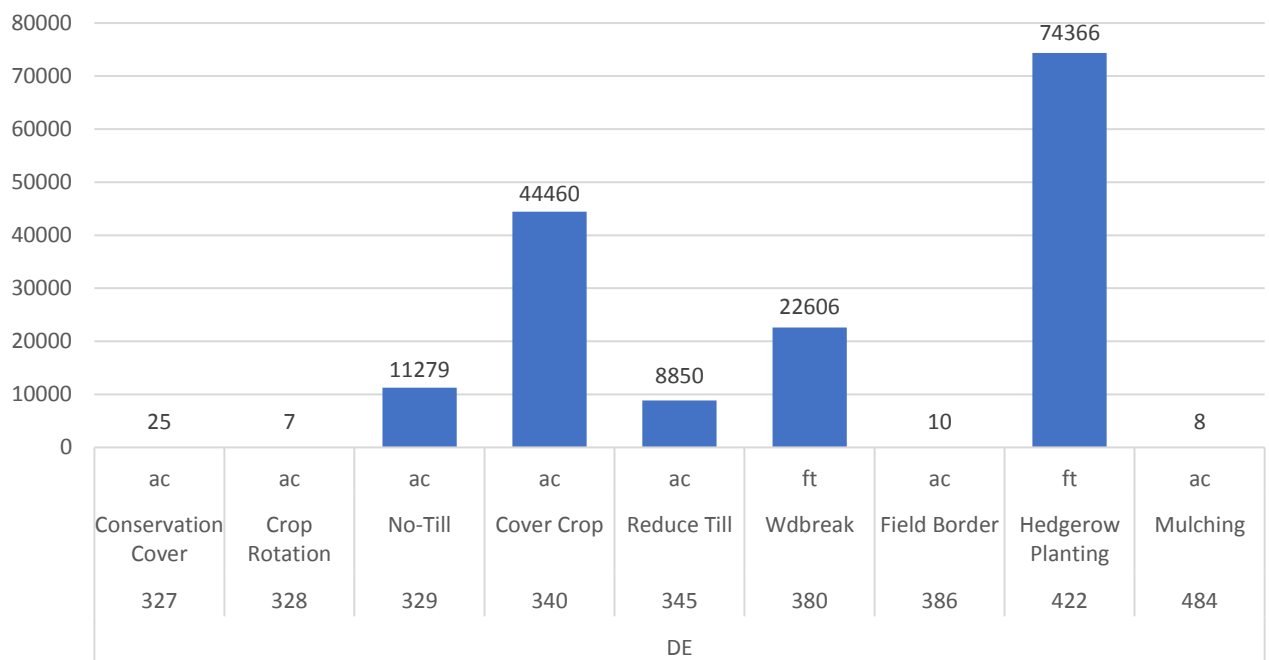
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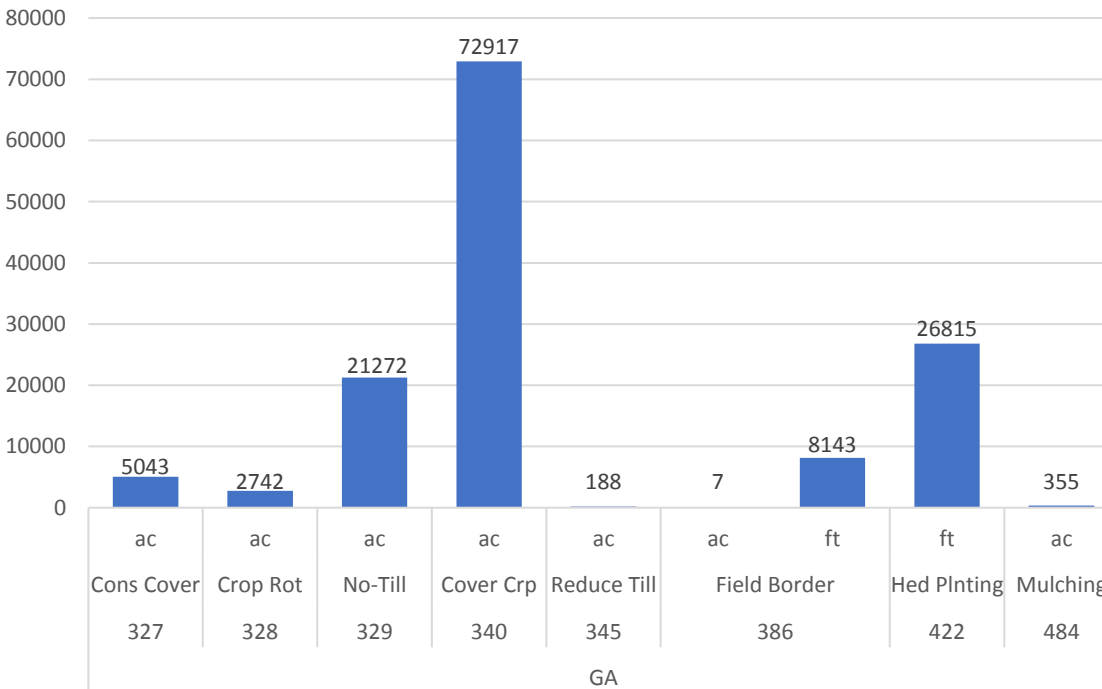
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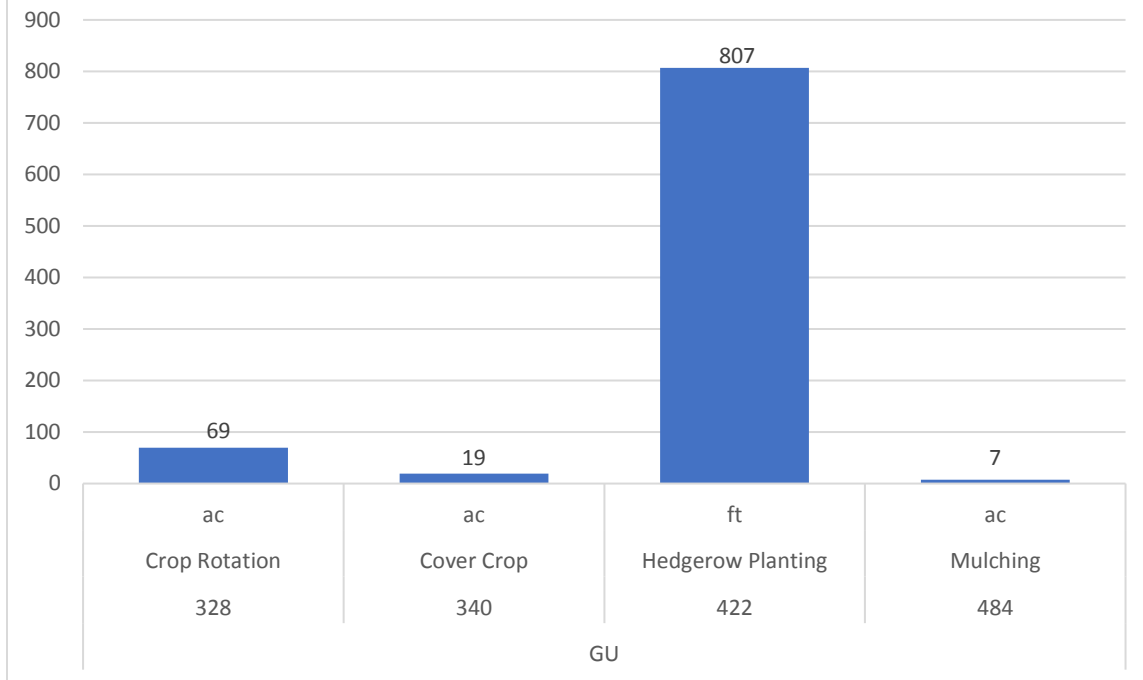
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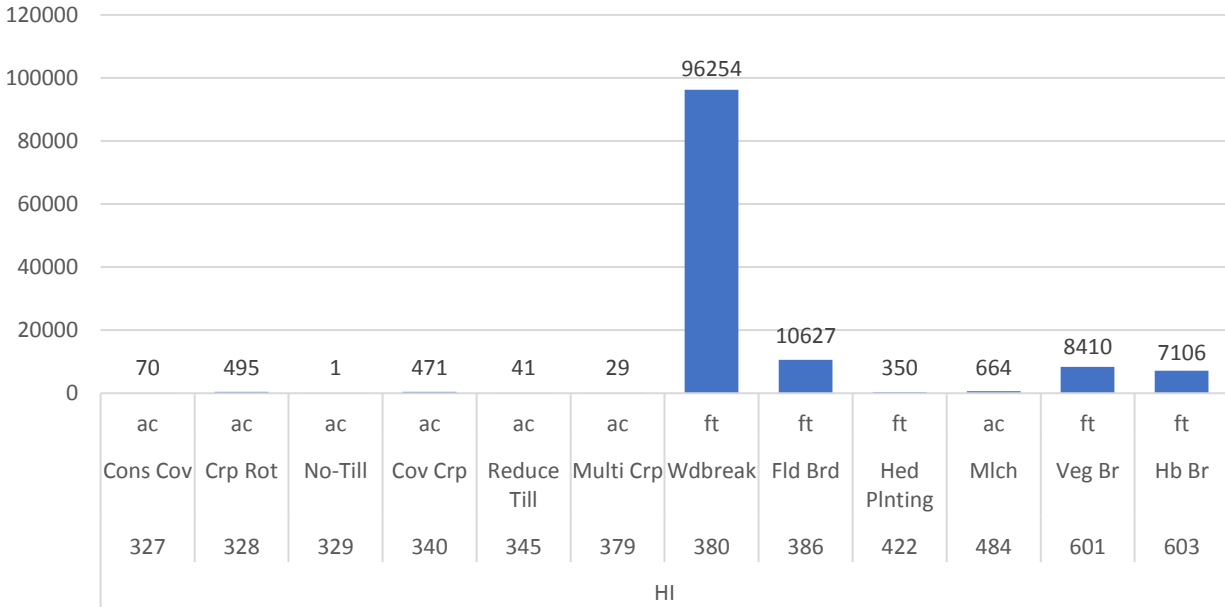
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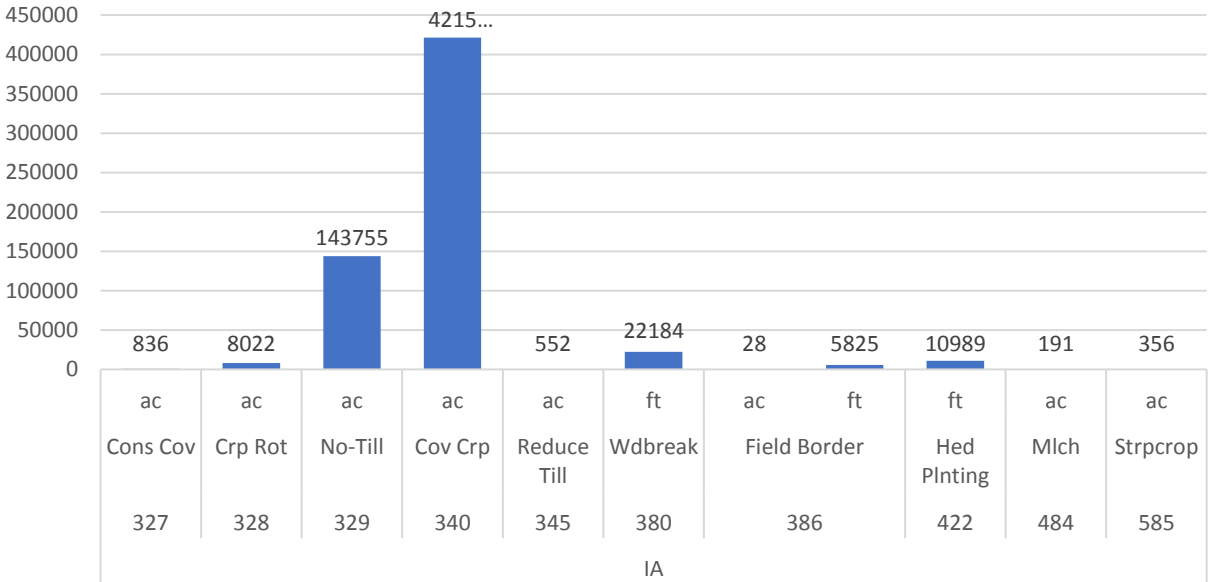
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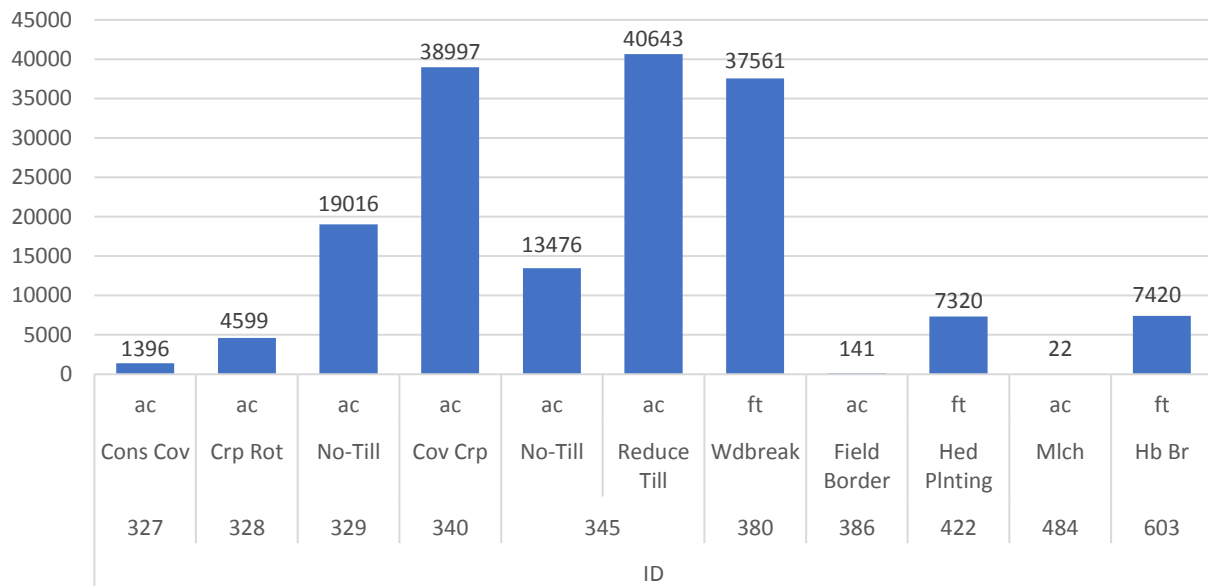
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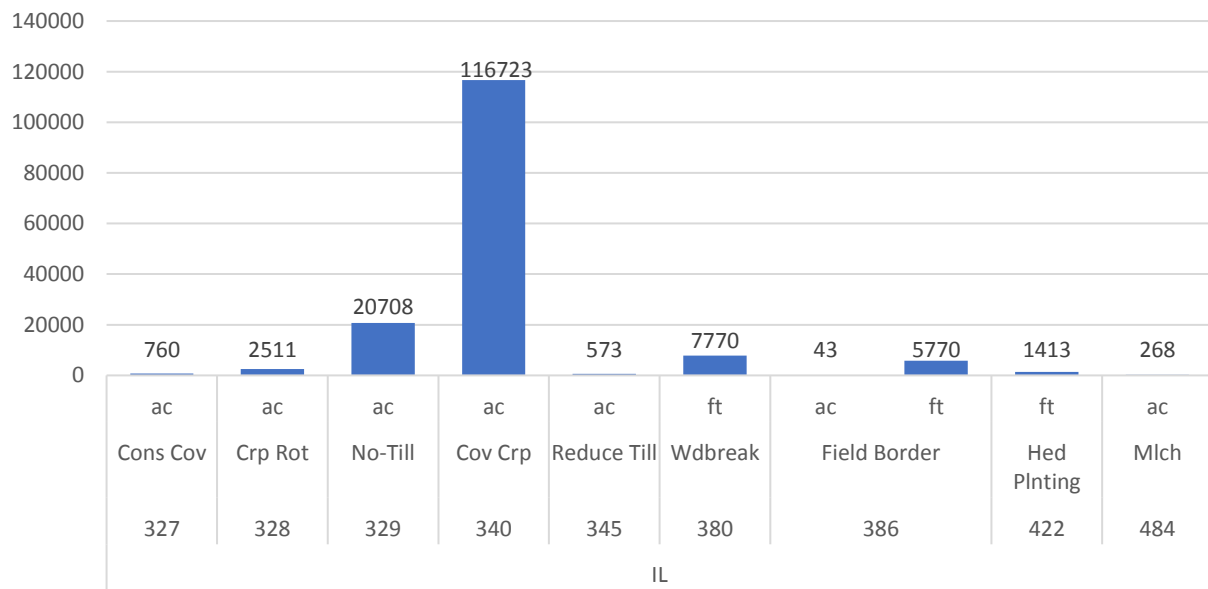
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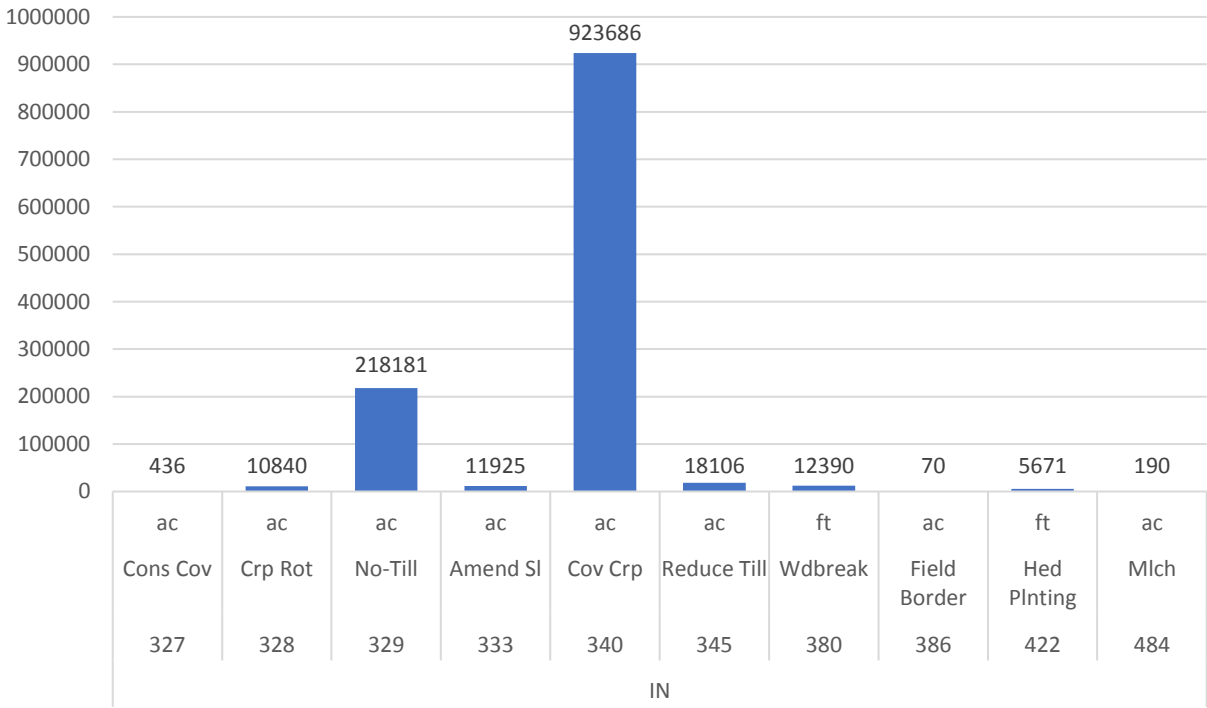
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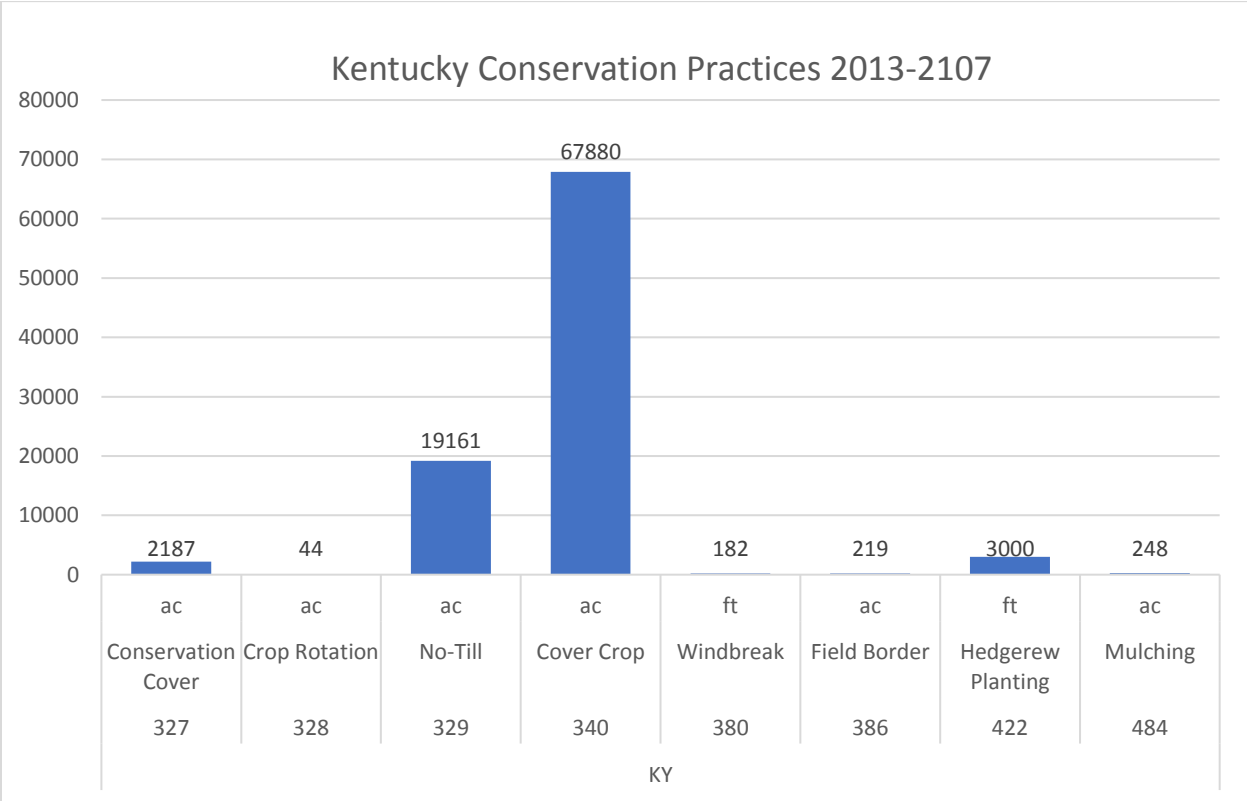
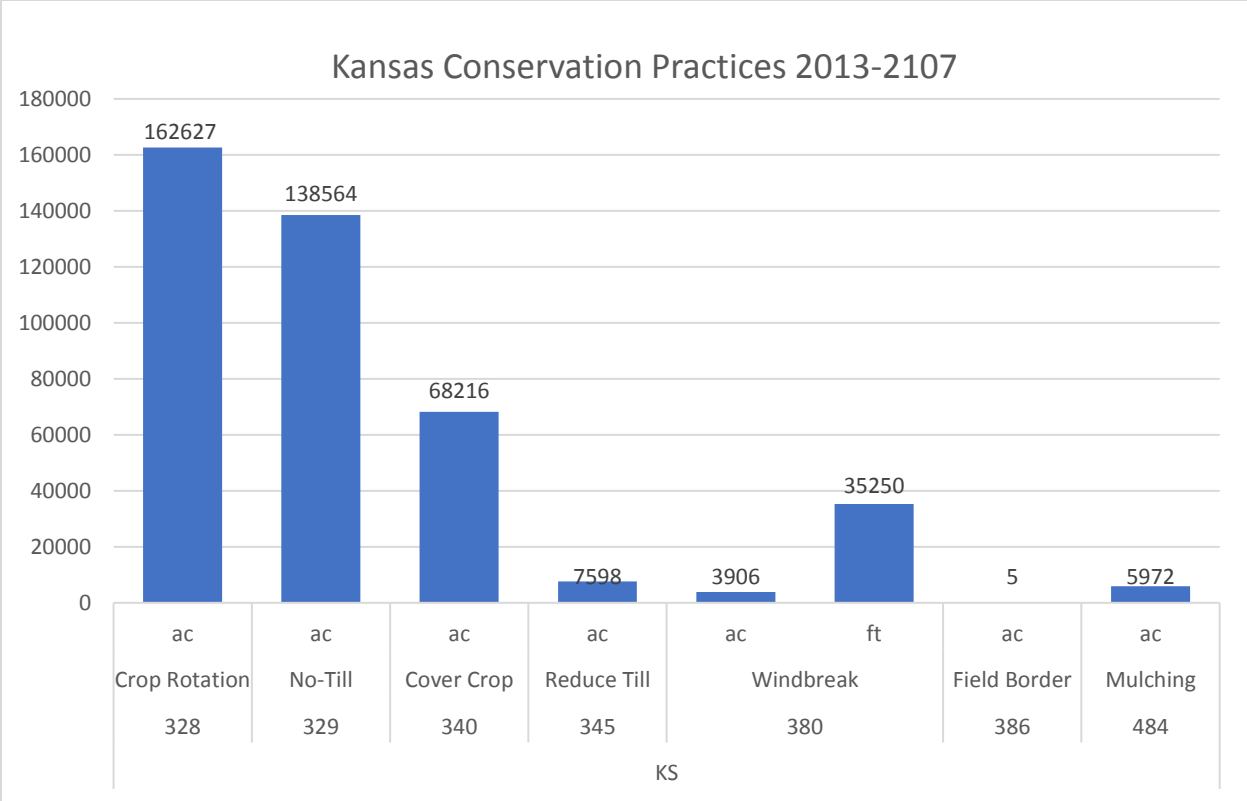


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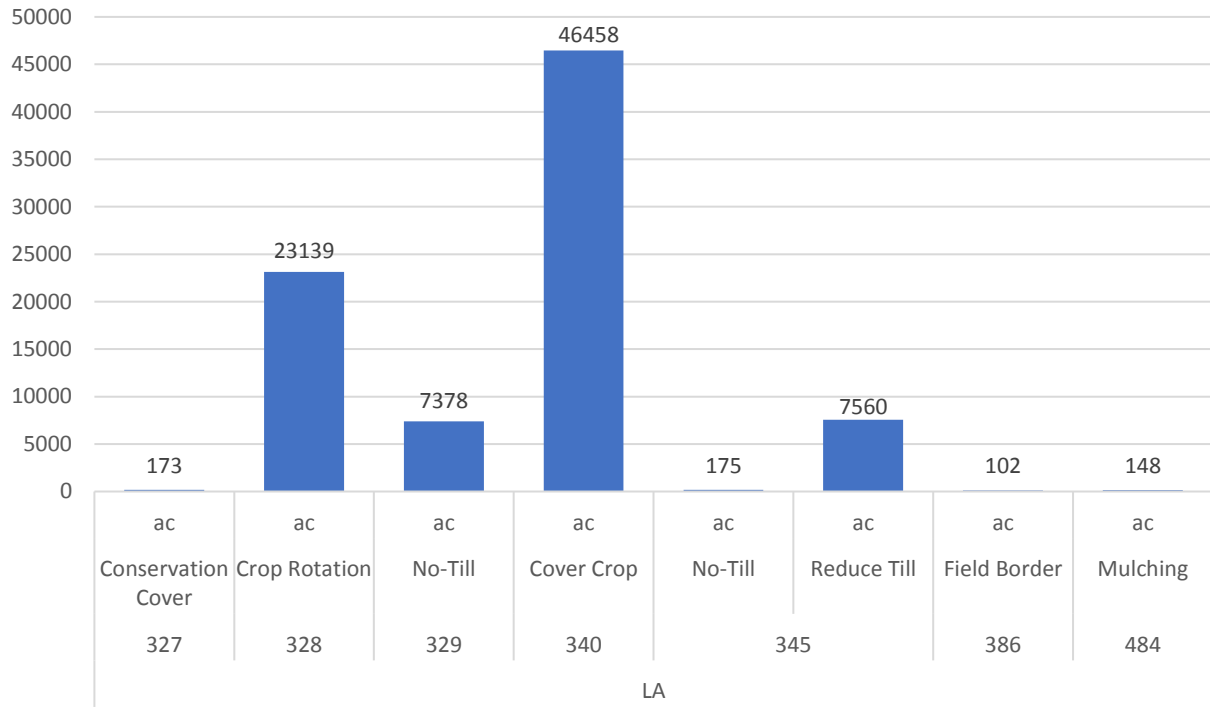


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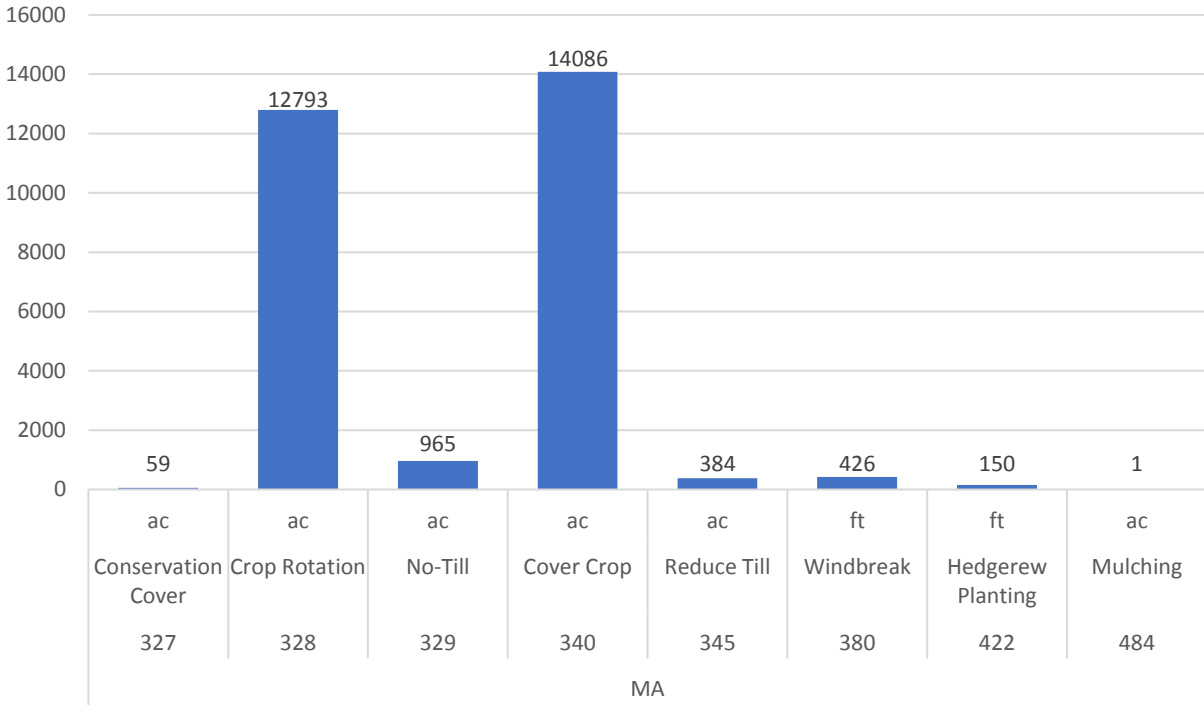




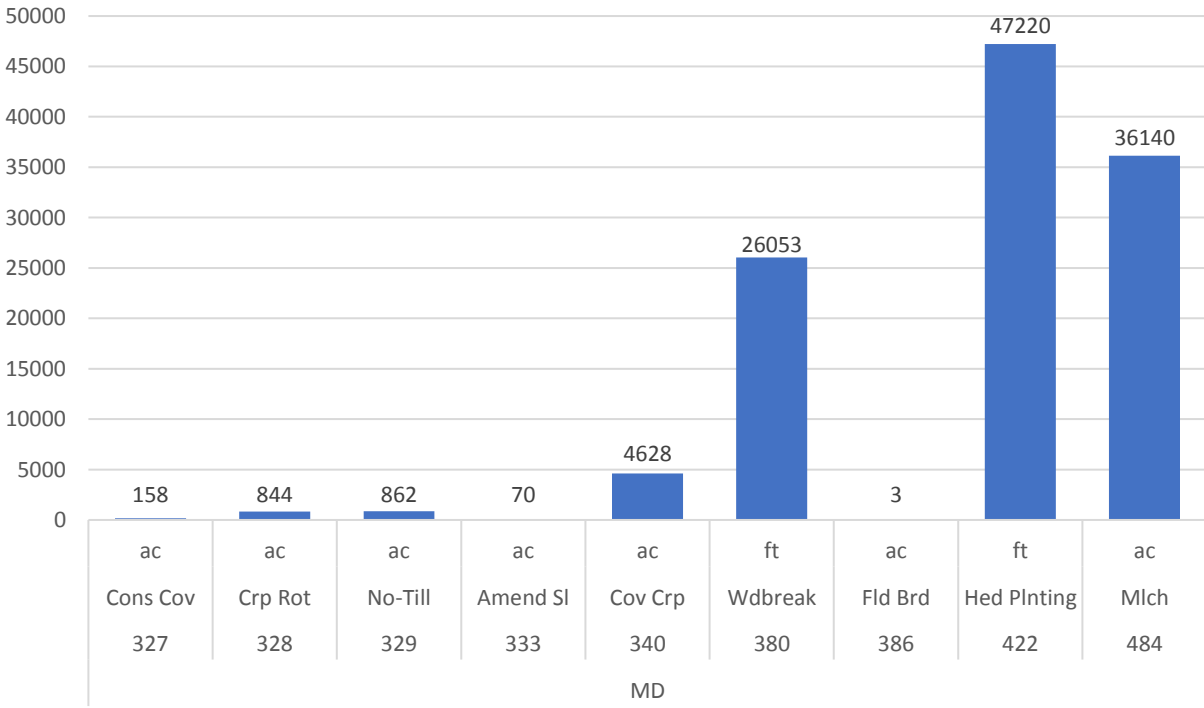
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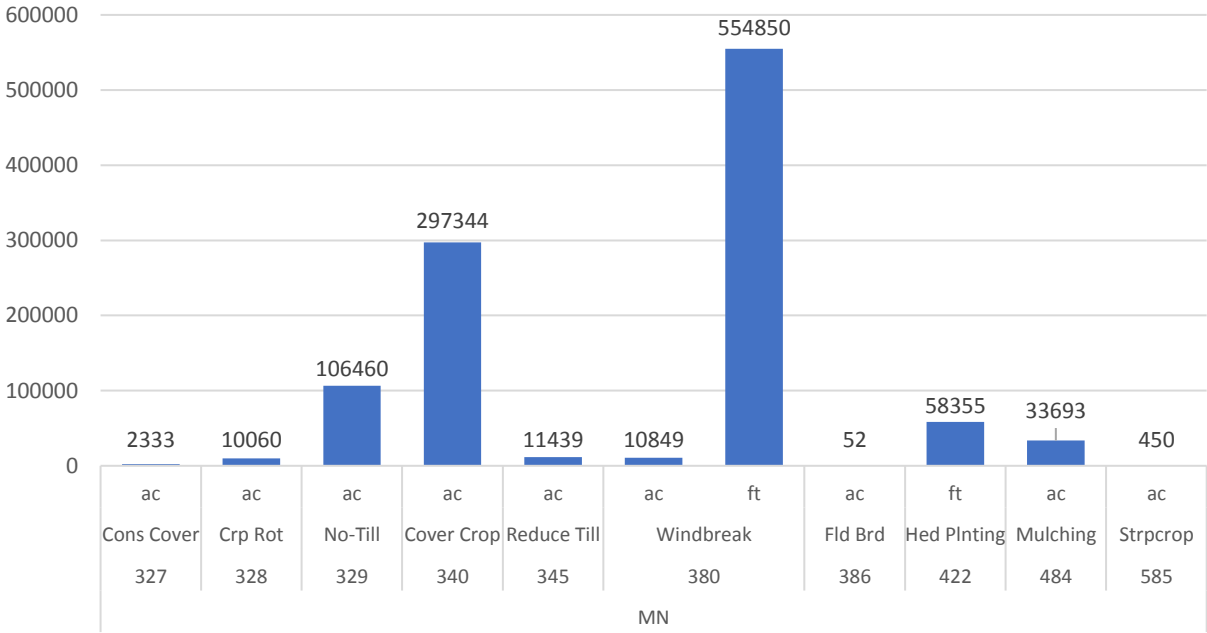
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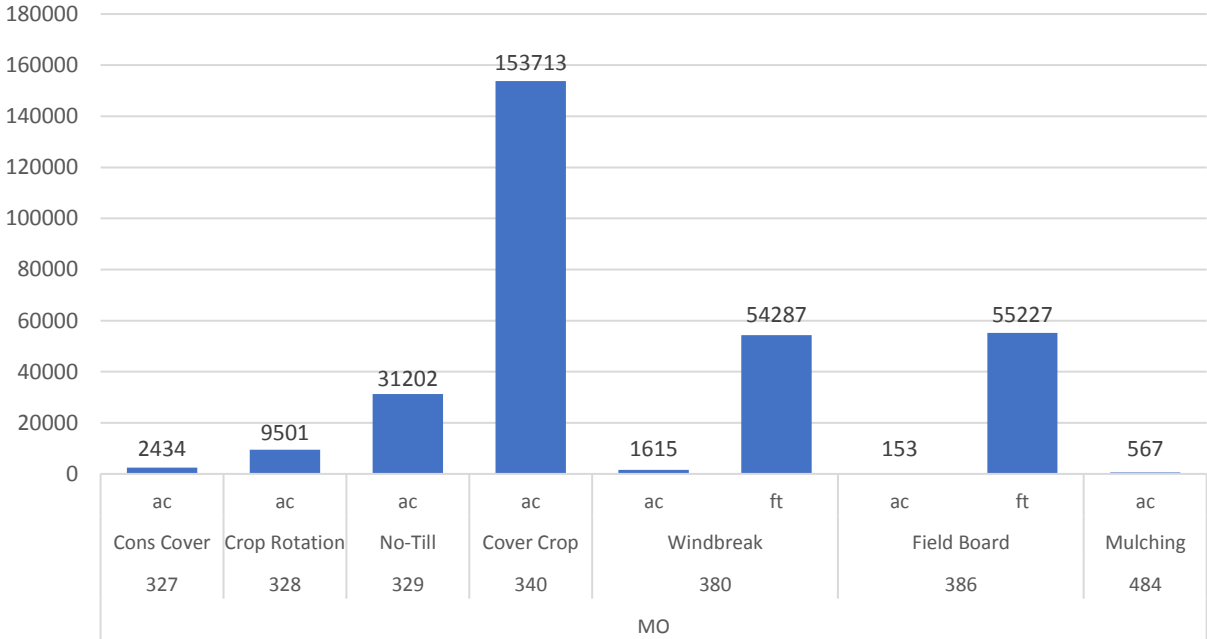
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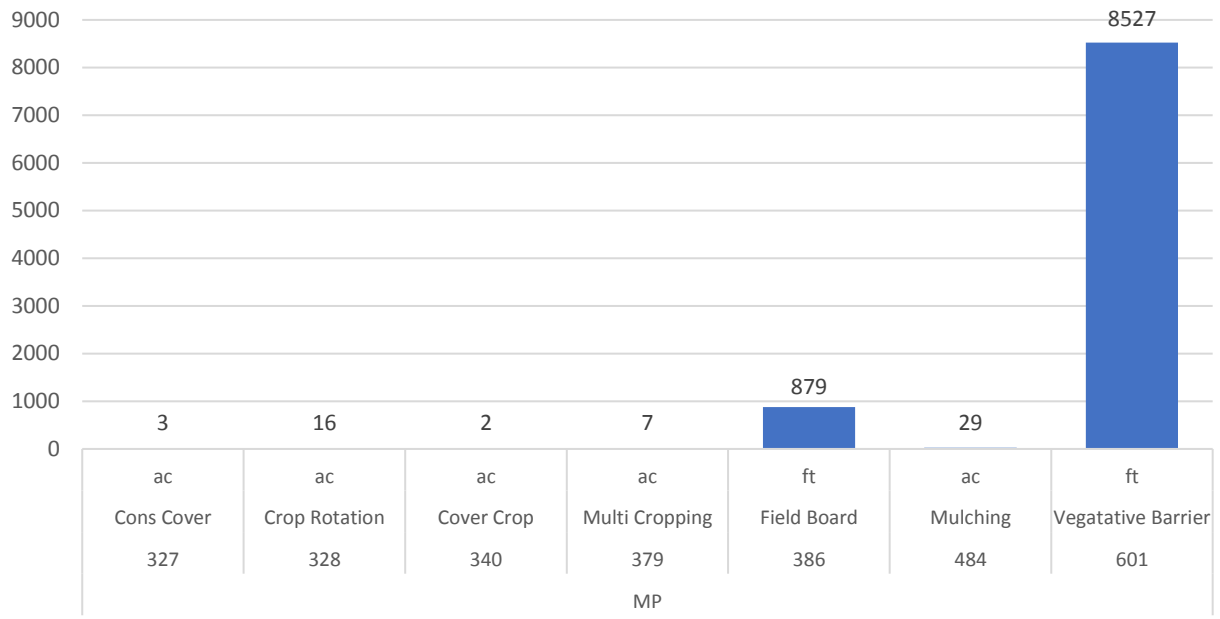
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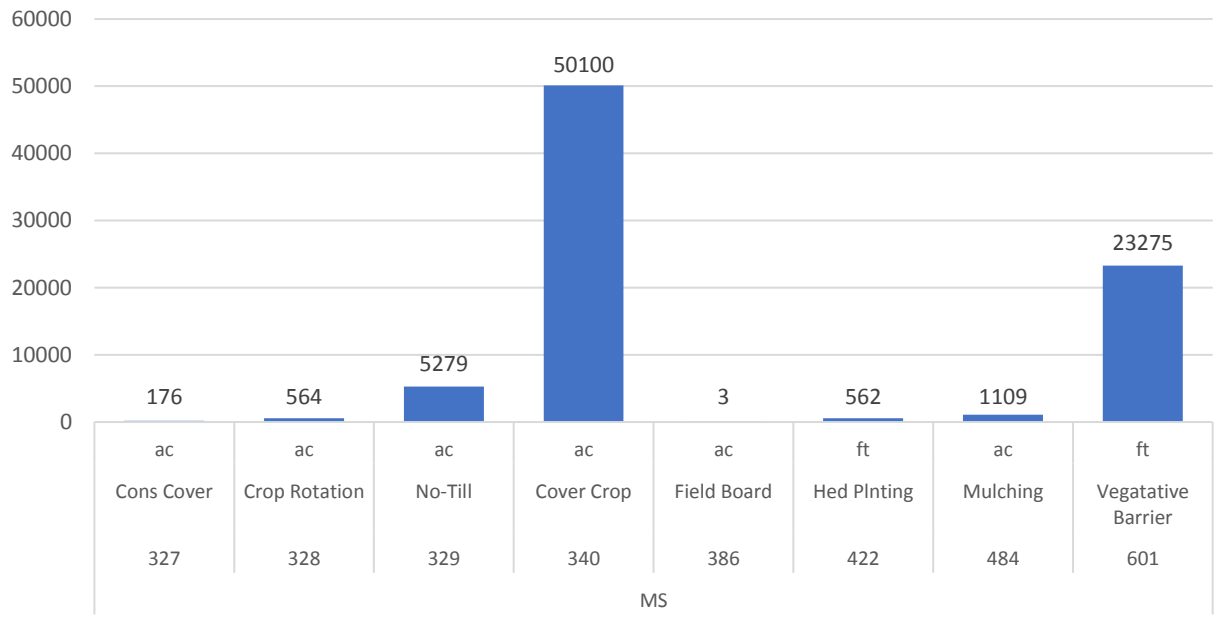
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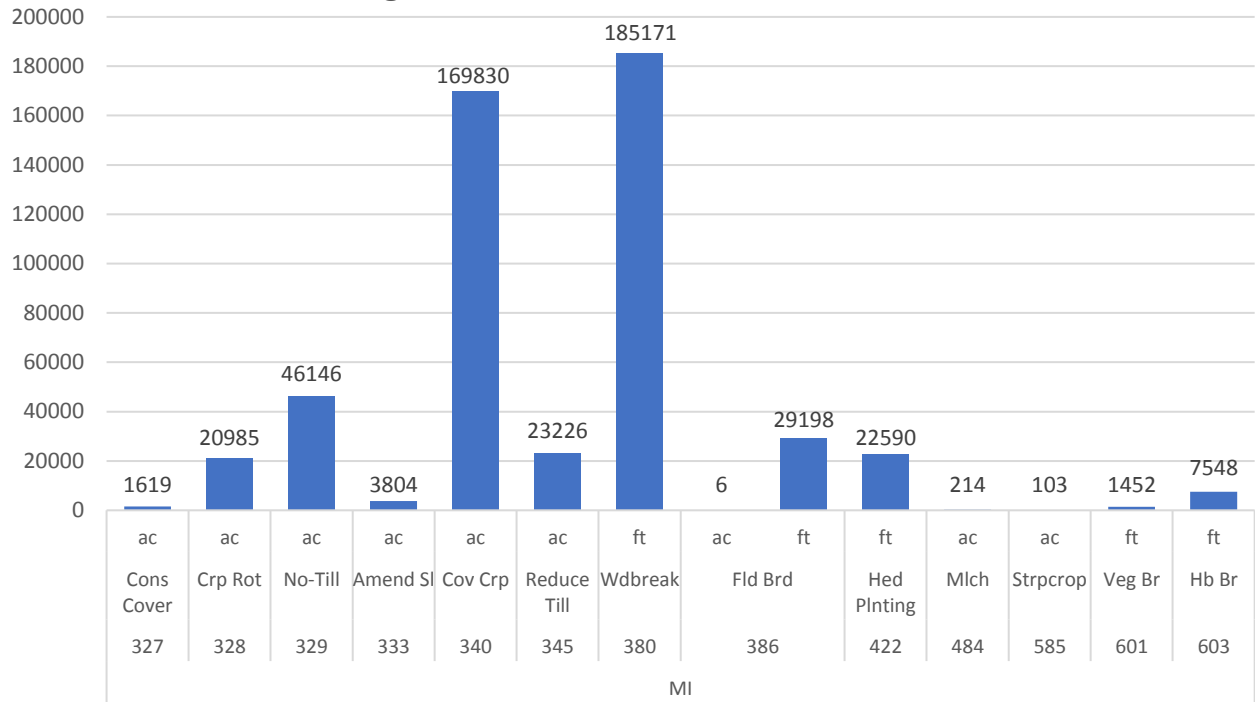
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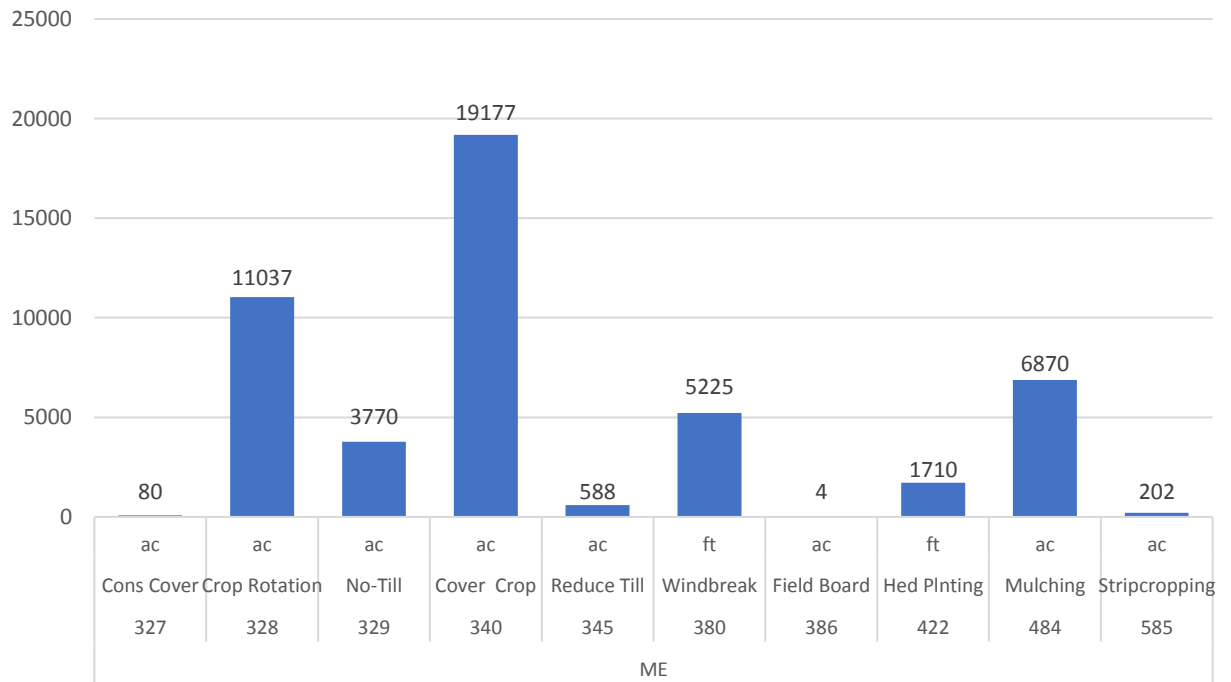
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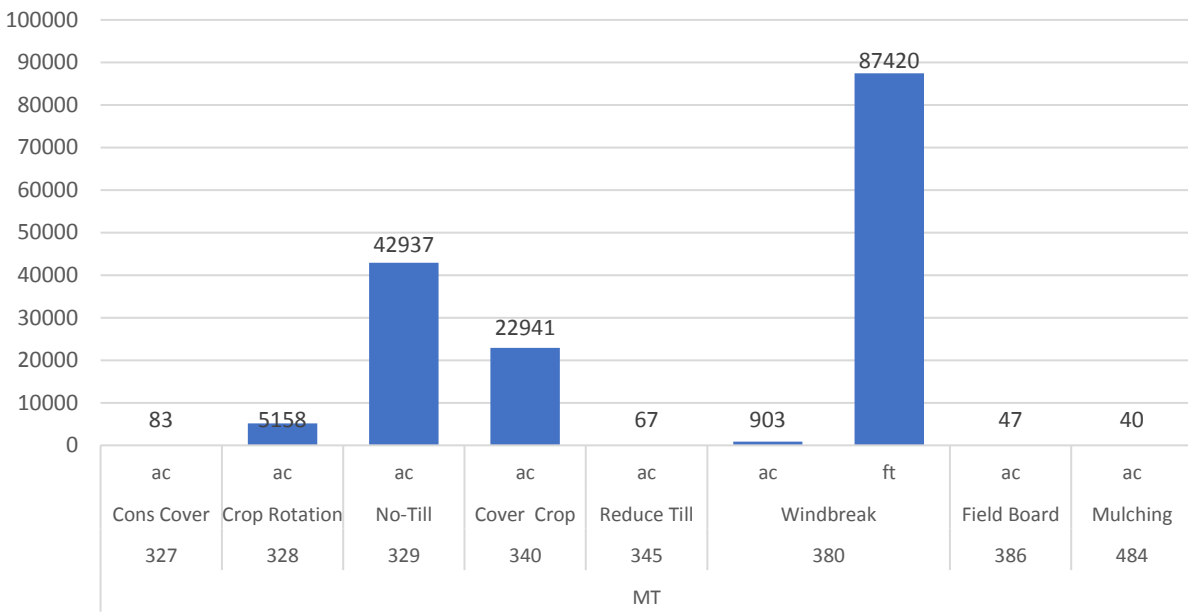
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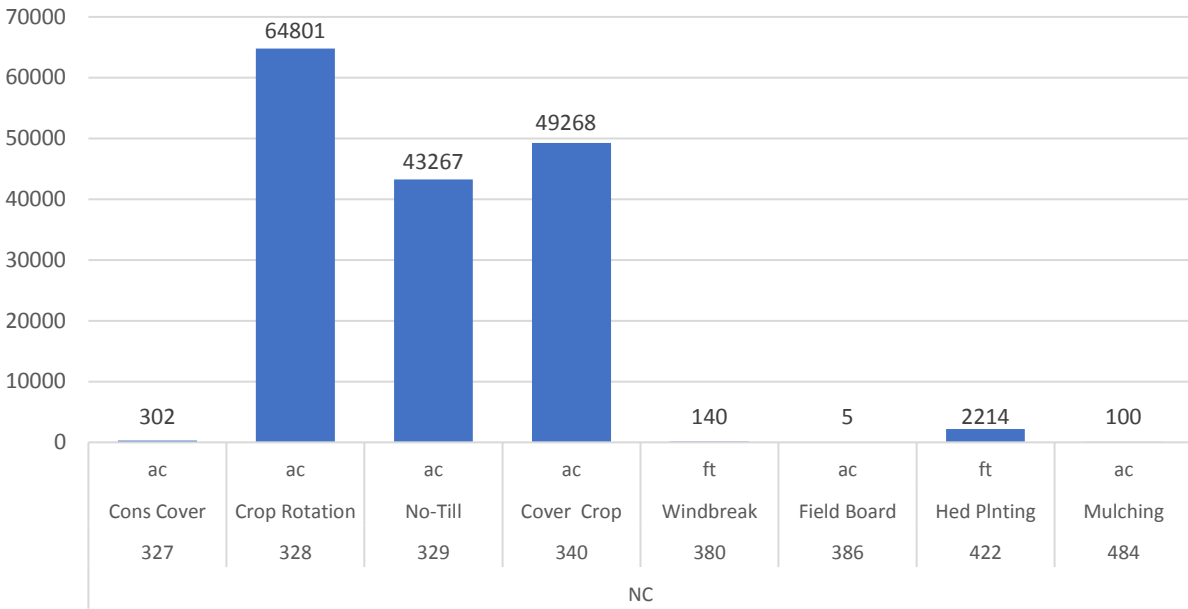
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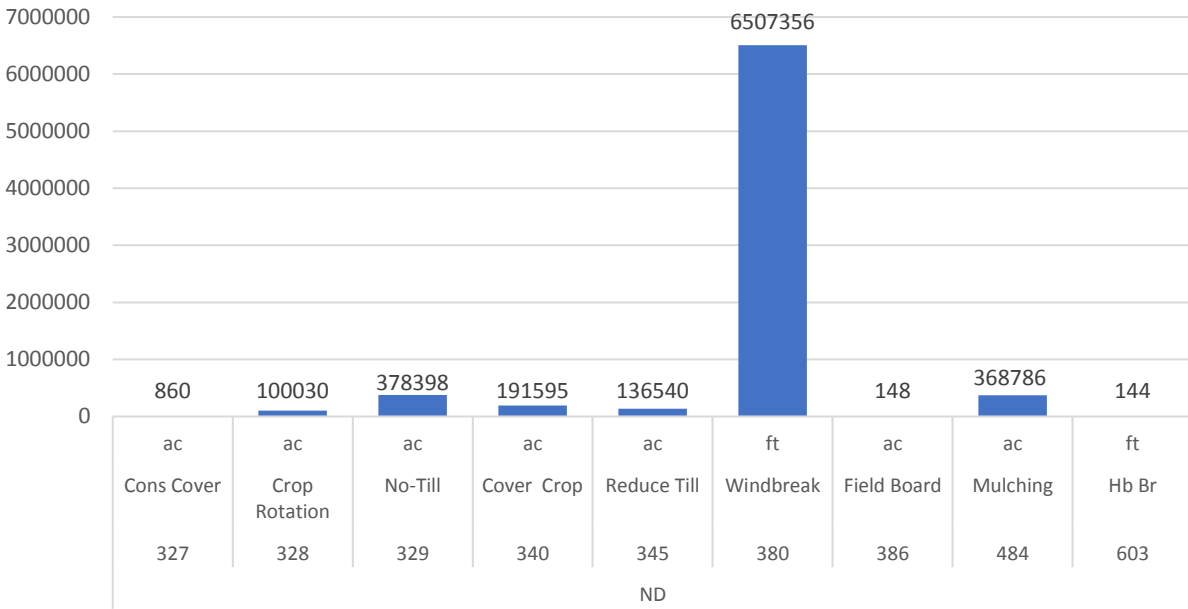
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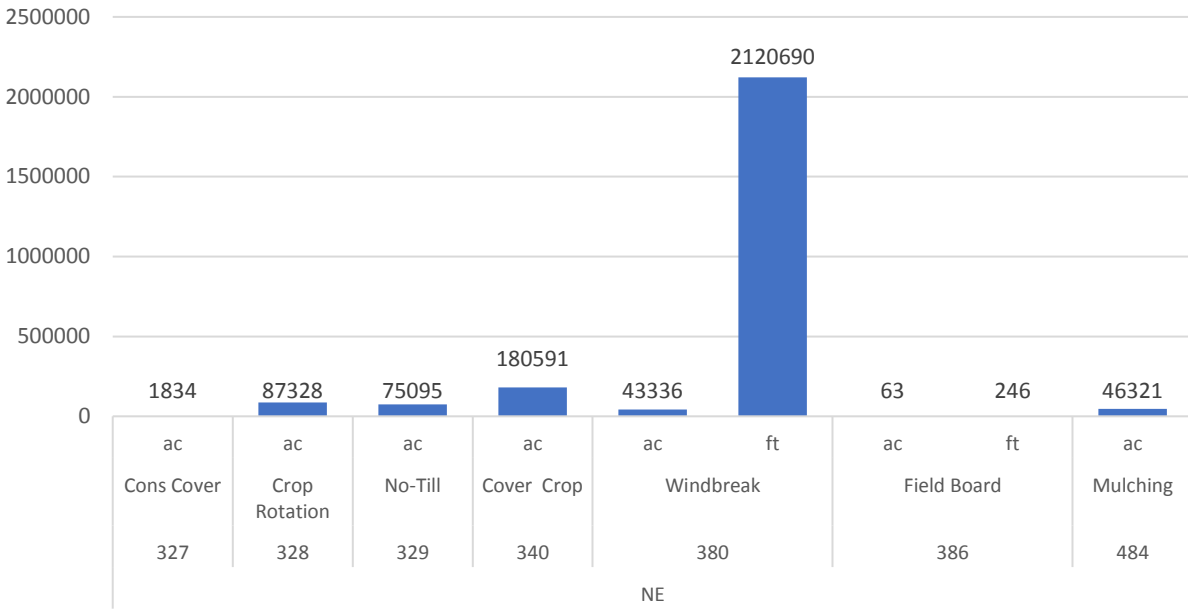
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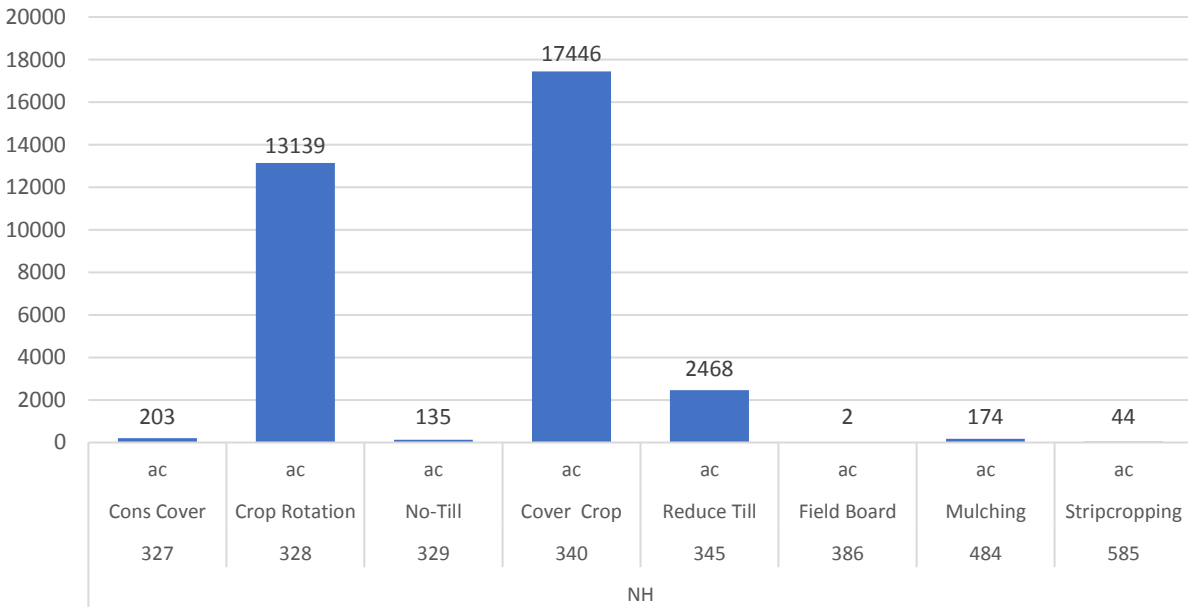
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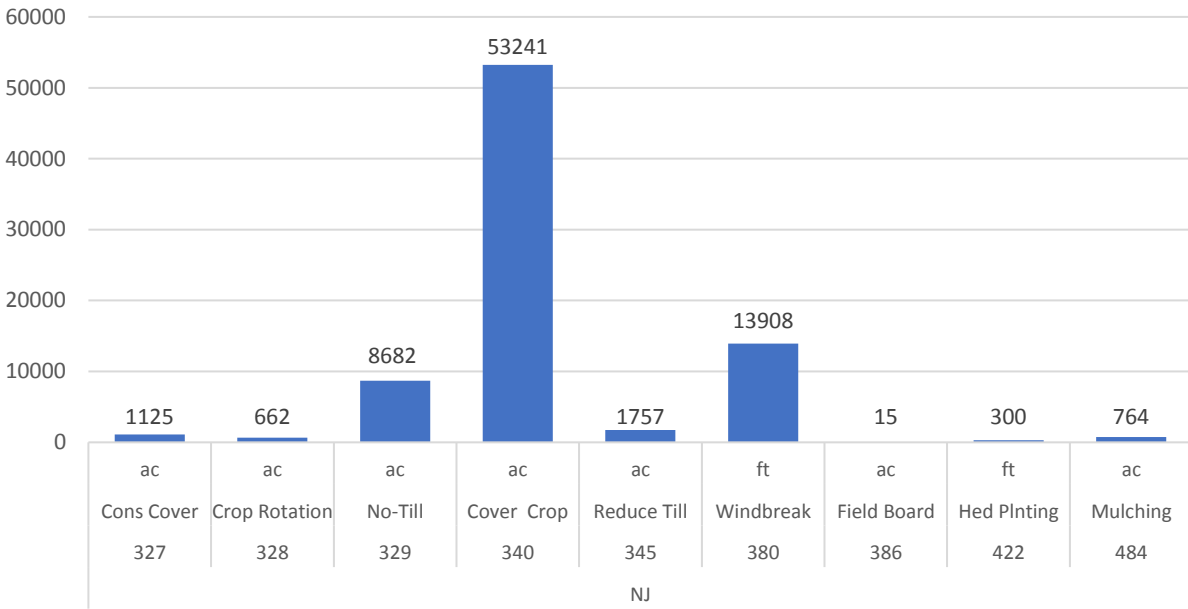
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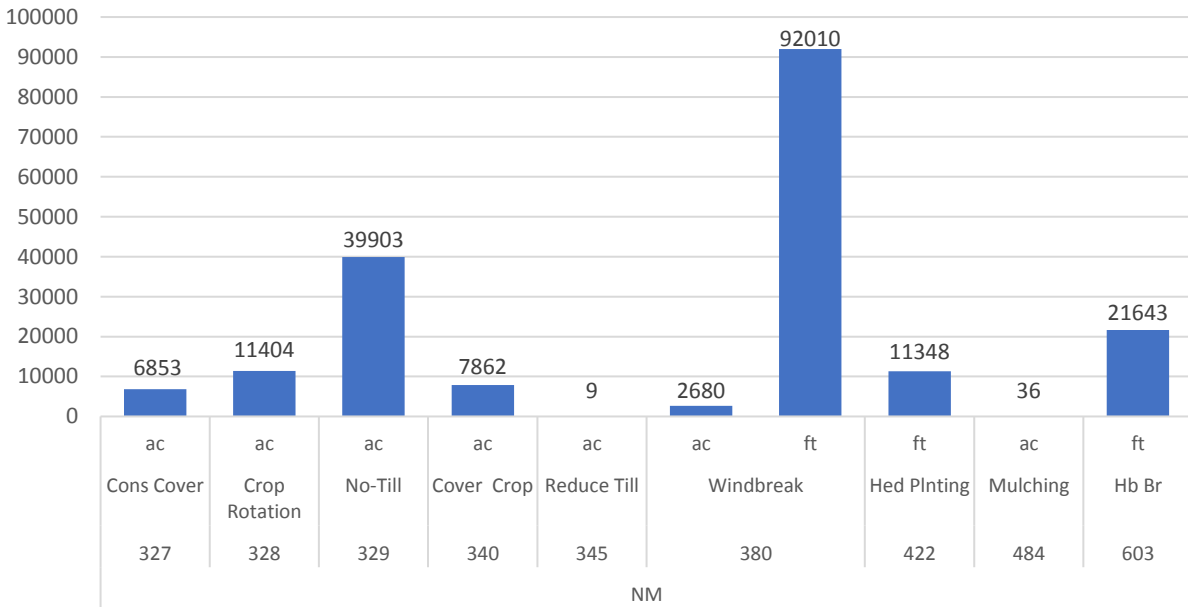
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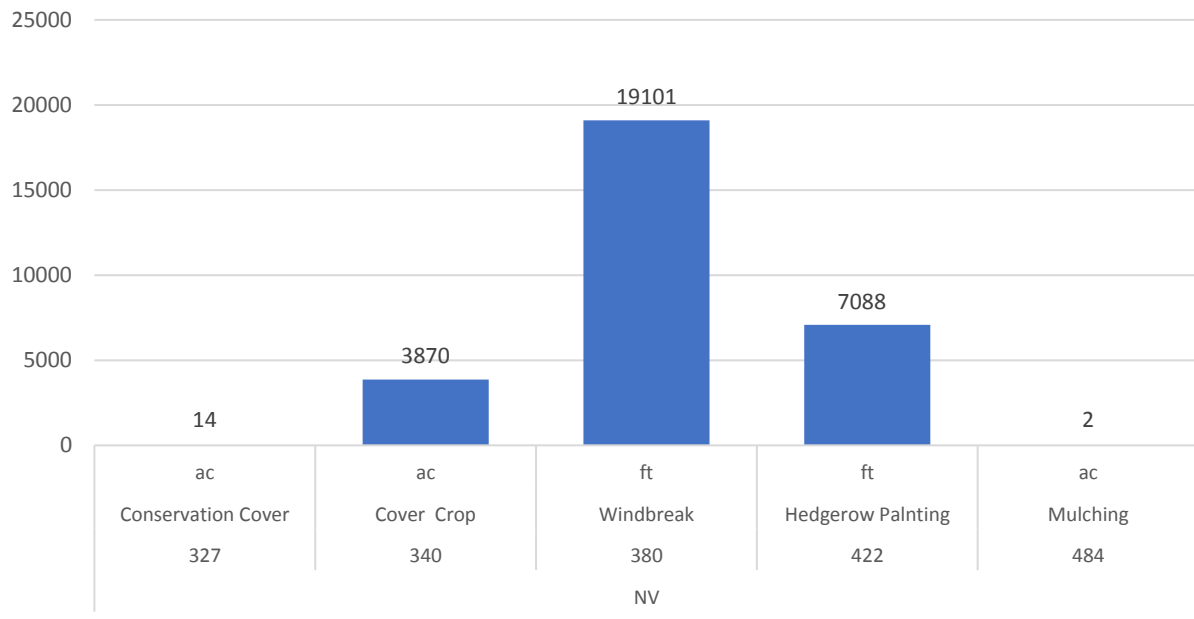
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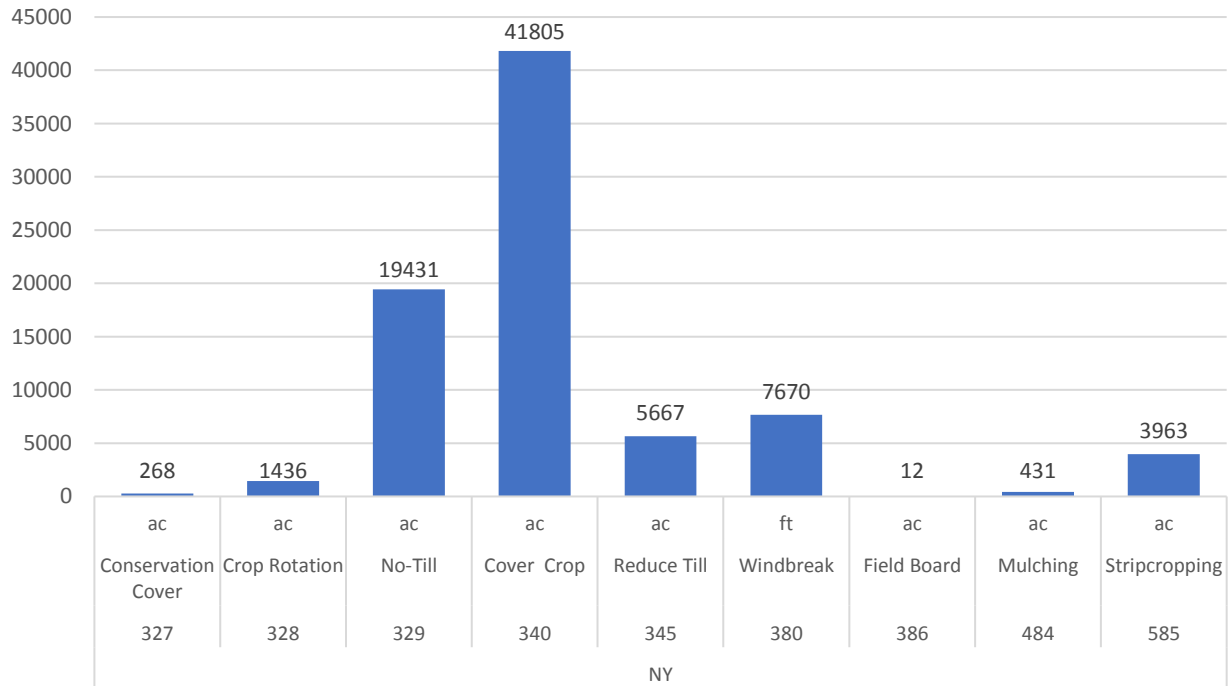
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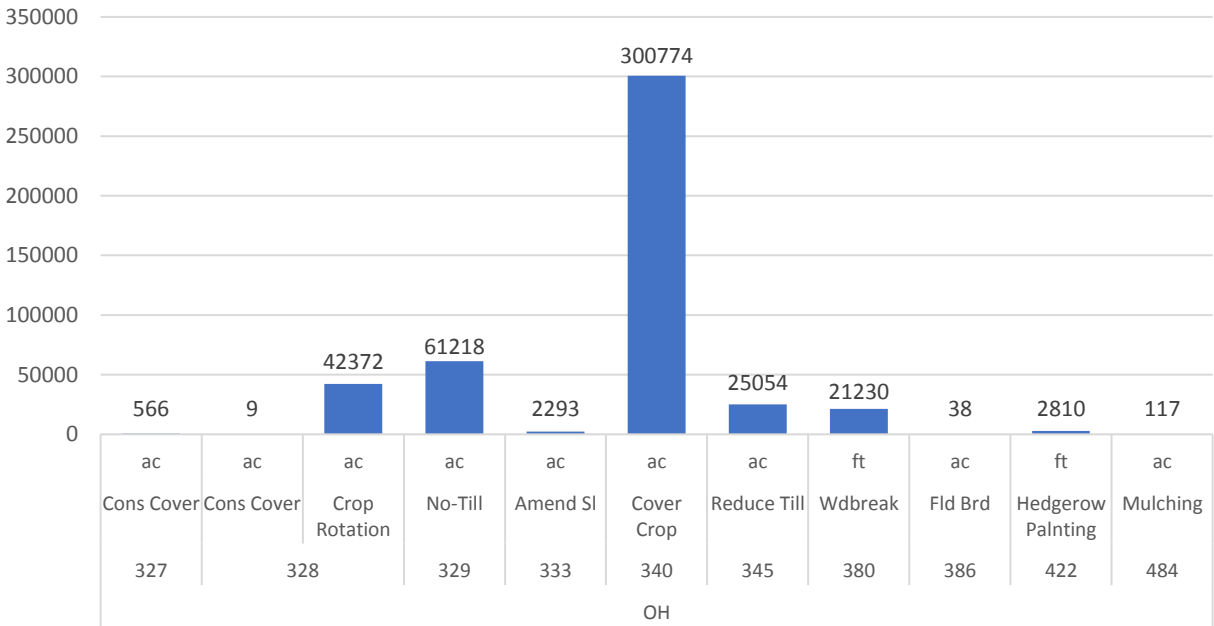
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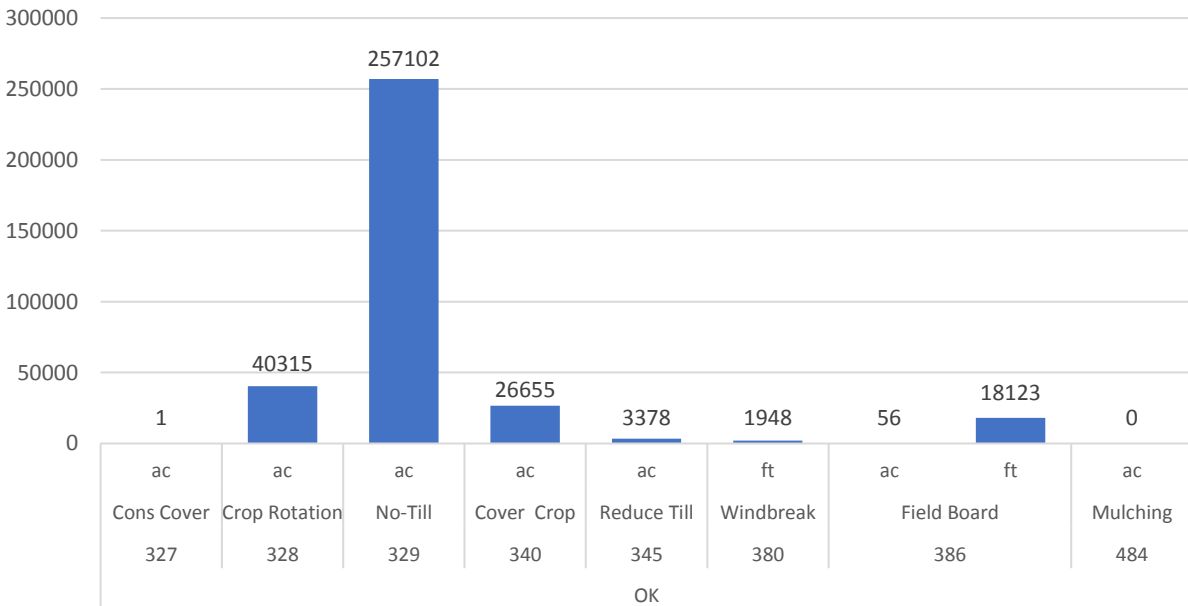
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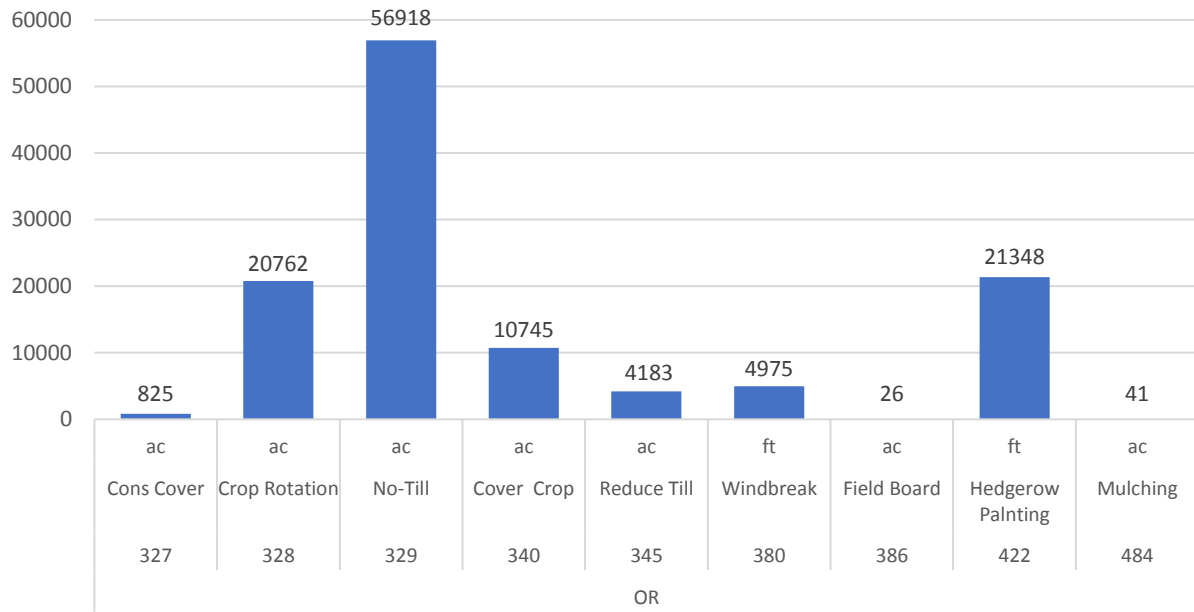
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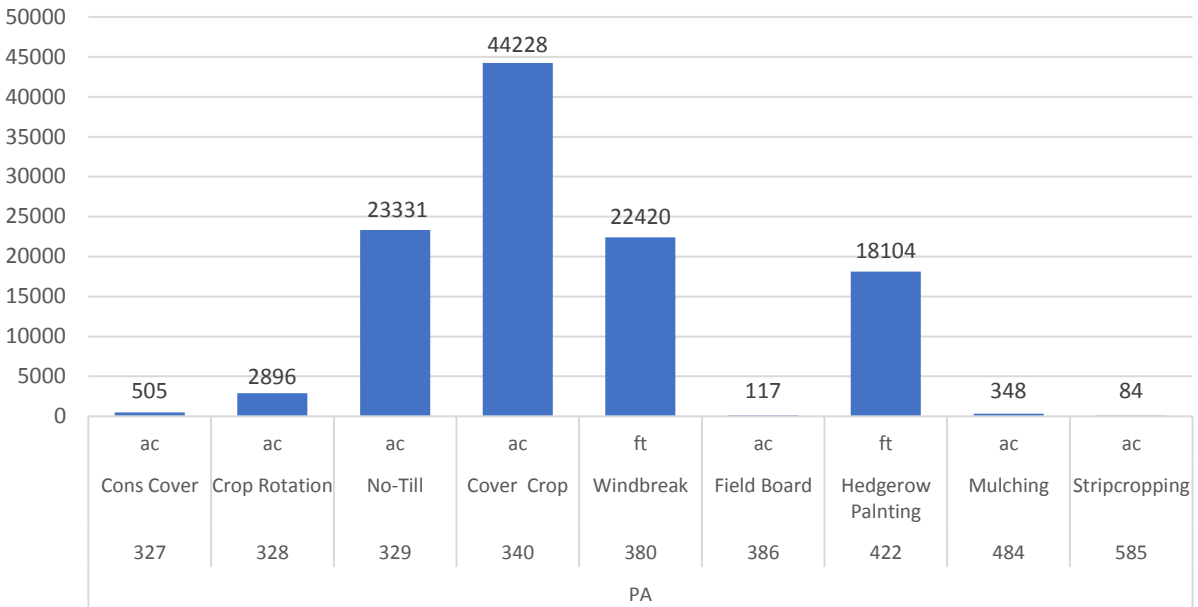
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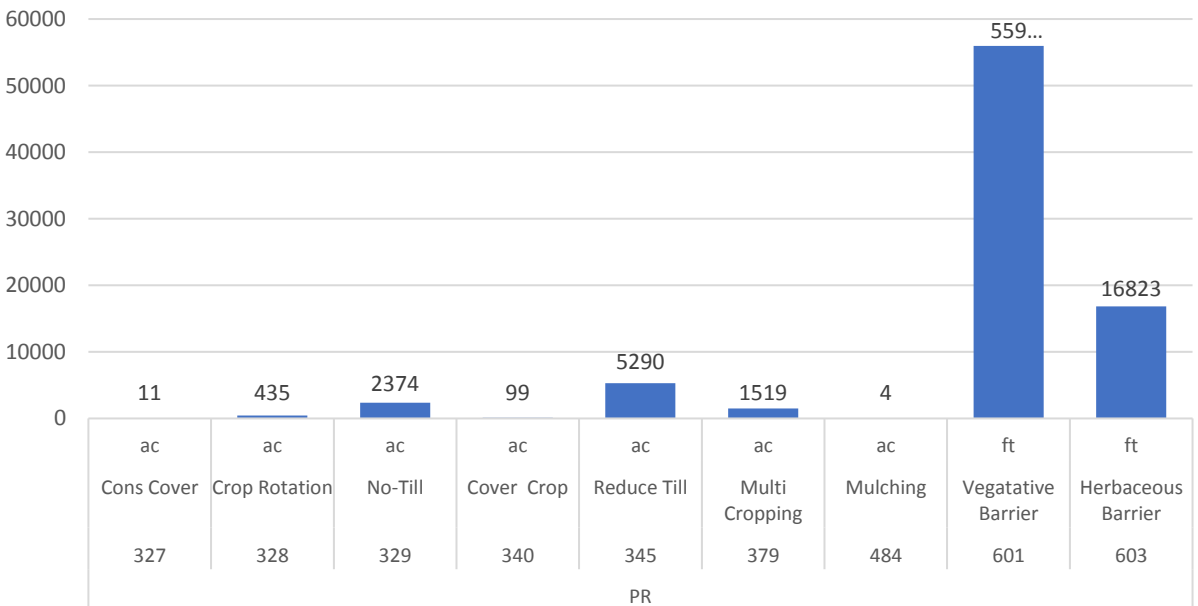
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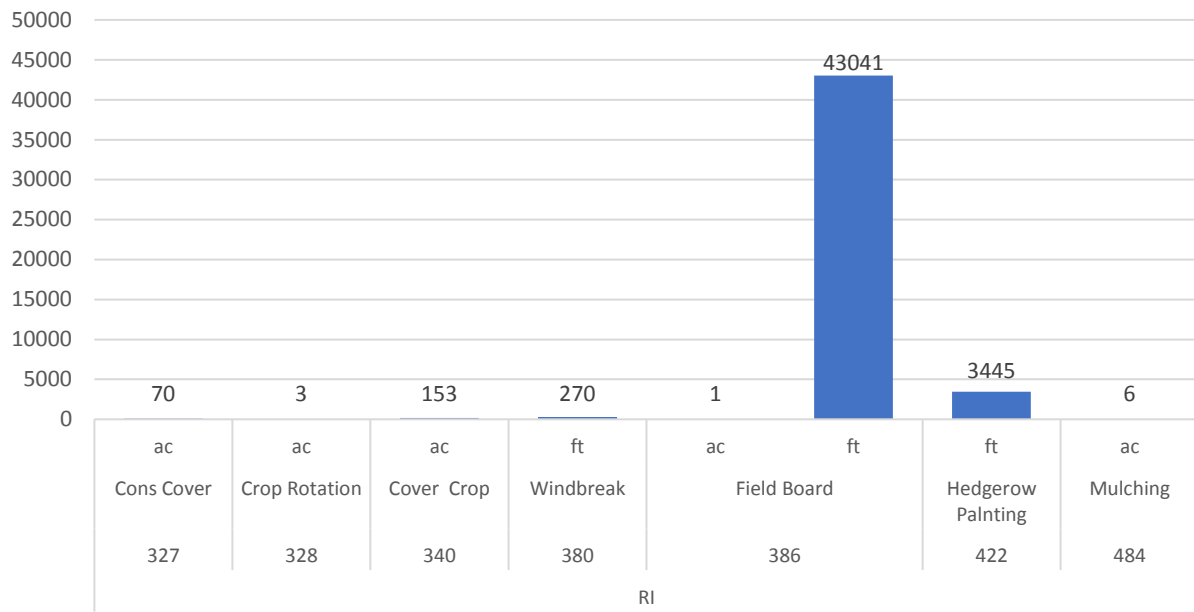
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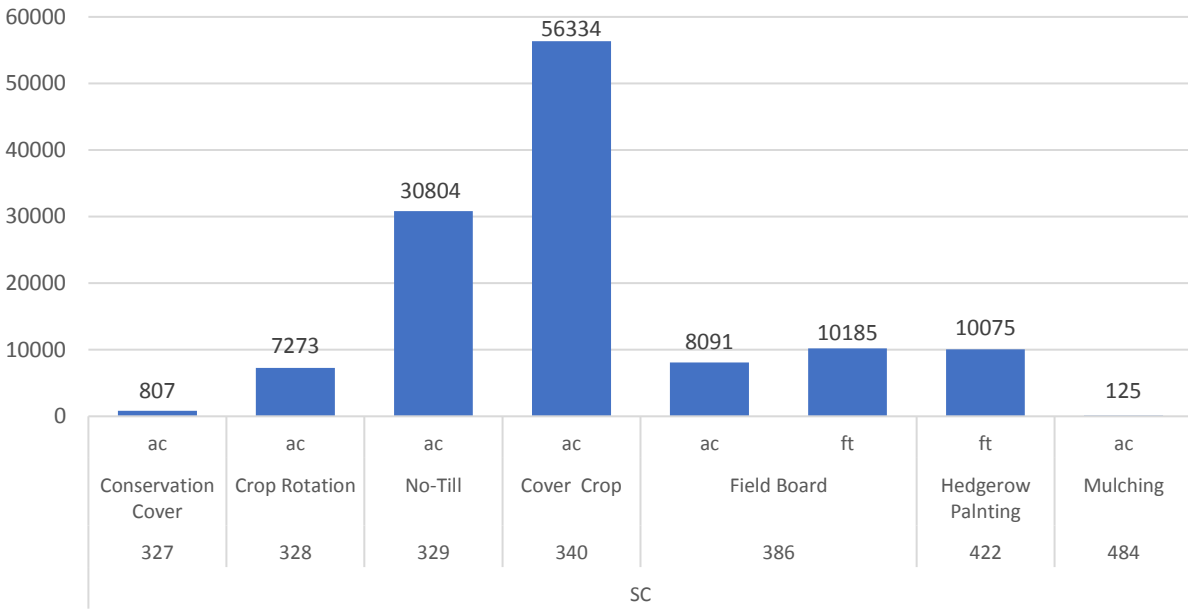
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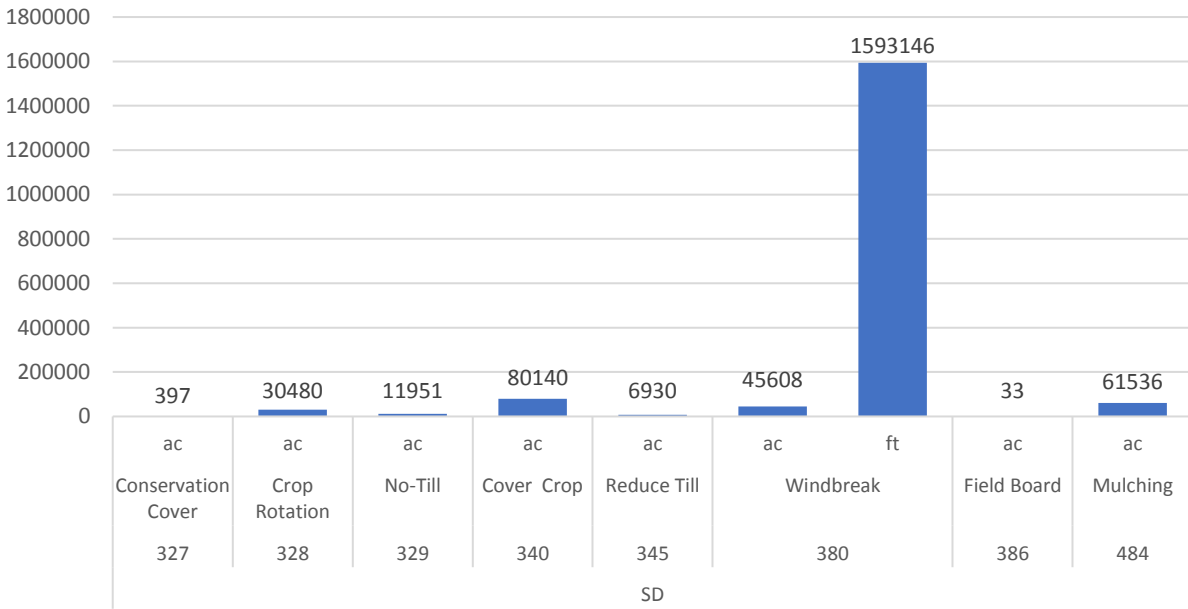
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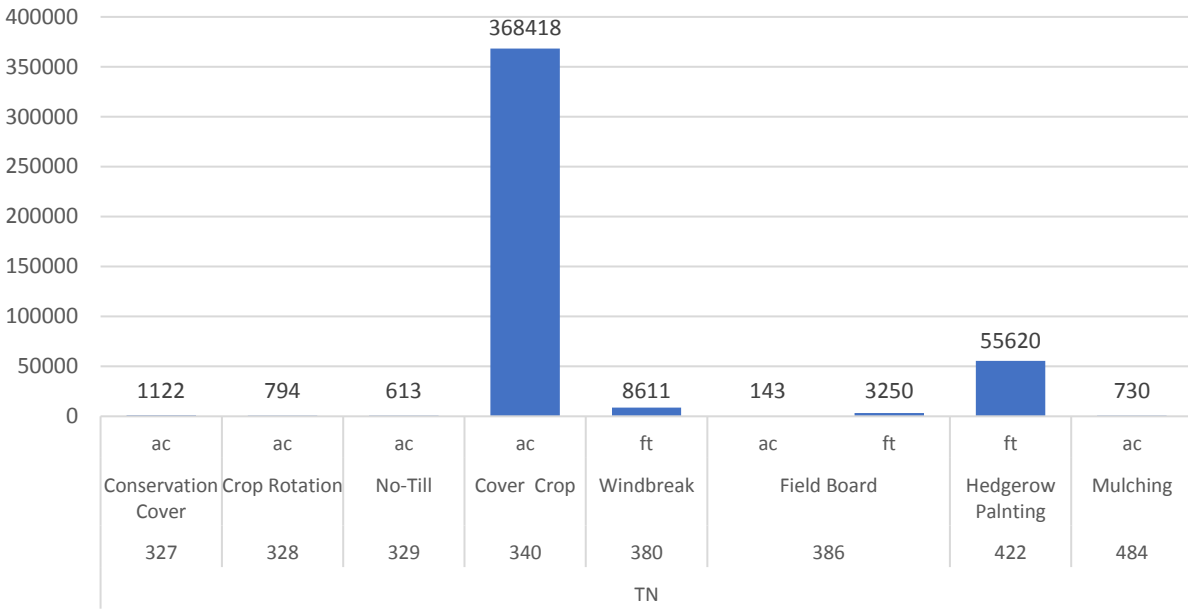
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South Dakota Conservation Practices 2013-2107



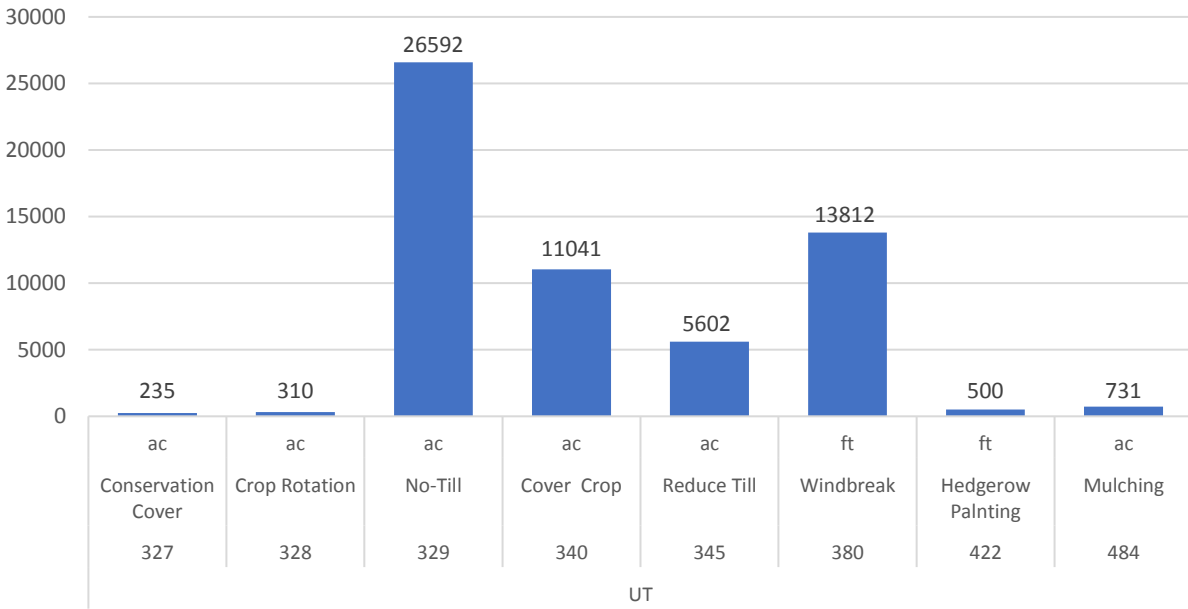
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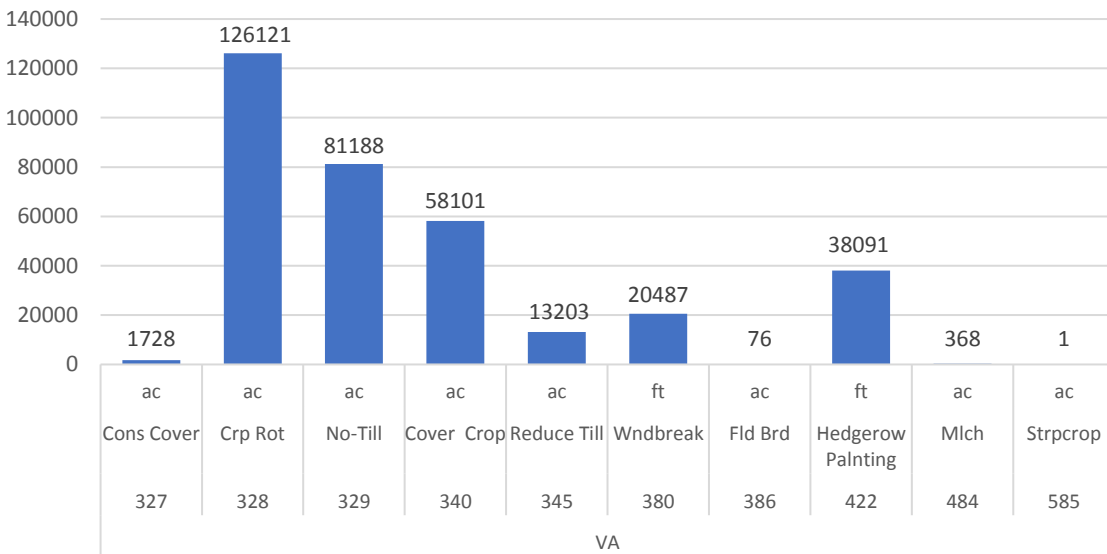
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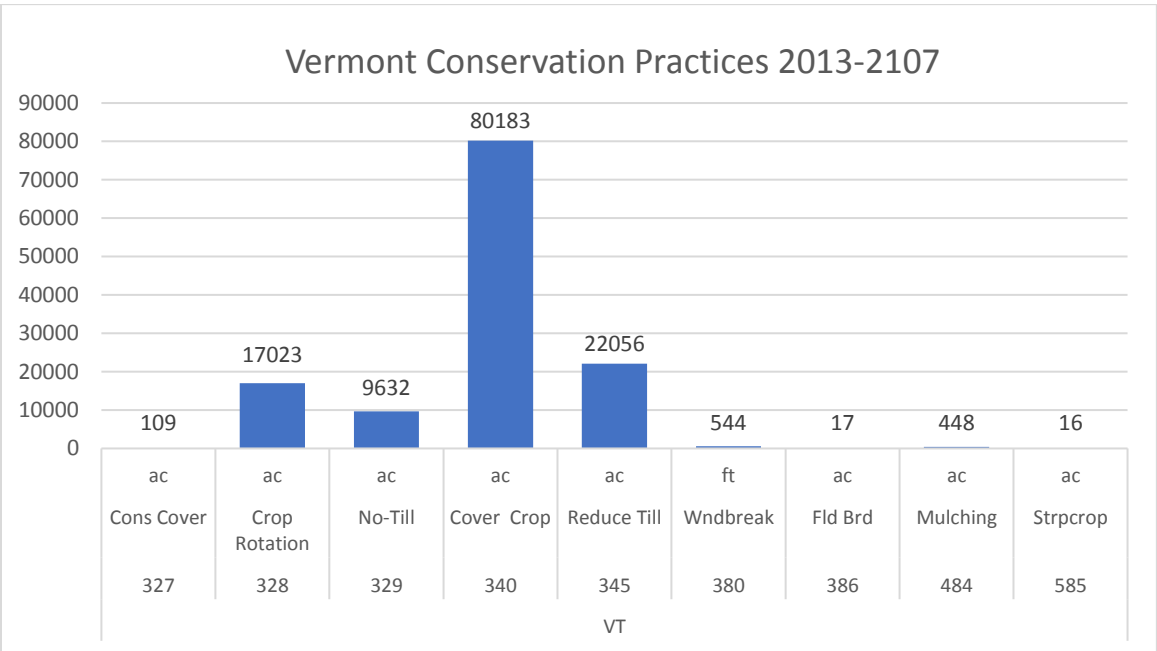
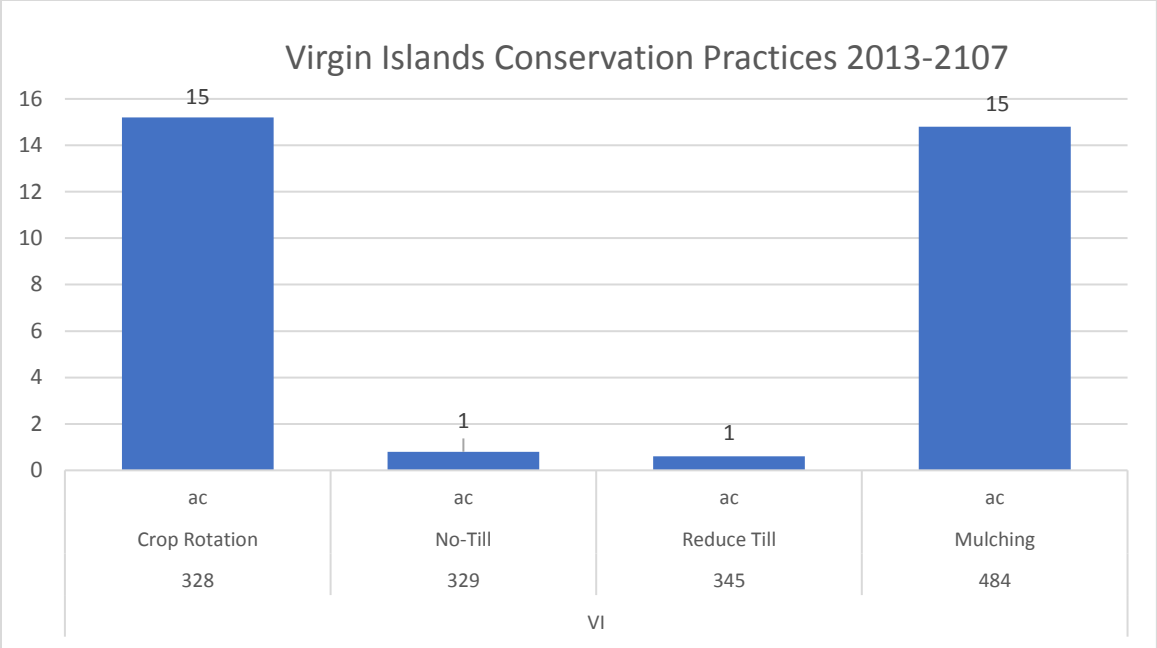


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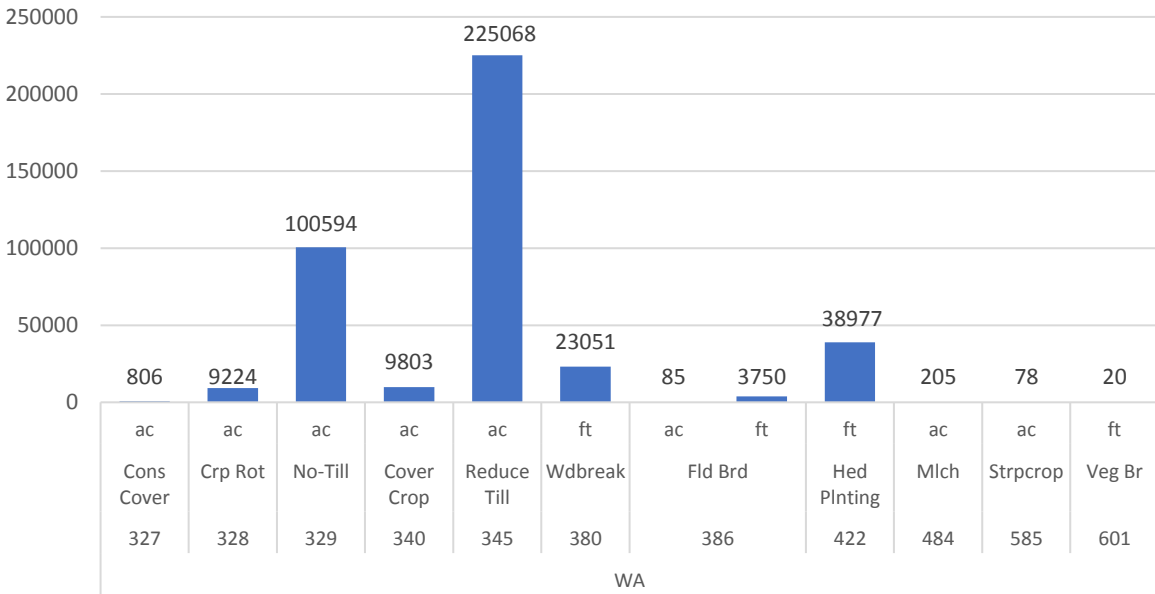


Virginia Conservation Practices 2013-2107

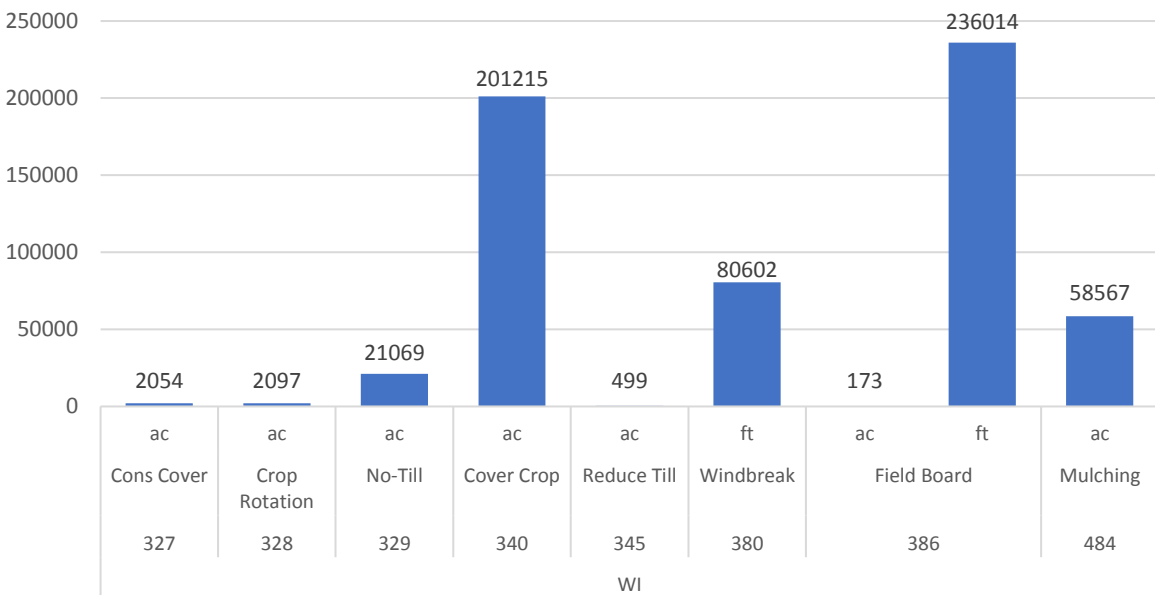




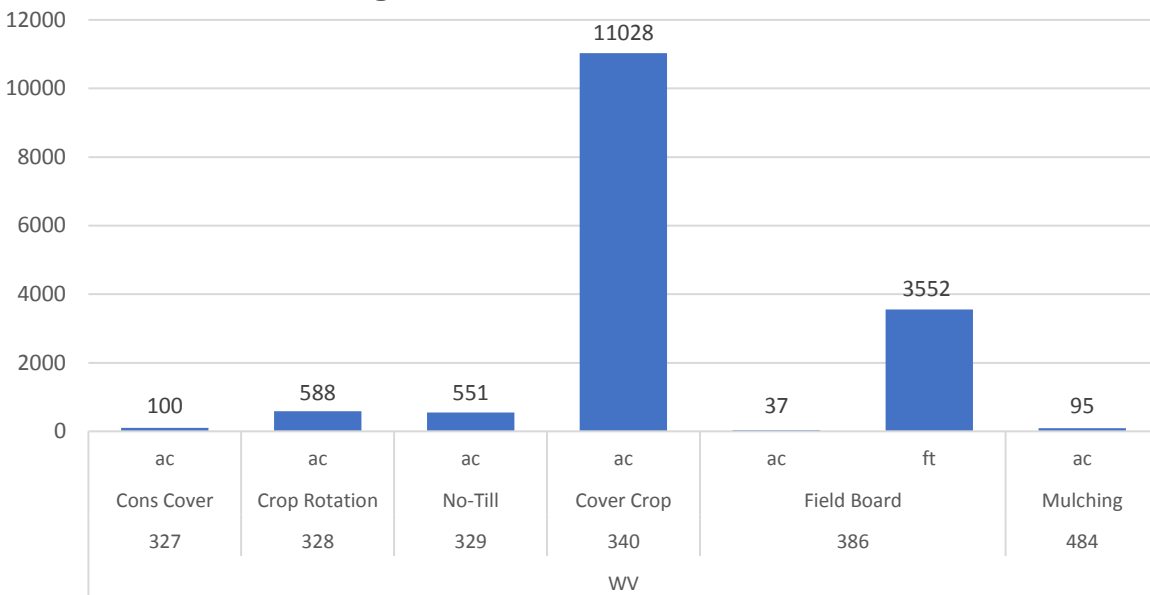
Washington Conservation Practices 2013-2107



Wisconsin Conservation Practices 2013-2107



West Virginia Conservation Practices 2013-2107



Wyoming Conservation Practices 2013-2107

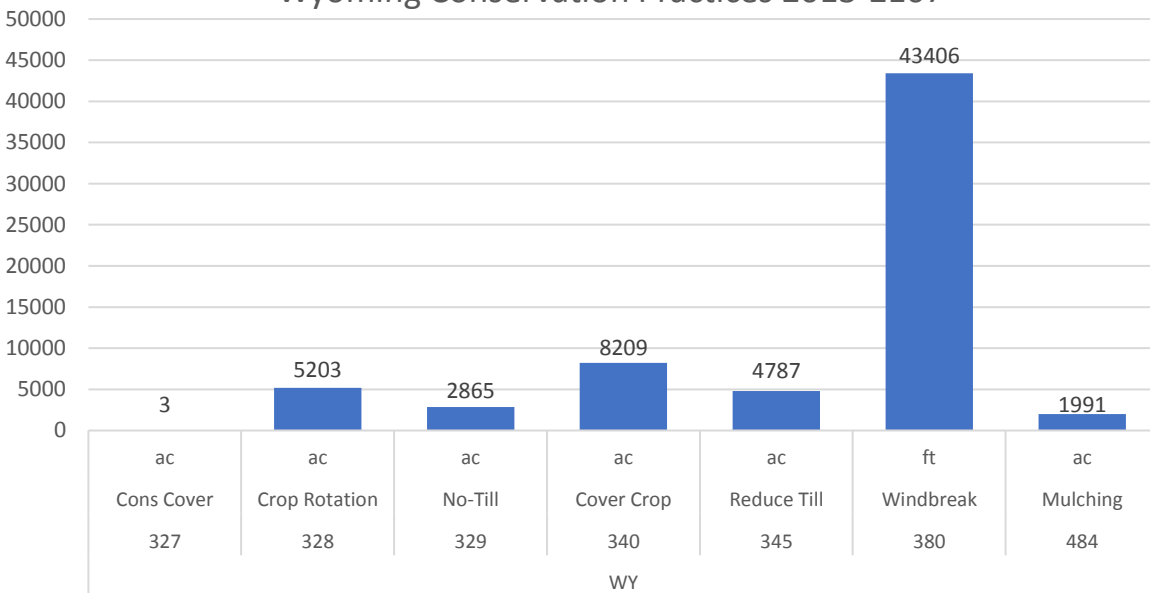


Exhibit 6-2: The Soil Conditioning Index (SCI)



The Soil Conditioning Index and improving your score

What is the Soil Conditioning Index?

The Soil Conditioning Index (SCI) is a tool that can predict the consequences of cropping systems and tillage practices on soil organic matter. Organic matter is a primary indicator of soil quality and an important factor in carbon sequestration and global climate change.

The SCI has three main components:

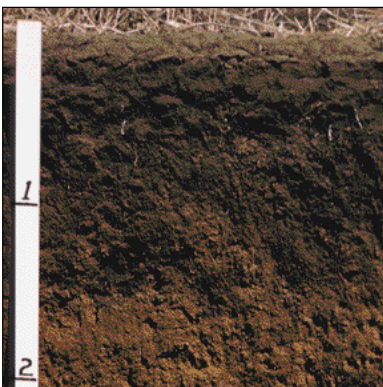
- 1) **OM or Organic Matter.** This accounts for the amount of organic material returned to the soil. Organic material from plant or animal sources may be either grown and retained on the site or imported to the site.
- 2) **FO or Field Operations.** This accounts for the effect of field operations which stimulate organic matter breakdown. Tillage, planting, fertilizer application, spraying and harvesting crush and shatter plant residues and aerate or compact the soil. These effects increase the rate of residue decomposition and affect the placement of organic material in the soil profile.
- 3) **ER or Erosion.** This accounts for the effect of removal and/or sorting of surface soil material by the sheet, rill, and/or wind erosion processes which are predicted by water and wind erosion models. It does not account for the effect of concentrated flow erosion such as ephemeral or classic gullies. Erosion contributes to loss of organic matter and decline in long-term productivity.



The SCI gives an overall rating based on these components. If the rating is a negative value, the system is predicted to have declining soil organic matter. If the rating is a positive value, the system is predicted to have increasing soil organic matter. The model is designed to aid Natural Resources Conservation Service (NRCS), landowners and Conservation District staffs in planning and designing cropping systems and residue management practices to resolve low organic matter, poor soil tilth, and other soil quality-related problems during conservation planning. The Revised Universal Soil Loss Equation Version 2 (RUSLE2) is the official NRCS tool that is used to calculate SCI.

Why is the SCI important?

The SCI is a quick way to characterize the organic matter dynamics of a farming system. Organic matter is a critical component of soil function for several reasons. Surface residue protects soil from the impact of rain and wind. As residue decays, it feeds microbes that improve soil structure and water infiltration, and thus reduces runoff. Soil organic matter contributes to nutrient and water holding capacities. Regular varying inputs of organic material foster a diverse microbial community that supports plant health and productivity.



The SCI along with RUSLE2, the NRCS soil erosion prediction model, can help assess two basic components of good soil management: building organic matter and controlling erosion.

SCI and the 2004 Conservation Security Program

The SCI plays a critical role in the implementation of the Conservation Security Program (CSP). It is used to determine the basic eligibility of cropland for CSP. Cropland must have a score of greater than 0.0 to be eligible for the program. Once an application is accepted into CSP, the SCI is one of the tools used to help determine the potential payment amount. All CSP applications will be assigned an enrollment category, which is partially based on the SCI score.

The Index is also used to help calculate some of the enhancement payment component of the CSP contract. Another NRCS tool, the Soil Tillage Intensity Rating (STIR), is also used to help determine enhancement payments. STIR, also automatically calculated by RUSLE2, measures the amount of soil disturbance based on tillage operations.



Other SCI Uses

The SCI is a component of several practice standards in NRCS technical guides. It is designed to help plan and design conservation crop rotations and residue management practices when low organic matter, poor soil tilth, surface crusting, or erosion are identified as concerns.

What do the numbers mean?

The SCI does not indicate a desirable or target level of soil organic matter, but it will predict if a particular management system will have a positive or negative effect on SOM. For example, a near-zero SCI value indicates that soil organic matter levels are probably being maintained, but soil health may still be poor if the soil organic matter is being maintained at a low level.

If the calculated index is a negative value, soil organic matter levels are predicted to decline under that production system. If the index is a positive value, soil organic matter levels are predicted to increase under that system.

Cautions

Organic matter is an important factor determining soil quality in many systems, but it is not the only factor. Other important aspects of soil quality include quality of organic matter, sedimentation, soil biota, nutrient management, contaminants, soil pH, bulk density and infiltration rate. These are not directly reflected in the Soil Conditioning Index, but can be improved to some extent with gains in organic matter.

Improving your score

Consider some of the following to help increase your SCI score.

- Raise crops that produce high amounts of residue that are retained on the field
- Utilize cover crops when possible to increase organic matter.
- Utilize manure or crop mulch to add organic matter to the soil
- Limit the number of tillage operations.
- Limit the amount of soil disturbance each operation created--A field cultivation operation normally disturbs less soil than a chisel type operation.
- Minimize the amount of wind and water erosion occurring on the field.
- Use production techniques that will increase crop and residue production.

Helpful websites

For SCI:

- http://soils.usda.gov/sqi/soil_quality/land_management/sci.html

For CSP:

- <http://www.nrcs.usda.gov/programs/csp/>
- <http://www.ia.nrcs.usda.gov/programs/csp.html>

For RUSLE2:

- http://fargo.nsert.purdue.edu/rusle2_dataweb/RUSLE2_index.htm

Exhibit 6-3: Cover Crop Economics Tool Factsheet

Natural Resources Conservation Service

COVER CROP\$ TOOL

An Economics Decision Support Tool

Economics 101

Interest in cover crops is growing across Iowa and the country. The reason? The potential benefits they offer farmers. Before jumping on the trend, it is important to assess the impacts cover crops may have on your operation. Adding cover crops means new operational costs and other benefits—some with a real cash value. That's what most farmers want to know. NRCS has a new tool to assess the economics and focus on new costs and benefits. That knowledge is key to the decision-making process. It can improve farmers' ability to commit to using cover crops as a long-term and successful conservation solution on their farm.

About The Tool

The specific costs and benefits associated with adding cover crops to a rotation are highly variable and site specific. NRCS encourages producers and landowners interested in assessing the economic considerations for their farm to download the "Cover Crop Economics Decision Support Tool." This tool is a partial budgeting tool based in a spreadsheet. It helps producers, landowners, planners and others make informed decisions when considering adding cover crops to their production system. The tool is available for download from the NRCS IA website at <http://www.nrcs.usda.gov/wps/portal/nrcs/main/ia/technical/dma/econ/>. For more details, visit your local NRCS office.

What The Tool Tells You

Offering a partial budget analysis, the tool focuses only on operational changes you make. To keep the analysis relevant, the focus is on actual costs and benefits farmers see when they add cover crops. We focus on benefits easily expressed in terms of dollars. The tool offers a simple economic and financial comparison that does not require in-depth crop budgets or enterprise analysis data. Concepts that the tool considers include:

- **Time Frame** — When assessing the economics of cover crops, the 'time horizon,' or length of time you evaluate really matters. The short-term view, typically less than 10 years, assesses immediate benefits from cover crop use. The long-term view assesses continued and long-term use of cover crops, which may lead to more economic benefits like improved soil health.

Potential Benefits —

- **Direct Nutrient Credits** – These are credits farmers expect to receive and use for the cash crop they will plant after the cover crop. This credit counts as 'already applied' fertilizer that is readily available for the crop, reducing actual fertilizer farmers would normally purchase. Typically, these nutrient credits are associated with legume cover crops specifically managed to provide nitrogen credits.
- **Herbicide/Insecticide/Fungicide Input Reductions** – Cover crop residue, surface vegetation competition, and subsurface microbial activity may result in reduced chemical application needs for the following cash crop. For example, having an early season mulch layer may eliminate the need and costs for herbicide treatments.
- **Yield Increases** – When cover crops solve yield-limiting problems like compaction and moisture availability, growth of your next cash crop can improve. The tool calculates this benefit by assessing the value of the added yield per acre.





- **Reduced Erosion** – Cover crops may immediately reduce onsite soil erosion. This benefit includes an estimate of the fertility value per ton typically lost to soil erosion, which is now under control. In some cases, reducing erosion with cover crops also reduces machinery costs to repair gullies and clean sediment out of ditches.
- **Grazing (short-term benefit)** – Using cover crops for grazing livestock that are already part of the farming operation is one of the most reliable ways to capture value from cover crops. Grazing cover crops can improve daily weight gain in stockers and offset hay and feed costs.
- **Overall Soil Fertility (long-term benefit)** – When used as part of a crop rotation over many years, cover crops impact both physical and biological soil properties. These soil improvements may result in the soil’s ability to increase available nitrogen, phosphorus and potassium in plants/crops. This can offset the purchase of additional nutrients for crop production from external sources.
- **Improved Water Storage and Infiltration (long-term benefit)** – As soil organic matter increases, the soil’s ability to store water also increases. The economic benefits of improved soil infiltration and water storage can reduce irrigation costs or increase the soil’s resilience from drought in dryland systems and curb yield losses.

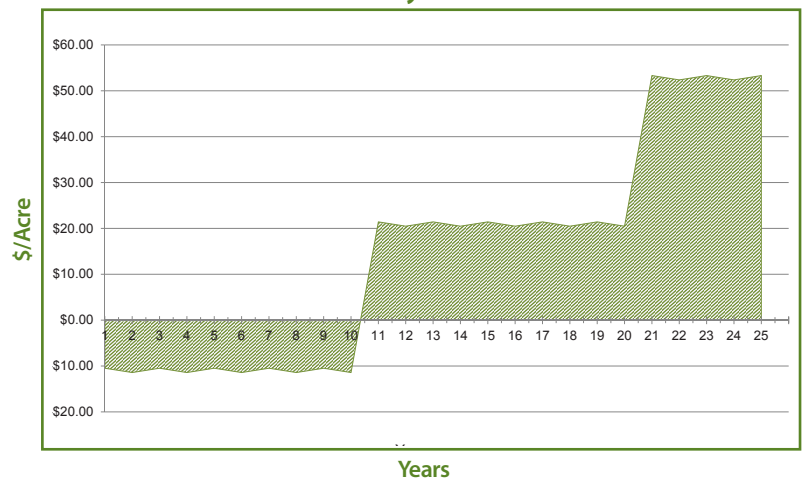


General Notes on the Tool:

- Please review the instruction page to understand data inputs required by users and the results the tool provides.
- The tool’s analysis depends upon user-supplied values. Where users are unsure of exact variables, they can use the tool to run “what if” scenarios based on different potential ranges of data inputs. The model will store and retrieve up to 5 default scenarios and offer a starting point for running the model.
- The tool provides analysis results both numerically and graphically.
- A References & Citations page is included, which provides users with additional technical and scientific details used to build the tool.
- Results are presented in two ways, showing immediate short-term net benefits and long-term net benefits (up to 50 years). The long-term benefits assess the impact of improved soil health with continued use of cover crops.



Financial Analysis Net Benefits



Example from the tool’s graphic display of financial results for a scenario assessing 25 years of including cover crops into a corn/soybean rotation where 10 years are required to change soil organic matter 1%. Graphic shows change in operating costs, negative numbers represent increased operating costs.

Exhibit 6-4: Cover Crop Chart

Cover Crop Chart

GROWTH CYCLE	PLANT ARCHITECTURE	RELATIVE WATER USE
A = Annual	γ = Upright	● = Low
B = Biennial	* = Upright-Spreading	●● = Medium
P = Perennial	≡ = Prostrate	●●● = High

-----COOL-----

-----WARM-----

--GRASS--

-----BROADLEAF-----

--GRASS--

--GRASS--			-----BROADLEAF-----						--GRASS--	
			-----LEGUME-----							
A ● γ ANNUAL FESCUE									A ● γ BROWNTOP MILLET	
A ● γ BARLEY								A ● γ AMARANTH	A ● γ FOXTAIL MILLET	
A ●● γ OAT	A/B ● γ CAMELINA	A/P ● * MUSTARD	A ● ≡* BALANSA CLOVER	A ● * CHICKPEA	A/P ● γ MEDIC	A ● * COWPEA	A ● * CLUSTER BEAN	A ●● γ BUCKWHEAT	A ● γ PEARL MILLET	
A ● γ SPELT	A ● γ PHACELIA	A/B ●● * CANOLA	A ●● γ BERSEEM CLOVER	A ● γ PEA	A ● γ LUPIN	A/P ● ≡* LABLAB	A/P ● * JACK BEAN	A ●● γ QUINOA	A ●● γ PROSO MILLET	
A ●● γ WHEAT	A ●● γ FLAX	A ●●● * RADISH	A ●● * CRIMSON CLOVER	A ● * LENTIL	A ●● γ FABA BEAN	A/P ● γ FENUGREEK	A ● * VELVET BEAN	P ●● * CHICORY	A ●● γ GRAIN SORGHUM	
A ●●● γ CEREAL RYE	A ●● * KALE	B ●●● * TURNIP	B/P ●● γ RED CLOVER	A/P ●● ≡* LESPEDEZA	A/B ●● γ SWEET CLOVER	A/P ● * PIGEONPEA	A ●● * MUNG BEAN	A ●●● * CUCURBITA	A ●● γ SUDAN GRASS	
A ●●● γ TRITICALE	A ●● * SPINACH	B ●●● * BEET	P ●● ≡* WHITE CLOVER	P ●● ≡ BIRDSFOOT TREFOIL	P ●●● γ ALFALFA	A ●● γ PARTRIDGE PEA	A ●● * SOYBEAN	A ●●● γ SAFFLOWER	A ● γ TEFF	
P ● γ SALINE TOLERANT	A/B ●●● * CHARD	A/B ●●● * CARROT	P ●● ≡ KURA CLOVER	A/B ●● ≡ VETCH	P ●●● γ SAINFOIN	A ●● γ SUNNHEMP	A/P ●●● * PEANUT	A ●●● γ SUNFLOWER	A ●●● γ CORN	

Cover Crop Chart

The Cover Crop Chart is produced and distributed by the staff of the Northern Great Plains Research Laboratory at Mandan, ND.

The Cover Crop Chart represents a compendium of information from multiple sources. Primary sources of information included the Midwest Cover Crops Council, USDA-SARE, USDA-NRCS PLANTS database, and relevant peer-reviewed journal articles. Designation of warm/cool season crops is based on prevalent growth habits and not photosynthetic pathway. Ranges for seeding depth take into consideration moisture conditions at planting and variation in soil texture. Values for crude protein and C:N ratio assume homogenous samples of aboveground plant material unless stated otherwise. Information on specific crops is occasionally generalized, approximate, and/or incomplete and may not reflect performance in on-farm conditions. USDA-ARS makes no guarantee to the performance of specific crops based on information provided herein. Content and data for crops were assembled by Holly Johnson and Mark Liebig with input from Dave Archer, V.C. Baligar, Heather Dose, Wayne Duckwitz, Marvin Hatzenbuehler, John Hendrickson, Naeem Kalwar, Robert Kolberg, Nancy Jensen, Steve Merrill, Kristine Nichols, Delmer Schlenker, Marty Schmer, Eric Scholljegerdes, Don Tanaka, Cal Thorson, and Dawn Wetch. Chart design by Mark Liebig, Holly Johnson, and Jill Gunderson. The Cover Crop Chart was originally generated with input from producers and technicians in the Area IV Soil Conservation Districts of North Dakota and NRCS staff at the Bismarck and Dickinson Field/Area Offices.

• **Useful cover crop resources:**

- **Managing Cover Crops Profitably, 3rd Ed. Andy Clark (Ed.). Handbook Series Book 9, Sustainable Agriculture Network, Beltsville, MD.**
- **Midwest Cover Crops Council, www.mccc.msu.edu**
- **Sustainable Agriculture Research and Education Program, University of California-Davis, www.sarep.ucdavis.edu**
- **USDA-NRCS, PLANTS Database, www.plants.usda.gov**

For further information please contact:

Cover Crop Chart

USDA-ARS Northern Great Plains Research Laboratory

P.O.Box 459 Mandan, ND 58554-0459

Voice: 701 667-3079 FAX: 701 667-3054

<https://www.ars.usda.gov/plains-area/mandan-nd/ngprl/>

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Crop Sequence Effects

CROP RESIDUE	----- HIGH RISK CROPS (Crops with the worst performance following a particular residue) -----								
Barley	Barley								
Wheat	Wheat								
Canola	Canola	Mustard	Pea	Dry Bean	Flax	Safflower			
Mustard	Soybean	Sunflower							
Flax	Flax								
Pea	Pea	Flax							
Lentil	Lentil								
Chickpea	Buckwheat	Lentil							
Soybean	Canola	Wheat	Barley						
Buckwheat	Chickpea	Sunflower	Grain Sorghum	Sunflower					
Safflower	Safflower	Sunflower	Soybean	Mustard	Dry Bean				
Sunflower	Sunflower	Canola	Pea	Lentil	Buckwheat	Grain Sorghum	Corn	Wheat	Barley
Proso Millet	Proso Millet	Grain Sorghum	Buckwheat						
Grain Sorghum	Grain Sorghum	Proso Millet	Pea	Lenti	Wheat				
Corn	Corn	Wheat	Buckwheat	Grain Sorghum	Proso Millet				

Table adapted from Crop Sequence Calculator (v. 3.1).

Software available for download at <https://www.ars.usda.gov/plains-area/mandan-nd/ngprl/>


 Back to Cover Crop Chart

Annual fescue

(*Vulpia myuros* L.; *Fetuca* sp.)

- Cool Season, grass
- Annual
- Upright plant architecture
- Alternate names: Rattail fescue, Foxtail fescue
- Low water use
- Poor salinity tolerance
- Seeding depth: ¼ – 1 inch
- Crude protein: hay 8-10%
- Benefits from arbuscular mycorrhizal associations



Barley

(*Hordeum vulgare* L.)

- Cool Season, grass
- Annual
- Upright plant architecture
- Low water use
- Good salinity tolerance
- Seeding depth: $\frac{3}{4}$ – 2 inches
- Crude protein: hay 10-15%, grain 11-15%
- C:N ratio: 20
- Benefits from arbuscular mycorrhizal associations
- Self pollinator (wind)
- Rated 'very good' at scavenging nitrogen from the soil

◆ *View table for known crop sequence effects*



Oat

(*Avena sativa* L.)

- Cool Season, grass
- Annual
- Upright plant architecture
- Medium water use
- Fair salinity tolerance
- Seeding depth: 1 – 2 inches
- Crude protein: hay 9-15%, grain 13-18%
- C:N ratio: 33
- Forms arbuscular mycorrhizal associations
- Self pollinator (wind)
- Rated 'very good' at scavenging nitrogen from the soil



Spelt

(*Triticum spelta* L.; *Triticum aestivum* var. *spelta*(L.) L.H. Bailey)

- Cool season, grass
- Annual
- Upright plant architecture
- Good to fair salinity tolerance
- Seeding depth: ½ – 1 ½ inches
- Crude protein: overall 11-14%, grain 13-16%
- Forms arbuscular mycorrhizal associations
- Self pollinator (wind)
- An efficient available nitrogen accumulator among cool season grasses
- Spelt is an older cereal grain and is more prone to lodging than wheat



Wheat

(*Triticum aestivum* L.)

- Cool season, grass
 - Annual
 - Upright plant architecture
 - Includes spring and winter wheat varieties
 - Medium water use
 - Good to fair salinity tolerance
 - Seeding depth: ½ – 1 ½ inches
 - Crude protein: straw 4-10%, grain 12-16%
 - C:N ratio: leaf 15-29, stem 31-65, root 24-74 , straw 80-95 [*end of season*]
 - Benefits from arbuscular mycorrhizal associations
 - Self pollinator (wind)
 - Rated 'very good' at scavenging nitrogen from the soil
- ◆ *View table for known crop sequence effects*



Cereal rye

(*Secale cereale* L.)

- Cool Season, grass
- Annual
- Upright plant architecture
- High water use
- Good salinity tolerance
- Seeding depth: $\frac{1}{4}$ – 2 inches
- Crude protein: straw 4%, grain 14%
- C:N ratio: 40 – 50*
 - * This number can vary based on whether the plant was grown in monoculture or a biculture and the stage the plant was in when it was tested
- Forms arbuscular mycorrhizal associations
- Self pollinator (wind)
- Rated 'very good' at scavenging nitrogen from the soil



Triticale

(*Triticale hexaploide* Lart.; *Triticosecale rimpau* Wittm.)

- Cool Season, grass
- Annual
- Upright plant architecture
- Fall and spring types available
- High water use
- Good salinity tolerance
- Seeding depth: 1 ½ – 2 inches
- Crude protein: hay 9-16%, grain 17%
- C:N ratio: 20
- Forms arbuscular mycorrhizal associations
- Self pollinator (wind)



Saline Tolerant Grasses

- Cool Season, grass
- Perennial
- Upright plant architecture
- Low to moderate water use
- Moderate to high salinity tolerance
- Seeding depth: $\frac{1}{4}$ – 1 inch
- Crude Protein: 7 – 19%
- Forms arbuscular mycorrhizal associations
- Many species are available in this category; each varies slightly in plant characteristics

See the next six slides for more detail

RS Hybrid Wheatgrass

(*Elymus hoffmannii* K.B. Jensen & K.H. Asay)

- Cool season, grass
- Perennial
- Upright plant architecture
- Alternate name: Green wheatgrass
- Low water use
- Moderate to high salinity tolerance
- Seeding depth: $\frac{1}{4}$ – $\frac{1}{2}$ inch
- Crude protein: 7 – 12%
- RS hybrid wheatgrass is a hybrid between quackgrass (*Elymus repens*) and bluebunch wheatgrass (*Pseudoroegneria spicata*)



◆ [Back to Cover Crop Chart](#)

Saline Tolerant

Cool Season Grass

Tall Wheatgrass

(Thinopyrum ponticum (Podp.))

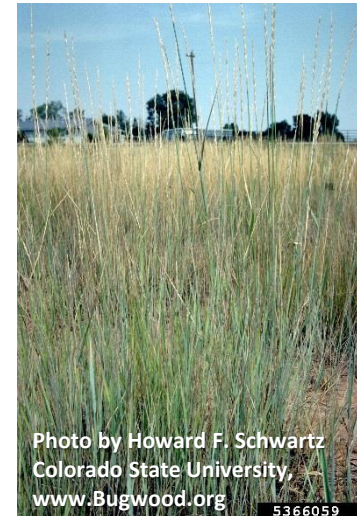
- Cool season, grass
- Perennial (introduced)
- Upright plant architecture
- Alternate name: Rush wheatgrass
- Moderate water use
- Excellent salinity tolerance
- Seeding depth: $\frac{1}{4}$ – 1 inch
 - *shallower for finer textured soils
- Crude protein: 7 – 19%
 - vegetative >10%
 - late bloom 6%
 - fully mature 2-3%



Intermediate Wheatgrass

(*Thinopyrum intermedium* (Host) Barkworth & D.R. Dewey)

- Cool season, grass
- Perennial (introduced)
- Upright plant architecture
- Alternate name: Pubescent wheatgrass
- Low to moderate water use; drought tolerant
- Good salinity tolerance
- Seeding depth: ½ – 1 inch
- Crude protein: 8 – 17%*
 - *Northern Plains: may fall below 4% at the end of the season
- Cross-pollinates.
- Spreads vegetatively; under ideal conditions, it can slowly spread into adjacent communities
- Persistence of stand is limited (typically < 5 yr)



◆ [Back to Cover Crop Chart](#)

Saline Tolerant

Cool Season Grass

Slender Wheatgrass

(Elymus trachycaulus (Link) Gould ex Shinnners)

- Cool season, grass
- Perennial, short-lived (native)
- Upright plant architecture
- Low water use; will not tolerate water-logged soils
- Good salinity tolerance
- Seeding depth: $\frac{1}{4}$ – $\frac{3}{4}$ inch
- Crude protein: 22 – 25% (Spring); less than 10% (fall)
- May form arbuscular mycorrhizal associations



◆ [Back to Cover Crop Chart](#)

Saline Tolerant

Cool Season Grass

Russian Wildrye

(*Psathyrostachys junceus* (Fisch.) Nevski)

- Cool season, grass
- Perennial (introduced)
- Upright plant architecture
- Low water use
 - drought tolerant
 - does not tolerate flooding
- Good salinity tolerance
- Seeding depth: $\frac{1}{4}$ – $\frac{1}{2}$ inch
 - Sensitive to seeding depth – too deep will inhibit seed germination
- Crude protein: 5 – 17 %
- Difficult to establish

Photo by Larry Holzworth
USDA-ARS, NRCS Idaho Plant Materials Program and
USDA-ARS, Forage and Range Research Laboratory



Alkaligrass

(*Puccinellia* sp. Parl.)

- Cool season, grass
- Perennial
- Upright plant architecture
- Nuttall's alkaligrass, *Puccinellia nuttalliana* [Schult.] Hitch.
 - Native to semi-arid, North American zones
- Weeping alkaligrass, *Puccinellia distans* [Jacq.] Parl.
 - Introduced [Eurasia]
 - Highest salinity tolerance of this genus
- Low to moderate water use
 - Can survive arid areas as well as marsh, basin, or wetland zones
- Excellent salinity tolerance
- Seeding depth: ¼ - ½ inch

- *This slide completes the review of saline tolerant grasses*



Camelina

(*Camelina sativa* (L.) Crantz)

- Cool Season, broadleaf
- Annual, Biennial
- Upright plant architecture
- Alternate names: False flax, gold-of-pleasure, linseed dodder, largeseed falseflax, leindotter, Siberian oilseed
- Low water use
- Fair salinity tolerance
- Seeding depth: $\frac{1}{8}$ – $\frac{1}{4}$ inch
- Crude Protein: 46%
- C:N Ratio: stems 40-95; pods 25-70; seed 12-16
- Does not form arbuscular mycorrhizal associations
- Mainly a self pollinator but benefits genetically from exposure to high population of pollinators
- Sensitive to soil herbicide imidazolinones and sulfentrazone
- Volunteer plants can become problematic
- Potentially allelopathic for flax



◆ [Back to Cover Crop Chart](#)

Cool Season Broadleaf

Phacelia

(*Phacelia tanacetifolia* Benth.)

- Cool Season, broadleaf
- Annual
- Upright plant architecture
- Low water use
- Low salinity tolerance
- Seeding depth: $\frac{1}{8}$ – $\frac{1}{4}$ inch
- C:N ratio: 10 – 15
- Forms arbuscular mycorrhizal associations
- Attracts beneficial insects



Flax

(*Linum usitatissimum* L.)

- Cool Season, broadleaf
- Annual
- Upright plant architecture
- Medium water use
- Fair salinity tolerance
- Seeding depth: ½ – 1 ½ inch
- Benefits from arbuscular mycorrhizal associations
- Flowers attract pollinators



Kale

(*Brassica napus* L. var. *pabularia*)

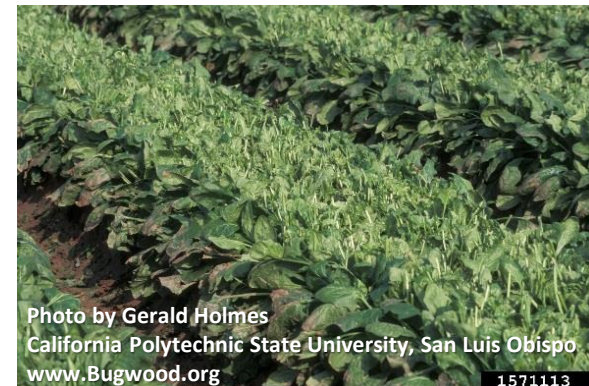
- Cool Season, broadleaf
- Annual
- Alternate names: also found under
Brassica oleracea – Acephala group
- Upright and spreading plant architecture
- Major types:
 - Siberian
 - Russian
- Medium water use
- Fair salinity tolerance
- Seeding depth: $\frac{1}{4}$ – $\frac{1}{2}$ inch
- Crude protein: $\approx 30\%$
- C:N ratio: 10 – 30
- Does not form arbuscular mycorrhizal associations



Spinach

(*Spinacia oleracea* L.)

- Cool Season, broadleaf
- Annual
- Upright and spreading plant architecture
- Low to medium water use
- Poor salinity tolerance
- Seeding depth: $\frac{1}{4}$ – $\frac{1}{2}$ inch
- Crude protein: $\approx 20\%$
- C:N ratio: 6 – 8
- Sensitive to acid soils
- Does not form arbuscular mycorrhizal associations



Chard

(Beta vulgaris L. ssp. *cicla* (L.) W.D.J. Koch)

- Cool season, broadleaf
- Annual, Biennial
- Upright spreading plant architecture
- Alternate names: Swiss chard, silverbeet, perpetual spinach, spinach beet, crab beet, bright lights, seakale beet, and mangold
- High water use
- Poor salinity tolerance
- Seeding depth: ½ - 1 inch
- Crude Protein: 32%
- Does not form arbuscular mycorrhizal associations
- Self pollinator (wind)

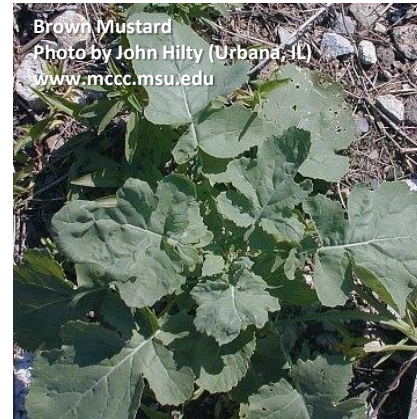


Mustard

(*Brassica sp.* L.)

- Cool Season, broadleaf
- Annual, Perennial
- Upright and spreading plant architecture
- Major types: Indian, Oriental, brown, yellow
- Related to crambe
- Low water use
- Poor salinity tolerance
- Seeding depth: $\frac{1}{4}$ – $\frac{1}{2}$ inch
- Crude protein: hay 10%, grain 24-35%
- C:N ratio: 10 – 30
- Does not form arbuscular mycorrhizal associations
- Rated 'good' at scavenging nitrogen from the soil
- Plants from the *Brassica* group have potential to release compounds or metabolic by-products that work as bio-toxins against bacteria, fungi, insects, nematodes, and weeds
- Flowers may attract pollinators

◆ [View table for known crop sequence effects](#)



Canola

(*Brassica napus*)

- Cool Season, broadleaf
 - Major types:
 - Annual (spring-type)
 - Biennial (winter-type)
 - Upright and spreading plant architecture
 - Alternate name: Rapeseed
 - Medium water use
 - Good salinity tolerance
 - Seeding depth: ¼ – 1 inch
 - Crude protein: shoots 20-30, hay 16%, grain 21%, silage 12%, pasture 17%
 - C:N ratio: leaf 12-16, stem 21-37, root 24-43
 - Does not form arbuscular mycorrhizal associations
 - Rated 'very good' at scavenging nitrogen from the soil
 - Flowers attract pollinator
- ◆ [View table for known crop sequence effects](#)



Radish

(*Raphanus sativus*)

- Cool Season, broadleaf
- Annual
- Upright and spreading plant architecture
- Root crop
- Major types:
 - Oilseed (var. *oleiformis*)
 - Forage (var. *niger*): Daikon
- High water use
- Poor salinity tolerance
- Seeding depth: $\frac{1}{4}$ – $\frac{1}{2}$ inch
- Crude protein: 26-30%
- C:N ratio: oilseed 19 – 20
- Does not form arbuscular mycorrhizal associations
- Rated 'very good' at scavenging nitrogen from the soil
- Flowers attract pollinators



◆ [Back to Cover Crop Chart](#)

Cool Season Broadleaf

Turnip

(*Brassica rapa* L. var. *rapa*)

- Cool Season, broadleaf
- Biennial
- Upright and spreading plant architecture
- Root crop
- High water use
- Poor salinity tolerance
- Seeding depth: $\frac{1}{4}$ – $\frac{1}{2}$ inch
- Crude protein: tops 16%, root 12 – 14%
- C:N ratio: shoots 20 – 30, root 10 – 20
- Closely related to rutabaga
- Does not form arbuscular mycorrhizal associations
- Rated 'good' at scavenging nitrogen from the soil
- Flowers attract pollinators



Beet

(Beta vulgaris)

- Cool Season, broadleaf
- Biennial
- Upright and spreading plant architecture
- Root crop
- High water use
- Variable salinity tolerance, depending on beet type
- Seeding depth: $\frac{1}{2}$ - $\frac{3}{4}$ inch
- Crude protein: tops 12-15%, root 7-10%
- C:N ratio: tops 11 – 14
- Does not form arbuscular mycorrhizal associations
- Rated 'good' at scavenging nitrogen from the soil
- Self pollinator (wind)
- Multiple sub-species including garden beets and sugar beets



Carrot

(*Daucus carota* var. *sativus* L.)

- Cool Season, broadleaf
- Major types:
 - Biennial (cultivated)
 - Annual (wild)
- Upright and spreading plant architecture
- Root crop
- High water use
- Seeding depth: $\frac{1}{8}$ - $\frac{1}{4}$ inch
- Crude protein: 10%
- Forms arbuscular mycorrhizal associations
- Plants may bolt and flower starting in second year of growth
- Flowers may attract pollinators



Balansa Clover

(*Trifolium michelianum* Savi ssp. *balansae* (Boiss.) Ponert)

- Cool season, broadleaf
- Annual, short-lived Perennial
- Legume (N-fixation)
- Upright, upright spreading, or prostrate plant architecture
 - multibranched rosette but prostrate when grazed
- Also called bigflower clover
- Moderate salinity tolerance
- Seeding depth: ¼ inch
- Crude protein: 15 - 20%
 - variable depending on plant stage @ harvest
- C:N ratio: 15
- Requires inoculation with root-nodule bacterium *Rhizobium* sp. at planting
- Flowers attract pollinators



Photo by Annie Young-Mathews, USDA-NRCS Corvallis Plant Materials Center

Berseem Clover

(*Trifolium alexandrinum* L.)

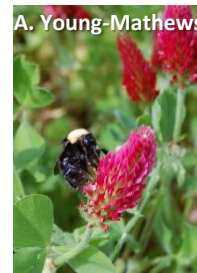
- Cool Season, broadleaf
- Annual
- Legume (N-fixation)
- Upright plant architecture
- Alternate name: Egyptian clover
- Low water use
- Fair salinity tolerance
- Seeding depth: ¼ – 1 inch
- Crude protein: 27-29%
- C:N ratio: 18 – 23
- Forms arbuscular mycorrhizal associations
- Flowers attract pollinators



Crimson Clover

(*Trifolium incarnatum* L.)

- Cool season, broadleaf
- Annual
- Legume (N-fixation)
- Upright and spreading plant architecture
- Medium water use
- Poor salinity tolerance
- Seeding depth: $\frac{1}{4}$ - $\frac{1}{2}$ inch
- Crude protein: 18%
- C:N ratio: 16 - 19
- Forms arbuscular mycorrhizal associations
- Flowers attract pollinators



Red Clover

(*Trifolium pratense* L.)

- Cool Season, broadleaf
- Biennial, short-lived Perennial
- Legume (N-fixation)
- Upright plant architecture
- Two types:
 - medium, perennial or biennial; (2-3 cuts per season)
 - mammoth (1 cut per season)
- Medium water use
- Poor salinity tolerance
- Seeding depth: $\frac{1}{4}$ – $\frac{1}{2}$ inch
- Crude protein: 15%
- C:N ratio: 15 – 23
- Forms arbuscular mycorrhizal associations
- Flowers attract pollinators



Photo by Todd Martin (MSU-KBS)
www.mccc.msu.edu



Photo by John Wright (Mississauga)
www.mccc.msu.edu

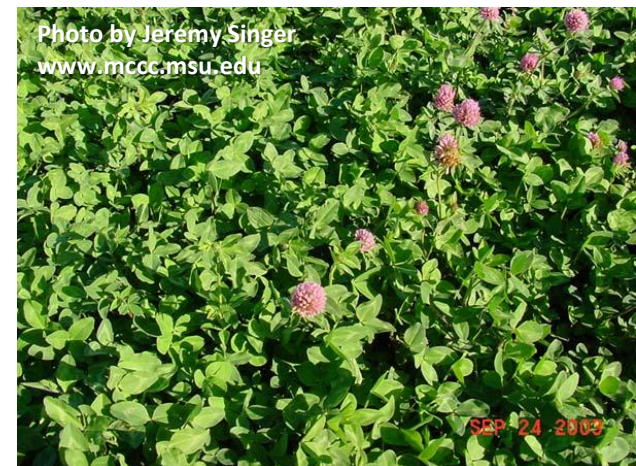


Photo by Jeremy Singer
www.mccc.msu.edu

White Clover

(*Trifolium repens* L.)

- Cool Season, broadleaf
- Perennial
- Legume (N-fixation)
- Upright and spreading or prostrate plant architecture
- 3 Types grouped by size:
 1. **Large:** tallest of the white clovers, upright architecture, high forage quality but less durable [var. Ladino]
 2. **Intermediate:** most common white clover, flowers earlier, and has a higher heat tolerance, upright architecture [var. Dutch white, New Zealand White]
 3. **Small:** lowest growing type, prostrate; survives grazing [var. Wild White]
- Medium water use
- Poor salinity tolerance
- Seeding depth: ¼ inch
- Crude protein: 24 – 30%
- C:N ratio: 13 – 23
- Forms arbuscular mycorrhizal associations
- Flowers attract pollinators
- Aggressive growth in some regions or habitats; may displace desirable vegetation if not properly managed



Kura Clover

(*Trifolium ambiguum* M. Bieb.)

- Cool season, broadleaf
- Perennial
- Legume (N-fixation)
- Prostrate plant architecture
- Also called Caucasian, honey, and pellet clover
- Moderate water use
- Poor salinity tolerance
- Seeding depth: $\frac{1}{4}$ – $\frac{1}{2}$ inch
- Crude protein: 23 – 25%
- Forms arbuscular mycorrhizal association
- Flowers attract pollinators

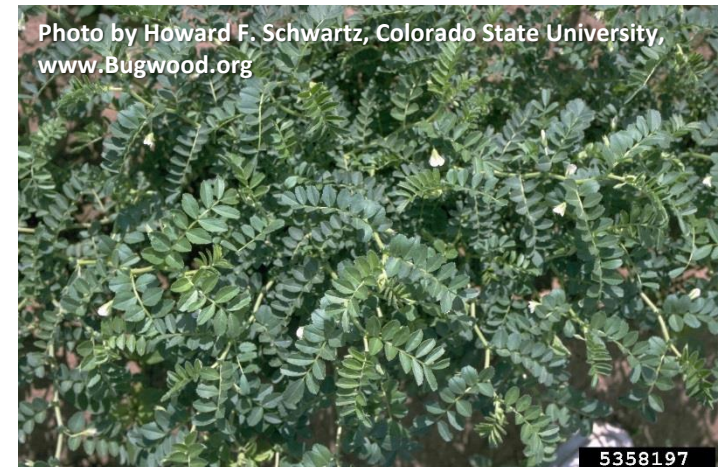


Chickpea

(*Cicer arietinum* L.)

- Cool Season, broadleaf
- Annual
- Legume (N-fixation)
- Two types
 - Desi
 - Kabuli
- Upright and spreading plant architecture
- Alternate name: garbanzo bean
- Low water use
- Poor salinity tolerance
- Seeding depth: 1 ½ – 2 inches
- Crude protein: straw 6%, grain 22%
- C:N ratio: leaf 10-15, stem 26-56, root 16-27
- Forms arbuscular mycorrhizal associations
- Flowers attract pollinators

◆ [View table for known crop sequence effects](#)



Pea

(*Pisum sativum arvense* L.)

- Cool Season, broadleaf
- Annual
- Legume (N fixation)
- Upright plant architecture (vine)
- Low water use
- Poor salinity tolerance
- Seeding depth: 1 – 3 inches
- Crude protein: hay 14%, grain 24%, silage 15%
- C:N ratio: leaf 13-25, stem 27-83, root 17-27
- Forms arbuscular mycorrhizal associations
- Flowers attract pollinators

◆ *View table for known crop sequence effects*



Lentil

(*Lens culinaris* Medik.)

- Cool Season, broadleaf
- Annual
- Legume (N-fixation)
- Upright and spreading plant architecture
- Low water use
- Poor salinity tolerance
- Seeding depth: 1 – 1 ½ inch
- Crude protein: hay 14%, grain 28%, silage 15%
- C:N ratio: leaf 11-21, stem 25-49, root 22-30
- Forms arbuscular mycorrhizal associations
- Self-pollinated but flowers may attract pollinators

◆ [View table for known crop sequence effects](#)



◆ [Back to Cover Crop Chart](#)

Cool Season Legume

Lespedeza

- Cool Season, broadleaf
- Legume (N-fixation)
- Variable plant architecture
- Seeding depth: ¼ - ½ inch
- Forms arbuscular mycorrhizal associations
- Lespedeza species are considered useful for forage, wildlife habitat, and reducing erosion
- Native & Introduced species
 - Native (U.S.)
 - Roundhead lespedeza, *Lespedeza capitata* (Michx.)
 - Introduced
 - Common lespedeza, *Kummerowia striata* (Thunb.) Schindl.
 - Korean lespedeza, *Kummerowia stipulacea* (Maxim.) Makino
 - Annuals
 - Sericea lespedeza *Lespedeza cuneata* (Dum. Cours.) G. Don
 - Perennial
- *Introduced species are adapted for warmer climates but have the potential to become weed-like (and are considered noxious weeds in certain areas of the U.S.)*



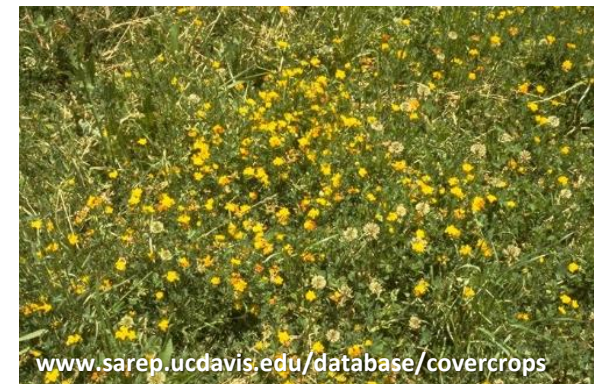
Roundhead lespedeza, Photos by Chris Evans
Illinois Wildlife Action Plan
www.Bugwood.org



Birdsfoot trefoil

(*Lotus corniculatus* L.)

- Cool Season, broadleaf
- Perennial, short lived
- Legume (N-fixation)
- Prostrate plant architecture
- Low to medium water use
- Fair salinity tolerance
- Seeding depth: $\frac{1}{4}$ – $\frac{1}{2}$ inch
- Crude protein: hay 16 - 22%
- Forms arbuscular mycorrhizal associations
- Attracts pollinators



Vetch

(*Vicia sp.*)

- Cool Season, broadleaf
- Annual, Biennial
- Legume (N-fixation)
- Prostrate plant architecture (vine)
- Common examples include hairy, purple, common, and smooth vetch
- Low to medium water use
- Poor salinity tolerance
- Seeding depth: 1 ½ – 2 ½ inches
- Crude protein: 13-20%
- C:N ratio: 10 – 19
- Forms arbuscular mycorrhizal associations
- Attracts pollinators

Hairy Vetch



Common Vetch, Photos by Annie Young-Mathews,
USDA-NRCS Corvallis Plant Materials Center



Medic (*Medicago* spp.)

- Cool Season, broadleaf
- Annual, Perennial
- Legume (N-fixation)
- Upright and spreading plant architecture
- Over 35 known medic species exist. Common examples include barrel, black, & burr.
- Low water use
- Poor to fair salinity tolerance
- Seeding depth: ¼ inch
- Crude protein: black medic 19-21%
- Forms arbuscular mycorrhizal associations
- Attracts pollinators



Lupin

(*Lupinus sp.* L.)

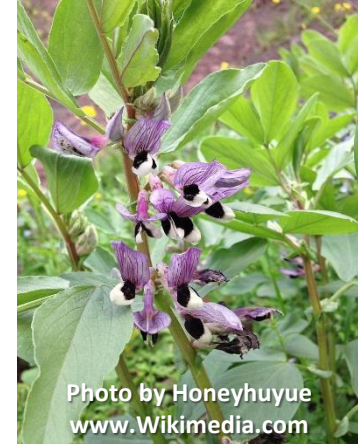
- Cool Season, broadleaf
- Annual
- Legume (N-fixation)
- Upright plant architecture
- Examples include blue, narrow-leaved, European yellow, white, Spanish, etc.
- Low water use
- Prefers acid soils
- Seeding depth: 1 – 2 inches
- Crude protein: silage 15%
- C:N ratio: leaf 12-30, stem 25-49
- Does not form arbuscular mycorrhizal associations
- Flowers attract pollinators



Faba Bean

(*Vicia faba* L.)

- Cool season, broadleaf
- Annual
- Legume (N-fixation)
- Upright plant architecture (vine)
- Alternate names: Bell bean, horse bean, Fava bean
- Medium water use; poor drought tolerance
- Moderate salinity tolerance (depending on variety)
- Seeding depth: 2-4 inches
- Crude protein: 17%
- Forms arbuscular mycorrhizal associations
- Flowers attract pollinators



Sweetclover

(*Melilotus* sp. L)

- Cool Season, broadleaf
- Annual, Biennial
- Legume (N-fixation)
- Two types
 - yellow *Melilotus officinalis* L.
 - white *Melilotus alba* L.
- Upright plant architecture
- Moderate water use
- Fair salinity tolerance
- Seeding depth: ½ inch
- Crude protein: 11-18%
- C:N ratio: 12 – 23
- Forms arbuscular mycorrhizal associations
- Attracts pollinators



Alfalfa

(*Medicago sativa* L.)

- Cool Season, broadleaf
- Perennial
- Legume (N-fixation)
- Upright plant architecture
- Alternate name: lucerne
- High water use
- Poor salinity tolerance
- Seeding depth: $\frac{1}{4}$ – $\frac{1}{2}$ inch
- Crude protein: 14-22%
- C:N ratio: 11 – 13
- Non-dormant cultivars can perform like an annual
- Forms arbuscular mycorrhizal associations
- Good at scavenging nitrogen from the soil
- Attracts pollinators



Sainfoin

(*Onobrychis viciifolia* Scop.)

- Cool Season, broadleaf
- Perennial
- Legume (N-fixation)
- Upright plant architecture
- Medium to high water use
- Fair to poor salinity tolerance
- Seeding depth: $\frac{1}{4}$ – $\frac{3}{4}$ inch
- Crude protein: 13-20%
- Forms arbuscular mycorrhizal associations
- Attracts pollinators



Cowpea

(*Vigna unguiculata* L.)

- Warm Season, broadleaf
- Annual
- Legume (N-fixation)
- Upright and spreading plant architecture (vine)
- Alternate names: Southern pea, black-eye pea
- Low water use
- Fair salinity tolerance
- Seeding depth: $\frac{3}{4}$ – 1 inch
- Crude protein:
 - grain and leaves 19-30%
 - stems 13-17%
- C:N ratio: 18 – 22
- Forms arbuscular mycorrhizal associations
- Attracts pollinators



Lablab

(*Lablab purpureus* (L.) Sweet)

- Warm Season, broadleaf
- Annual, Perennial
- Legume (N-fixation)
- Upright and spreading (vine) or prostrate plant architecture
 - Planting date determines growth habit
- Formerly called *Dolichos lablab* L.
- Alternate names: *Val* bean, , hyacinthbean, Indian butter bean, helmet bean, Egyptian kidney bean,
- Low water use
- Poor salinity tolerance
- Seeding depth: 1-4 inch
- Crude protein:
 - leaves 21-38%
 - seeds 20-28%
- C:N ratio: 17 (green manure/Brazil); 34 (North Carolina)
- Doesn't easily form arbuscular mycorrhizal associations



Fenugreek

(*Trigonella sp.* L.)

- Warm Season, broadleaf
- Annual, Perennial
- Legume (N-fixation)
- Two types:
 - cultivated [*T. corniculata*];
 - forage or sickle fruit [*T. foenum-graecum*]
- Upright plant architecture
- Alternate name: Greek hay
- Low water use
- Poor salinity tolerance
- Seeding depth: 1 – 2 inches
- Crude protein: 16 – 25%
- Forms arbuscular mycorrhizal associations
- Self pollinator (wind)
- Used as a forage, spice, and for health benefits*
 - *contains nutraceuticals:
 1. steroidal sapogenin
 2. galactomannan
 3. isoleucine



Pigeonpea

(*Cajanus cajan* (L.) Millsp.)

- Warm season, broadleaf
- Annual, Perennial
- Legume (N-fixation)
- Upright and spreading plant architecture
- Alternate names: Angola pea, Congo pea, dhal, no-eye pea, gungo pea, and red gram
- Low water use
- Moderate to high salinity tolerance
- Seeding depth: 1 ½ – 4 inches
- Crude protein: 28-36%; leaf alone 10 – 15%
- C:N ratio: 20
- Forms arbuscular mycorrhizal associations
- Mostly self-pollinated



Partridge Pea

(*Chamaecrista fasciculata* (Michx.) Greene var. *fasciculata* ;
Cassia fasciculata Michx.; *Cassia chamaecrista* L.);

- Warm season, broadleaf
- Annual
- Legume (N-fixation)
- Upright plant architecture
- Alternate names: sleeping plant, prairie senna, large-flowered sensitive-pea, locust weed, dwarf cassia, golden cassia
- Low to moderate water use
- Seeding depth: $\frac{1}{4}$ " – $\frac{3}{4}$ " inch
- Forms arbuscular mycorrhizal associations
- Attracts pollinators, especially bees
- Used as a green manure, forage, or fiber crop
 - Forage is nutritious but also contains cathartic substance in fresh material or hay which can potentially be dangerous to cattle. Check before feeding to livestock
- Attractive to wildlife, particularly several game bird species
- Potential for phytoremediation (tolerance to cadmium)



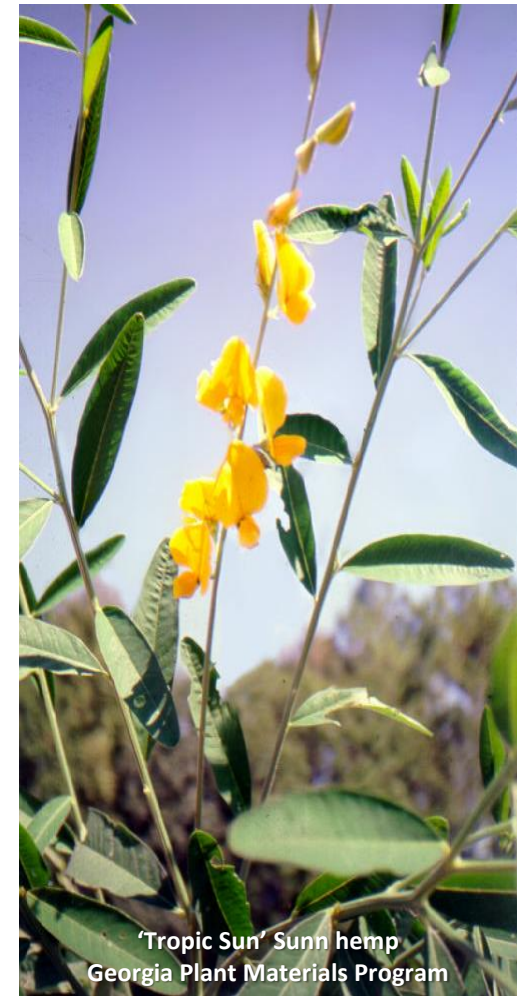
Photos by Alan Shadow
USDA-NRCS,
East Texas Plant Materials Center



Sunnhemp

(*Crotalaria juncea* L.)

- Warm season, broadleaf
- Annual
- Legume (N-fixation)
- Upright plant architecture
- Low to moderate water use
- Poor salinity tolerance
- Seeding depth: ½" – 2 ½" inches
- 'Good' N-fixation capacity
- Forms arbuscular mycorrhizal associations
- Self pollinates (wind) as well as cross-pollinates (insects/birds)
- Rated 'Excellent' at controlling soil nematodes
- Used as a green manure, forage*, or fiber crop
 - * Certain cultivars contain alkaloids which are poisonous to livestock; check before feeding to animals



Cluster bean

(*Cyamopsis tetragonoloba* L. Taub)

- Warm Season, broadleaf
- Annual
- Legume (N-fixation)
- Upright and spreading plant architecture
- Alternate names: Guar, guar bean, c
- Low water use
- Good salinity tolerance
- Seeding depth: 1 – 1 ½ inch
- Crude protein:
 - Straw 7 – 10%
- C:N ratio: 65 (residue)
- Forms arbuscular mycorrhizal associations
- Self-pollinated
- Can be used as a green manure or forage
- Plant extract (gum) has industrial uses



Jack bean

(Canavalia ensiformis (L.) DC.)

- Warm Season, broadleaf
- Annual, Perennial
- Legume (N-fixation)
- Upright and spreading plant architecture (vine)
- Alternate names: wonderbean, sword-bean, coffee bean, giant stock-bean, horse-bean
- Low water use
- Fair salinity tolerance
- Seeding depth: 1 – 3 inches
- Crude protein: ≈ 30%
- C:N ratio: 21 (green manure/Brazil)

* **Special Note:**

HUMAN: Although young pods/green seeds can be eaten, mature beans can contain harmful compounds and must be cooked prior to eating

LIVESTOCK: Because of the potential toxic compounds in the seed, meal must be heat-treated to denature the enzymes or limited to 30% of the ration



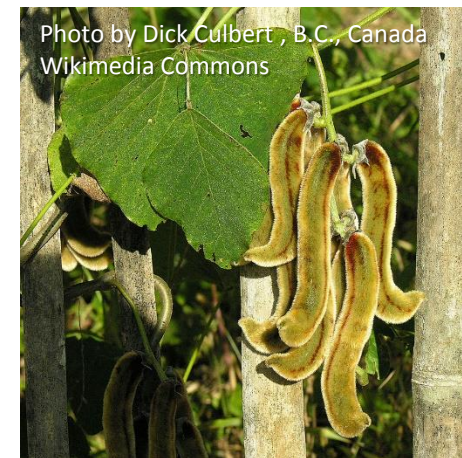
Velvet bean

(*Mucuna pruriens* (L.) DC.)

- Warm Season, broadleaf
- Annual, Biennial
- Legume (N-fixation)
- Upright and spreading plant architecture (vine)
- Alternate names: Itchy bean, buffalobean, bengal bean, devil bean, cowitch
- Low water use
- Seeding depth: 1-3 inches*
 - * In some circumstances, can be planted as deep as 4 inches
- Crude protein:
 - leaves 11-23%
 - grain 20-35%
- C:N ratio: 29
- Does not form arbuscular mycorrhizal associations
- Moderate at accumulating nitrogen

Special Note:

- * Seed contains an amino-acid (L-dopa) that may be used for medicinal purposes. However, if untreated it can be toxic to humans or non-ruminant animals
- * Tiny hairs on mature pods are a skin irritant. To avoid, terminate plant before seed production.



Mung bean

(*Vigna radiata* L.)

- Warm Season, broadleaf
- Annual
- Legume (N-fixation)
- Upright and spreading plant architecture
- Low to medium water use
- Poor salinity tolerance
- Seeding depth: 1 ½ – 3 inches
- Crude protein: 16-23%
- C:N ratio: 10 – 15
- Forms arbuscular mycorrhizal associations
- Self-pollinated



Soybean

(*Glycine max* (L.) Merr.)

- Warm Season, broadleaf
 - Annual
 - Legume (N-fixation)
 - Upright and spreading plant architecture
 - Medium water use
 - Poor salinity tolerance
 - Seeding depth: 1 – 2 inches
 - Crude protein: hay 17%, grain 42%
 - C:N ratio: leaf 14, stem 39, root 34
 - Forms arbuscular mycorrhizal associations
 - Self-pollinated but flowers may attract pollinators
- ◆ *View table for known crop sequence effects*



Peanut

(Annual - *Arachis hypogaea* L.; Perennial – *Arachis glabrata* L.)

- Warm season, broadleaf
- Annual, Perennial
- Legume (N-fixation)
- Upright and spreading (annual) or prostrate (perennial) plant architecture
- Alternate name: Groundnut
- High water use
- Poor salinity tolerance
- Seeding depth: 1 – 4 inches
 - *Perennial peanuts are planted using rhizomes only
- Crude Protein: 13 – 20%
- Forms arbuscular mycorrhizal associations
- Mainly self-pollinate (wind); small % cross-pollinate
- Rated 'Efficient' at scavenging P & K from soil
- Perennial varieties used as cattle forage



Photo by Rebekah D. Wallace
University of Georgia, Bugwood.org

Annual Peanut - *Arachis hypogaea*



Photo by William M. Brown Jr.
Bugwood.org

Perennial Peanut - *Arachis glabrata*

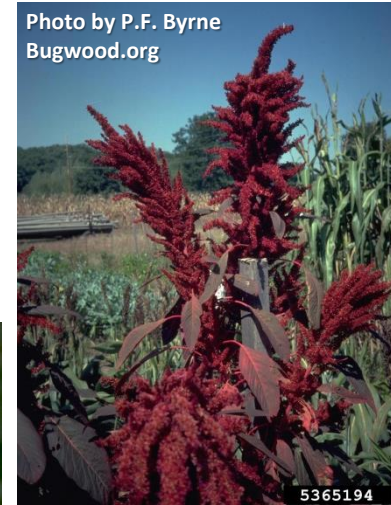


www.tropicalforages.info

Amaranth

(*Amaranthus sp.*)

- Warm Season, broadleaf
- Annual
- Upright plant architecture
- Over 50 species; some exhibiting glyphosate resistance
- Low water use
- Tolerant of heat and drought
- Seeding depth: ½ – 2 inches
- Crude protein: ≈14%
- Does not form arbuscular mycorrhizal associations
- Self-pollinated (wind)
- Flowers may attract pollinators



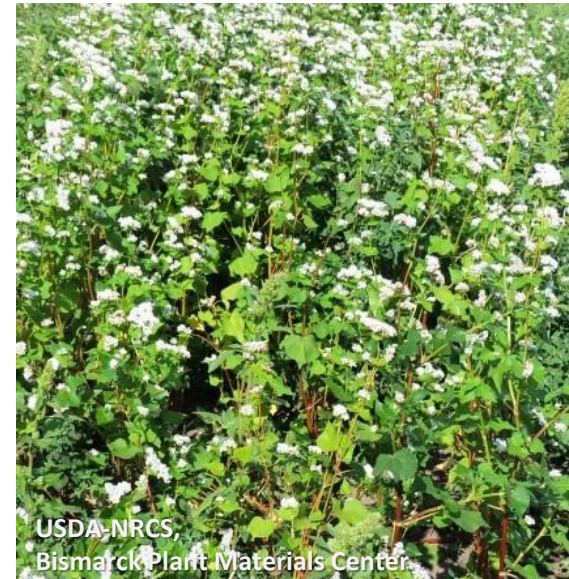
◆ [Back to Cover Crop Chart](#)

Warm Season Broadleaf

Buckwheat

(*Fagopyrum esculentum* Moench; *Fagopyrum sagittatum* Gilib)

- Cool Season, broadleaf
 - Warm season growth characteristics
 - Annual
 - Upright plant architecture
 - Medium water use
 - Poor salinity tolerance
 - Enhances soil P availability
 - Seeding depth: ½ inch
 - Crude protein: straw 5%, grain 13%
 - C:N ratio: leaf 8-10, stem 12-32, root 28-47
 - Does not form arbuscular mycorrhizal associations
 - Attracts pollinators
- ◆ *View table for known crop sequence effects*



Quinoa

(*Chenopodium quinoa* Willd.)

- Warm season, broadleaf
- Annual
- Upright plant architecture
- Moderate water use
- Good salinity tolerance
- Seeding depth: ½ - 1 inch
- Crude protein: 14%
- C:N ratio: 14-25
- Does not form arbuscular mycorrhizal associations
- Self pollinates (wind); up to 15% may cross-pollinate
- Not susceptible to cereal diseases; slightly vulnerable to soil nematodes
- No registered herbicides for quinoa at this time



Chicory

(*Cichorium intybus* L.)

- Warm Season, broadleaf
- Perennial
- Upright and spreading plant architecture (vine)
- Alternate names: French endive, succory
- Medium water use
- Seeding depth: $\frac{1}{8}$ – $\frac{1}{2}$ inch
- Crude protein: 10-32%
- Forms arbuscular mycorrhizal associations
- Attracts pollinators
- Rated 'very good' at scavenging nitrogen from the soil
- Highly invasive



Cucurbita sp. [Family]

- This is a broad grouping including squash, gourd, cucumber, melon, and pumpkin
- Warm Season, broadleaf
- Annual
- Prostrate plant architecture (vine)
- Seeding depth: ½ – 1 inch
- Forms arbuscular mycorrhizal associations
- Attracts pollinators
- Can be used for weed suppression as a 'smother crop'



Photos by Howard F. Schwartz
Colorado State University,
www.Bugwood.org



Safflower

(*Carthamus tinctorius* L.)

- Warm Season, broadleaf
- Annual
- Upright plant architecture
- High water use
- Good salinity tolerance
- Deep rooted
- Effective at 'mining' mobile nutrients deep in the soil profile
- Seeding depth: 1 – 1 ½ inch
- Crude protein: hay 10-13%, grain 18%
- C:N ratio: leaf 21, stem 56, root 73
- Forms arbuscular mycorrhizal associations
- Flowers attract pollinators

◆ *View table for known crop sequence effects*



Sunflower

(*Helianthus annuus* L.)

- C3 plant with warm season growth characteristics, broadleaf
- Annual
- Upright plant architecture
- High water use
- Fair salinity tolerance
- Deep rooted
- Effective at 'mining' mobile nutrients deep in the soil profile
- Seeding depth: 1 – 3 ½ inches
- Crude protein: silage 11-12%, grain 20-28%
- C:N ratio: leaf 11-14, stem 41-46, root 50-68, flower 14-19
- Forms arbuscular mycorrhizal associations
- Flowers attract pollinators

◆ [View table for known crop sequence effects](#)



Browntop Millet

(*Urochloa ramosa* (L.) Nguyen)

- Warm Season, grass
- Annual, Perennial
- Upright plant architecture
- Alternate name: dixie signalgrass
- Moderate water use
- Seeding depth: ½ - 1 inch
- Forms arbuscular mycorrhizal associations
- Self pollinator (wind)

Special Notes:

- * *If grown under dry or cold conditions, plant has potential to accumulate toxic levels of nitrate. Test before feeding to livestock.*
- * *Regarded as a weedy species in some areas of the United States.*
- * *Can be used for soil remediation of lead and zinc contamination.*



◆ [Back to Cover Crop Chart](#)

Warm Season Grass

Foxtail Millet

(*Setaria italica* L.)

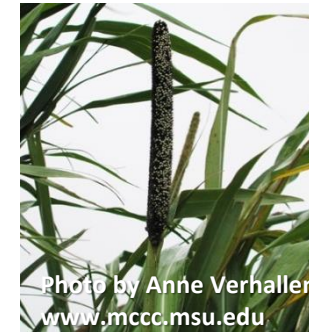
- Warm Season, grass
- Annual
- Upright plant architecture
- Alternate name: Italian millet
- Low water use
- Poor salinity tolerance
- Seeding depth: 1 inch
- Crude protein: hay 15%
- C:N ratio: 44
- Forms arbuscular mycorrhizal associations
- Self pollinator (wind)



Pearl Millet

(*Pennisetum glaucum* L.)

- Warm Season, grass
 - Annual
 - Upright plant architecture
 - Low water use
 - Poor salinity tolerance
 - Seeding depth: ½ – 1 inch
 - Crude protein: hay 13%
 - C:N ratio: 50
 - Forms arbuscular mycorrhizal associations
 - Self pollinator (wind)
- ◆ *View table for known crop sequence effects*



Proso Millet

(*Panicum milaceum* L.)

- Warm Season, grass
 - Annual
 - Upright plant architecture
 - Medium water use
 - Poor salinity tolerance
 - Seeding depth: 1 inch
 - Crude protein: hay 10%
 - C:N ratio: leaf 12-16, stem 12-35, root 17-26
 - Forms arbuscular mycorrhizal associations
 - Self pollinator (wind)
- ◆ [View table for known crop sequence effects](#)



Grain Sorghum

(*Sorghum bicolor* L. Moench)

- Warm Season, grass
- Annual
- Upright plant architecture
- Alternate name: Sorghum-sudan grass
 - *Grain sorghum and sudan grass were formerly separate species that have been combined. They are separated in the chart due to different plant attributes.*
- Medium water use
- Fair salinity tolerance
- Seeding depth: 1 – 2 inches
- Crude protein: hay 7%, stover 5%, grain 10%
- C:N ratio: leaf 11-17, stem 10-27, root 22-30
- Forms arbuscular mycorrhizal associations
- Self pollinator (wind)
- Stress conditions that limit growth (e.g., drought, frost) can contribute to prussic acid accumulation in leaves

◆ **[View table for known crop sequence effects](#)**



Sudan grass

(*Sorghum bicolor* L. Moench)

- Warm Season, grass
- Annual
- Upright plant architecture
- Alternate name: Sorghum-sudan grass
 - *Grain sorghum and sudan grass were formerly separate species that have been combined. They are separated in the chart due to different plant attributes.*
- Medium water use
- Fair salinity tolerance
- Seeding depth: 1 inch
- Crude protein: hay 7-11%, silage 6-17%
- C:N ratio: 48 - 63
- Forms arbuscular mycorrhizal associations
- Rated 'Excellent' at nutrient scavenging
- Self pollinator (wind)
- Stress conditions that limit growth (e.g., drought, frost) can contribute to prussic acid accumulation in leaves
- Known alleopathic effects on annual ryegrass



Teff

(*Eragrostis tef* (Zuccagni) Trotter)

- Warm Season, grass
- Annual
- Upright plant architecture
- Medium water use
- Poor salinity tolerance
- Seeding depth: ½ inch
- Crude protein: 10-18%
- Forms arbuscular mycorrhizal associations
- Self pollinator (wind)



Corn

(*Zea mays* L.)

- Warm Season, grass
 - Annual
 - Upright plant architecture
 - High water use
 - Poor salinity tolerance
 - Seeding depth: 1 – 2 inches
 - Crude protein: grain 9-10%, stover 5%, silage 8-11%
 - C:N ratio: stalk 11-65, leaf 13-20, root 20-49
 - Forms arbuscular mycorrhizal associations
 - Self pollinator (wind)
- ◆ *View table for known crop sequence effects*



Exhibit 6-5: A Comprehensive Guide to Cover Crop Species Used in the Northeast United States

Big Flats Plant Materials Center
3266-A State Route 352, Corning, NY 14830 • P 607.562.8404 • F 607.562.8516 • <http://Plant-materials.nrcs.usda.gov>

A Comprehensive Guide to Cover Crop Species Used in the Northeast United States

Prepared by: Shawna Clark

The following sections include 22 species that are used throughout the Northeast as cover crops. After each section and at the end of this review, the sources of information used are listed. Each reference will provide a more in depth description for the values given. This is a guide, based on literature from books, journal articles, and web sites, and will differ based on location and annual climatic differences.



Annual Ryegrass or Italian Ryegrass (*Lolium multiflorum*)

~annual, cool season, winter or spring annual (bunchgrass)

Planting Dates:	Source
mid-summer-early fall (@ least 40d before frost)	11
Mar 15- May 1 or July 20- Sept 15	3, 42, 76
Seeding Rates (lbs/A):	
20-30 bc; 10-20 dr; 8-15 mix	3, 11
12-15 mix; 20-25	42
(depends on use)	
Seeding Depth (in):	
.25-.5	3,11
Flowering Dates:	
June-Aug	71
Root System:	
shallow, dense fibrous	3, 91, 71
Winter-Kill Temp:	
will over winter	3, 71
Competition with weeds	
excellent	11, 3, 71
Total Dry Matter Biomass (lbs/A)	
2600 (OSU Extension)	90
3300-4000 (seeded early spring or late summer in ME)	20
1840 (Nov planted, seeded in March)	71
4000-8000 (multi-cut system, over full season with high moisture and fertility)	11
1300-2000 (fall seeded)	91
Root Biomass (lbs/A):	
778 (Nov planted, harvest in March)	71

Percent N (%):	Source
2.1-2.4	90, 71
ave 1.5 (fall seeded)	91
1.37	71
C:N Ratio:	
20:1-31:1	49,71
lbs/bu:	
24-26	
seeds/lb:	
217000-230000	71,77, 42, 49
Re-seeding Characteristics:	
very high, if not killed	11, 3, 71
Mix with:	
legumes, grasses	11
Soils:	
wide range, best in loam	3
5-8 pH	71
Shade Tolerance:	
intolerant	71
N (lbs/A): (high N user)	
43 (takeup) (if survives winter, CA Study from UCSARP)	11,71
62 (recycled)	90
~60 by mid-May following corn in MD study	11

Additional Comments:

~good for erosion control, improving aggregate stability

~can tolerate some flooding

~uses of a lot of water and N

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Austrian Winter Pea (*Pisum sativum*)

~summer annual legume (north)

Planting Dates:	Source
early spring as early as possible	11, 20
Mar-Apr or Sept-Oct	2
Aug or spring	66
Seeding Rates (lbs/A):	
60-90 dr	91
30-40; 20-30 mix	2, 77
140	3
100-220	20
Seeding Depth (in):	
.25-2	2, 51, 71
Inoculants:	
Rhizobium leguminosarum biovar viceae	77
Flowering Dates:	
32-55 d after seeding	71
Canopy Cover:	
26-36" fall	11
Root System:	
Shallow fibrous	66, 71
Winter-Kill Temp:	
will winter kill, but generally winter hardy (10 F)	11, 71
sustained below 18 F	11
Will not overwinter N of MD	66
Competition with weeds:	
high	11
Total Dry Matter Biomass (lbs/A)	
4000 (aboveground, in North East)	41, 67
5100-6200 (ME seeded early spring))	20, 90
5000 (planted in spring) (North East)	11, 41
3000 (NY)	30

Root Biomass (lbs/A):	Source
350-1000	88
Percent N:	
2.6	90
3-4	71
N (lbs/A) (producing):	
170-190 (PA)	66
90-150 (depending on incorporation)	11
119 (Southern Tier NY)	30
ave 99	26
50-150 (PA)	51
C:N Ratio:	
9:1-11:1	26
17:1	90
lbs/bu:	
60	2
seeds/lb:	
18000	76
Re-seeding Characteristics:	
does not re-seed well	32
Mix with:	
cereals, brassicas, and other legumes	66, 71
Soils:	
4.2-8.3 pH	71
well limed, well drained clay or heavy	
Shade Tolerance:	
Semi-tolerant	11
Cost (\$/lb)	
.60-1.20	11

Additional Comments:

- ~decomposes fast (low C:N ratio)
- ~reduces soil erosion, and supplies N to soil
- ~intolerant to salinity, drought, or water-logged soils

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Barley (*Hordeum vulgare*)

~spring, cool season annual, cereal grass

Planting Dates:	Source
Apr-May or Aug-Oct	2, 64
spring or summer	33, 43
spring	11, 20, 42
Sept 10-Sept 30	51
Seeding Rates (lbs/A):	
80-120 or 60-90 mix (bc)	2, 20
50-100 dr; 80-125 bc; 25-50 mix (spring)	11
50-125	43
72-96	42
90-120	64
Seeding Depth (in):	
.75-2	2, 43, 51, 11
Flowering Dates:	
mid-late summer	71
Root System:	
fibrous	11
Winter-Kill Temp:	
17.6 F	71
Competition with weeds:	
excellent	43, 71
Total Dry Matter Biomass (lbs/A):	
4500 (aboveground, killed end of Apr)	51
2570 (cut May 9 PA, seeded in fall)	92
3000-10000 (aboveground, grown until full bloom, SE US)	43
ave 8800 (spring seeded in ME)	20

Percent N:	Source
3.5 (PA Rodale)	92
1.2	71
N (lbs/A):	
38 (PA, Rodale)	92
45-50 (killed end of Apr)	51
62 (top N) (seeded fall; killed in May)	26, 29
C:N Ratio:	
20:1	71
medium	78
lbs/bu:	
48	2, 51
seeds/lb:	
13500-14000	2, 42, 51
Re-seeding Characteristics:	
does not re-seed well	71
Mix with:	
annual legumes, other small grains	11
Soils:	
5-8.5 pH	78
light soils	11
Shade Tolerance:	
intolerant	78
Cost \$/lb:	
.17-.37	11

Additional Comments:

- ~drought tolerant, high salt tolerance; quick growing, reduces soil erosion
- ~does not tolerate wet soils, low fertile soils, good salinity tolerance
- ~scavenger of excess nutrients and adds OM

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Brown Mustard (*Brassica juncea*)

~annual cool season forb

Planting Dates:	Source
Apr-May 15 (summer cover crop)	48
mid July-Aug (after cash crop)	3
mid May-June	11
spring (less in MI) or summer-fall (better)	33, 11
Seeding Rates (lbs/A):	
10-12 dr; 10-15 bc	71
5-12 dr; 10-15bc	3, 11
6-8	48, 33
Seeding Depth (in):	
.5-1.5	3, 48
Flowering Dates:	
Mid to late May	3
4-6 wks after planting	3, 71
Root System:	
taproot	59, 71
Winter-Kill Temp:	
17-25 F	11, 71, 78
Competition with weeds:	
allelopathic; very high	3, 30, 71
Total Dry Matter Biomass (lbs/A):	
8500 (Salinas Valley, CA)	11
Root Biomass (lbs/A):	
700 lbs/A (East Lansing MI)	61

	Source
N content (lbs/A):	
328 on high residual N veg ground	11
C:N Ratio:	
15:1; low	71, 78
lbs/bu:	
18	78
seeds/lb:	
200000-230000	48,78
Re-seeding Characteristics:	
high, do not let go to seed	3
Mix with:	
cereals, vetch	71
Soils:	
loam to heavy soils	59
pH 5.5-7.5	11
Shade Tolerance:	
intolerant	78
Cost /lb (\$):	
1.50-3.00	11
66/A	11

Additional Comments:

~do NOT use in rotations with other Brassicas

~good for weed suppression, nematode and soil fungal control, breaking up compacted soils, organic matter

~flowers will attract honey bees

~breaks down fast

~cannot tolerate flooding

~do not over-seed, too much will infect leaves with diseases

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Rapeseed or Canola (*Brassica napus*)

~annual spring forb (winter-types are Brassica rapa)

~canola is rapeseed that has been bred to have low conc. of glucosinates and erucic acid in the seed

Planting Dates:	Source
6 wks prior to killing frost	59, 87
Apr 1- May 1 or Aug 1- Sept 1	2, 71, 76
spring around corn time planting	59
Aug	3, 84
Seeding Rates (lbs/A):	
4-12	51
5-10 dr; 8-14 bc	3, 11, 87
5-8 dr; 4-6 mix	2, 72
Seeding Depth (in):	
.25-1	3, 71
Flowering Dates:	
early spring	76
Canopy Cover:	
80% or more	11
Root System:	
deep taproot	11
Winter-Kill Temp:	
low temps ~10 F (winter-type cultivars)	11
In ME will winter kill	
Competition with weeds:	
high (rapeseed)	59, 71
Total Dry Matter Biomass (lbs/A)	
1500-2500 lbs/A (ND)	48
4000-6700 lbs/A (seeded mid-June, harvested Sept)	3, 73
6200-8000 lbs/A 90d after seeding	30, 59
2500-3500 (MD)	84, 87

Root Biomass (lbs/A)	Source
4000-7600 (MA; MD)	72, 82
1000 (MD sampled in fall)	94
Percent N:	
low	78
Biomass of N (lbs/A)(accumulate):	
120 lbs/A	11
C:N Ratio:	
20:1-30:1 shoots: 10:1-20:1 roots	11
lbs/bu:	
50	48
seeds/lb:	
140000-157000	48, 49, 76
Re-seeding Characteristics:	
high in proper conditions	59, 76
Mix with:	
small grains	59
Soils:	
pH above 6	87
coarse textured	84
Shade Tolerance:	
intolerant	11
Cost/lb (\$)	
1.00-2.00; 80-100 \$/A	11, 30

Additional Comments:

~supplies organic matter, weeds suppression, enhances soil properties, captures nitrate, erosion control, use as forage

~does not perform well on poorly drained soils

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Turnips (*Brassica rapa*)

~annual, biennial cool season forb

Planting Dates:	Source
Aug-fall	3
spring-fall	87
~4wks prior to ave date of first 28 F	11
Seeding Rates (lbs/A):	
4-7 dr; 10-12 bc	3, 11
1.5-2	87
2-8 alone; 1-2 mix	
Seeding Depth (in):	
.25-.75	3
Flowering Dates:	
late spring	78
Root System:	
taproot	11
Winter-Kill Temp:	
yes- below 25 F	11
Competition with weeds:	
high	3, 11, 49
Total Dry Matter Biomass (lbs/A):	
4000-6700 lbs/A (seeded mid-June, harvested Sept, WI)	73
6200-8000 in PA	59
Root Biomass (lbs/A):	

C:N Ratio:	Source
20-30 shoots; 10-20 roots	11
lbs/bu:	
55	
seeds/lb:	
140000-220000	49, 77, 78
Re-seeding Characteristics:	
Will re-seed	
Mix with:	
cereals, vetch	11
Soils:	
5-8 pH	78
5.5-8.5	11
Shade Tolerance:	
intolerant	
Cost/lb (\$):	
1.00-2.00	11

Additional Comments:

~grows very fast and alleviates soil compaction

~low drought tolerance and a high fertility requirement

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Buckwheat (*Fagopyrum esculentum*)

~annual warm season forb/green manure

Planting Dates:	Source
12 wks prior to 1st frost	51, 48, 59, 71
June 15-Aug 15	33, 43, 64, 73
June	55
June-July	2,3
Seeding Rates (lbs/A):	73
30-50	2,3, 71
50dr; 70 bc	55
36-72	32
60-80	43, 51, 48, 64
50-60 dr; up to 96 bc	11
Seeding Depth (in):	
.5-1	2, 3, 43, 51
1-2	48, 55
Flowering Dates:	
mid summer	78
4-6 wks after seeding	17, 64, 71
Root System:	48
fine, extensive, fibrous, superficial	14, 64, 59, 71
Winter-Kill Temp:	
frost intolerant	71
Competition with weeds:	
it sown well, excellent	71
Canopy Cover:	55
dense	
Total Dry Matter Biomass (lbs/A):	
2000-3000 (NC)	14,17,43
1200-1800 lbs/A (PA, WI)	51, 55
4000-6000 (6-8 weeks after seeding)	11
Root Biomass (lbs/A):	

Percent N:	Source
1.25	17, 71
N (lbs/A):	
43 aboveground (NC)	14
C:N Ratio:	
34:1 (NC)	14
lbs/bu:	
48-52	2
seeds/lb:	
15000-20000	2, 78
Re-seeding Characteristics:	
yes, incorporate after 1 week flowering	14
~mow at 40 days	
Mix with:	
cowpeas, sesbina	71
Soils:	
most, poor on heavy limestone	51
avoid wet soils	
Shade Tolerance:	
intolerant	71
Cost (\$/A):	
30	14
30-32	11
11.00-12.50/bu	66

Additional Comments:

~use as smother crop, bee pasture, weed suppression, nutrient scavenging
 ~absorbs Ca, P

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Camelina sativa

~annual, summer oilseed crop or winter annual in warmer climates

Planting Dates:	Source
spring when soil temp is at least 38-40 F	87
Can be frost seeded in late Nov-Dec	96
Seeding Rates (lbs/A):	
3-5	87
Seeding Depth (in):	
.25-.50	
Flowering Dates:	
42-45 days from planting	96
Root System:	
Tap root	
Winter-Kill Temp:	
12	87
Competition with weeds	
good	87
Total Dry Matter Biomass (lbs/A):	
1800-2000 lbs of seed/A (sowed mid-march-april, harvested sept)	87
1000-1100 at 45 degrees N latitude	96

Additional Comments:

~tolerates drought stress
 ~Germinates and emerges in early spring before cereal grains.

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Percent N:	Source
2.42-2.73 (shoots)	Xue Pan, Nova Scotia University
C:N Ratio:	
High; due to its high cellulose content	
lbs/bu:	
50	
<i>Institute of Agricultural and Trade Policy</i> http://www.iatp.org/iatp/publications.cfm?accountID=258&refID=97279	
seeds/lb:	
225000-550000	87
Re-seeding Characteristics:	
Will produce viable seeds	96
Mix with:	
Legumes, spring wheat	87
Soils:	
Marginal lands	96
Shade Tolerance:	
Low-medium	
Cost:	
\$4.00/ lb	Ernst
\$45-\$65/A (reference directly below)	
<i>Institute of Agricultural and Trade Policy</i> http://www.iatp.org/iatp/publications.cfm?accountID=258&refID=97279	

Cereal Rye (*Secale cereale*)

~winter annual cereal grain (mainly for NE cv. 'Aroostook')

Planting Dates:	Source
Aug 1- Sept 30	75
late summer-fall	74
Late Aug-early Oct	64
2wks before kill frost/ 4wks after	18
Seeding Rates (lbs/A):	
90-120 (winter rye)	42
100-140; 50-60 mix	64
60-120 dr; 90-120 broadcast	3, 11
60-200	59
112-168	18
Seeding Depth (in):	
.75-2	55
Flowering Dates:	
early spring (Apr-May)	71, 78
Root System:	
extensive, fibrous	11, 71
Winter-Kill Temp:	
will over winter	11
Competition with weeds:	
high	11, 71
Total Dry Matter Biomass (lbs/A):	
2800-4000 (in ME seeded late summer/fall)	11, 90, 20, 79
6000-7000 (planted Sept, harvested mid-May WI)	29, 73
4000 lbs/A aboveground	18
1600 lbs/A top	51
Root Biomass (lbs/A):	
848 lbs/A 5 months after seeding	71
600 lbs/A	18, 89

Percent N:	Source
.89-1	90, 71
N (lbs/A):	
40-45 lbs/A N uptake	26
171 lbs/A of N in roots	71
313 lbs of N/A in tissue	71
80 accumulated(by May 19 plowdown in NY)	74
C:N Ratio:	
40:1 monoculture	71
25:1 biculture	71
40:1 @ boot; 14:1 young	51
48:1-50:1	14, 90
35:1	74
lbs/bu:	
56	
seeds/lb:	
15000-18000	42, 48, 55 ,77,78
Re-seeding Characteristics:	
high if let go to seed	71
Mix with:	
legumes, other grasses, vetches, brassica	11, 71
Soils:	
4.5-8.2 pH range	71, 78
low fertile	55
light loams, sandy	11
Shade Tolerance:	
intolerant	
Cost/lb (\$);	
.18-50	11
6.00-8.0/ bu	66

Additional Comments:

~prevents soil erosion, quick forage for grazing

~excellent scavenger for N and K, adds organic matter, suppresses weeds

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Forage Radish (*Raphanus sativus*); Oilseed Radish

~Annual cool season Forb

Planting Dates:	Source
late summer-fall	3, 43
4-10 wks before killing frost in fall	59
Seeding Rates (lbs/A):	
7-10 dr; 10-13 bc	3,43
Seeding Depth (in):	
.25-.5	10, 43
Flowering Dates:	
50-60days	
(Lesley Campbell, and Allison Snow OSU)	
Root System:	
Taproot (8-14 inches)	3, 59
Winter-Kill Temp:	
20-25 F (Dec-Jan)	82, 11
Competition with weeds:	
yes; allelopathic	87
Total Dry Matter Biomass (lbs/A):	
3000 lbs/A for late Aug planting	87
3600 lbs/A aboveground	46, 81, 82
3000lbs/A in 60d	10
6500	90
Canopy Cover:	
within 1-4 months closed canopy (depends on growing conditions)	71
Root Biomass (lbs/A):	
3000 (MD, sampled at max growth in fall)	94
as high as 3700 (belowground)	11

Additional Comments:

~quick forage for grazing, high N,P, S, Ca, B content

~significant amounts of N may be lost if next crop not planted in time to recapture N

~not recommended for planting in either corn or soybeans

Percent N:	Source
2.67	36
2.11	90
N (lbs/A):	
140(in MI and in MD)-200 lbs/A of N released in early spring	11, 71, 94
170 (in MD)	
184 N recycling	90
C:N Ratio:	
13:1	36, 71
19.5	90
lbs/bu:	
50	48
seeds/lb:	
140000	48, 77
Re-seeding Characteristics:	11
Will re-seed in warmer climates	
Mix with:	
other brassicas, mustards, small grains or crimson clover	11
Soils:	
well drained, pH 5.5-8.5	10
Shade Tolerance:	
intolerant	
Cost/lb (\$):	
1.5-2.50	11
Cultivars:	
Groundhog Forage Radish	

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Hairy Vetch (*Vicia villosa*)

~winter annual legume

Planting Dates:	Source
Aug 1-Sept	2, 3, 38, 51, 64, 66, 71, 75, 77, 87
sow by Oct 15	71
@ least 30-40d before killing frost	59
Inoculants:	
Type "C" Nitrogen	71
Seeding Rates (lbs/A):	
25-40 dr	2
15-20 dr; 25-30 bc	3, 11
20-40 dr	66
Seeding Depth (in):	
.25-1.5	2, 51, 71, 77, 87
Flowering Dates:	
May-July	59, 71, 78
mid July-Aug	
Root System:	
taproot	71
Winter-Kill Temp:	
will survive winter if planted 30-40d before frost	66
Competition with weeds	
high, once established	2
Total Dry Matter Biomass (lbs/A):	
2000-5000	8, 29, 90
4000 aboveground (PA, drilled at end of Sept)	66
4300-7000 lbs/A	71
3000-4000 lbs/A (normal, fall seeded in ME)	20, 30, 51, 59, 67

Additional Comments:

~supplies N to soil, improves soil tilth, erosion control, suppresses weeds
 ~most useful in veg crop production when sown in late summer

~High P and K requirement

Percent N:	Source
2.5-4	90, 71, 87
3.76	8
N (lbs/A): (most occurs in May)	
80-160 lbs/A provide	51
averaging 110 lbs N/A contribution (planted by mid-Sept, N available by mid-May)	11, 59, 67
ave 110-115 (N content)	26, 30, 60
140-150	38
71-85 (NC Coastal Plain)	80
C:N Ratio:	
10:1-15:1	26
8:1-15:1	11
11:1	71
lbs/bu:	
60	2, 51
seeds/lb	
16000-20000	2, 51, 77, 78
Re-seeding Characteristics:	
high, has fraction of hard seed	3, 59, 71
10-20% hard seed	66
Mix with:	
cereal grains, grass, brassicas	11
Soils:	
6-7 pH	11, 71
does not perform well on poorly drained soils	61
does best on sandy loam soils	59, 71
Shade Tolerance:	
tolerant	11
Cost/lb (\$)	
1.70-2.50	11
~1.00	66

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Japanese Millet (*Echinochloa esculenta*)

~summer annual grass

Planting Dates:	Source
after frost	43
June 15-July 15 (in MN and WI)	55
April- July	2,91, 48
Seeding Rates (lbs/A):	
15-30 dr; 25-35 bc; 8-12 mix	2
20-30 best	14, 20, 43, 71
10-15	48, 55, 91
Seeding Depth (in):	
.5-1	2, 43, 55, 71
Flowering Dates:	
Ripe grain after 45 days from seeding	
End of June-Sept (www.ext.msstate.edu/pubs/pub2111.htm)	
Root System:	
Extensive Fibrous	20
Winter-Kill Temp:	
yes	43
Competition with weeds	
high	43, 71
88-91% weed suppression 6wks after seeding	64
Total Dry Matter Biomass (lbs/A):	
3000 (NC)-5000 lbs/A	14, 73
high yields	55

Additional Comments:

- drought tolerant
- late season green forage
- Exceptional wildlife plant

	Source
Biomass of N (lbs/A):	
35 lbs/A aboveground (NC)	14
C:N Ratio:	
42:1 (NC)	14
lbs/bu:	
35	2
50	14
seeds/lb:	
143000	2
Re-seeding Characteristics:	
Medium to high	
Mix with:	
Over seed into spring crop	20
Soils:	
Med-heavy soils	
5.8 or greater pH	
Shade Tolerance:	
Cost (\$/A):	
14.50	14

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Oats (*Avena sativa*)

~annual cool season grass

Planting Dates:	Source
Mar 15-Apr 25	52, 75, 87
Aug-early Sept	64, 71, 73
early spring-July 1	43
no later than Sept 15	18
Spring (green manure) or fall (winter cover)	3
Seeding Rates (lbs/A):	
80-110 dr; 110-140 bc	3, 87
64-120; or 60-90 mix	2
60-96	42, 48, 51, 73, 75
Seeding Depth (in):	
.5-2	2, 43, 51, 77, 87
Flowering Dates:	
late spring	71, 78
Root System:	
fibrous	
Winter-Kill Temp:	
18 F	71, 87
Competition with weeds	
strong when in a mix; allelopathic	71
Total Dry Matter Biomass (lbs/A)	
2500 lbs/A	18, 46
8000-12000 lbs/A	17, 71
2000-8000 (up to 8000 in spring seeded)	11, 43
5000-6000 (planted mid-Apr, harvested late June, WI)	73
5000 (harvested between boot and dough in VT)	
Root Biomass (lbs/A):	
977 lbs/A	18

Additional Comments:

~primary use for veg. crops, nurse crop for legumes

~suppresses weeds, erosion control

~quick cover

Percent N:	Source
1.2-1.5	17, 71
Cover:	
80% if planted as early as possible	11
N (lbs/A):	
12 lbs/A catch	71
77 (absorb in 8-10 weeks in NE)	11
C:N Ratio:	
33:1	71
lbs/bu:	
32	2, 48, 87
seeds/lb:	
15500-19400	2, 42, 48, 87
Re-seeding Characteristics:	
low when left over winter	71
Some may survive, incorporate in spring	3
Mix with:	
vetches, brassicas, barley	71
Soils:	
tolerate pH as low as 4.5	71
best on loam-heavy loam	
Shade Tolerance:	
intolerant	
Cost/lb (\$):	
.17-37	11
3.85-5.00/bu	66

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Perennial Ryegrass (*Lolium perenne*)

~cool season perennial grass

Planting Dates:	Source
April-late Sept	77, 87
Mar-May or Aug 1- Sept 15	71
Feb-May or Aug-Sept	2, 64
early spring	20, 42
Seeding Rates (lbs/A):	
14-25	66
20-40; 4-15 mix	2, 42
15-20; 4-8 mix	87
18-25; 10-15 mix	71
18-20	64
Seeding Depth (in):	
.25-.5	2, 71, 77, 87
Flowering Dates:	
mid-spring	78
May-Sept	71
Root System:	
extensive fibrous	70
Winter-Kill Temp:	
more cold hardy than annual, but will in extreme temps	59, 64
Competition with weeds:	
yes, best in a mix	71
Total Dry Matter Biomass (lbs/A):	
1750 lbs/A	18
3000-4000 (early summer in ME)	20
Root Biomass (lbs/A):	
1500 lbs/A	18
6000 (Sown in corn and sampled following spr. Before plowing, OH; all parts underground) 42 (N content)	60

Percent N:	Source
2.3	71
Biomass of N (lbs/A):	
60 lbs/A in aboveground tissue	71
C:N Ratio:	
14-40 (based on plant growth stage)	
lbs/bu:	
24	2, 42, 55, 78
seeds/lb:	
227000-240000	2, 42, 55, 77, 78
Re-seeding Characteristics:	
High, if not winter killed	64
Mix with:	
clovers, trefoil, other grasses	71
Soils:	
not tolerant of pH above 8	71
best on heavy soils with good drainage	
Shade Tolerance:	
tolerant	
Cost/lb (\$);	
.7-1.30	11
.44-1.05	66

Additional Comments:

~good nutrient scavenger, establishes readily, excellent wear tolerance, high nutritive value

~great for erosion control

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Phacelia tanacetifolia

~annual cool season forb

Planting Dates:	Source
late spring- summer	
Seeding Rates (lbs/A):	
11-18	
7-12 dr	
Seeding Depth (in):	
.25"	
Flowering Dates: (blue flower)	
6-8 weeks after seeding (late aug-sept)	71
Root System:	
extensive fibrous	71
Winter-Kill Temp:	
18 F	
Competition with weeds	
yes, grows quick	71
Total Dry Matter Biomass (lbs/A):	
ave 4000 lbs/A aboveground	71
8500	85
Root Biomass (lbs/A):	
1300 lbs/A in 6 months	71

Percent N:	Source
4	71
Biomass of N (lbs/A):	
94.6 lbs/A supplied to system	71, 85
178 lbs/A N belowground	71
127 lbs/A N aboveground	71
C:N Ratio:	
10-15	
lbs/bu:	
n/a	
seeds/lb:	
235000	
Re-seeding Characteristics:	
low	
Mix with:	
Soils:	
Wide range	
Shade Tolerance:	
Not shade tolerant	
Cost:	
Not widely available, expensive- American Meadows VT \$15.95/lb	

Additional Comments:

~N catch crop, nectar source

~Low water use

One of the top producing honey producing flowers for honeybees and is also highly attractive to bumblebees and syrphid flies.

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Red Clover (*Trifolium pratense*)

~short-lived biennial/perennial legume

Planting Dates:	Source
Feb-May or Aug-Sept	2, 42
Feb 1-Apr 15 or Aug 1-Sept 15	3
April-May	51
Seeding Rates (lbs/A):	
8-12; 4-8 mix	2
10-15 bc; 6-15 dr	51
10-12; 6-8 mix	42, 87
12-14; 8-10 mix	73
Seeding Depth (in):	
.25-5	2, 42, 51, 77, 87
Inoculants:	
Rhizobium leguminosarium biovar trifoli	
Flowering Dates:	
May	3, 78
Root System:	
thick, deep taproot	51, 59, 66, 87
Winter-Kill Temp:	
low	87
Competition with weeds:	
Total Dry Matter Biomass (lbs/A):	
2000-2500	29,90, 54, 59, 87
4000-8000 full season over wintered	11
4000-6000 (spring, fall seeded in ME)	20
Root Biomass (lbs/A):	
1000 (averaged at 48 dates, OH)	60
(N content in roots 22/A)	

Percent N:	Source
2.61-2.77	90, 71
Biomass of N (lbs/A):	
100-150 lbs/A fix	39
70-120 (In OH, PA, over wintered 75 by May 15, up to 120 by June 22)	3,11, 66
125.1 lbs/A in aboveground; 46.3 lbs/A in roots	71
70-80 seeded and turned under in spring	59
C:N Ratio:	
15:1	90, 71
lbs/bu:	
60	
seeds/lb:	
252000-275000	2, 49, 42,51
Re-seeding Characteristics:	
kill before go to seed, will re-seed	63
Mix with:	
small grains, sweetclover, corn, soybeans, grass	11
Soils:	
loams- clays,	43
6.2-7 pH preference	59
Shade Tolerance:	
very tolerant	43, 66
Cost/lb (\$):	
1.40-3.30	11
.90-1.30	66
Distinct types:	
Medium, and Mammoth	11

Additional Comments:

~can cause bloat in livestock

~addition of N to system, weed suppression, erosion control

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Sorghum-Sudangrass (*Sorghum bicolor x S. bicolor var. sudanese*)

~warm season summer annual grass

Planting Dates:	Source
late spring-midsummer (May 1-July 1)	2, 3, 43, 48, 64, 55, 73, 75
when soil is at least 70 F	43
Seeding Rates (lbs/A):	
25-30	51
20	2, 55, 73, 75
30-40dr; 40-50 bc	43, 71
Seeding Depth (in):	
.5-1	2, 42
Flowering Dates:	
early summer	78
Aug	71
Root System:	
fibrous	71, 75
Winter-Kill Temp:	
very frost sensitive	42, 71
Competition with weeds:	
very high	48, 71
Total Dry Matter Biomass (lbs/A):	
4000-5000 (planted in early summer ME)	20
6000-10000 (seeded July 1, harvested mid-Aug WI)	73
7000 (NC)	14
13000-18000 (potential in WY, planted May-July 1)	59, 93
Root Biomass (lbs/A):	
1350	21

Percent N:	Source
.68-1.5	90 71
Biomass of N (lbs/A):	
185 lbs N/A recycled	90
78 aboveground (NC)	14
C:N Ratio:	
63:1	90
50:1	14, 71
lbs/bu:	
56	55, 87
seeds/lb:	
14000-28000	2, 42, 49, 55, 87
Re-seeding Characteristics:	
Low in the northeast	
Mix with:	
buckwheat, sesbina, sunn hemp, soybeans, cowpeas	59
Soils:	
can tolerate 8-9 pH	71
Or as low as 5 pH	11
Shade Tolerance:	
intolerant	
Cost/lb (\$):	
.4-1.00	11
16.20/A	14

Additional Comments:

~great use for SOM; Heat and Drought tolerant

~very high salt tolerance

~if stressed or succumb to frost, can produce prussic acid

~great scavenger for residual N, Suppresses weeds, builds soil tilth, breaks up compacted soils

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Yellow Blossom' Sweetclover (*Melilotus officinalis*)

~cool season biennial legume

Planting Dates:	Source
Feb1-May or July 20-Aug 30	2, 33, 56, 71, 77, 49
Seeding Rates (lbs/A):	
20-30	33
6-15; 3-8 in a mix	2
10-15	71
9-20	20, 43, 59
Flowering Dates:	
May-Aug (kill before flowering to max N benefit)	71, 78
Late June- July	64
Root System:	
deep taproot	11, 49, 59, 71
Winter-Kill Temp:	
winter hardy	49, 71
Competition with weeds:	
Grow slowly in first 60d	11
Total Dry Matter Biomass (lbs/A):	
2000-6000	54
up to 3000 in establishment year (NE)	11, 67
7500 lbs/A aboveground 2nd year (ME)	20, 59
Root Biomass (lbs/A):	
2640 (Nov seeding yr. OH) 95 (N content)	60
800 (July, yr following seeding, OH) 13 (N content)	90
Inoculant:	
<u>Sinorhizobium meliloti</u> and <u>Rhizobium leguminosarum biovar trifolii</u>	

Additional Comments:

- ~drought, flood, and salt tolerant
- ~good cover for wildlife, and can be harmful to livestock (Coumadin)
- ~good smother crop or catch crop, rapid growth rate
- ~greatest warm weather biomass producer of any legume

Percent N:	Source
2	71
N (lbs/A):	
90-170 lbs/A fix ((in OH 125 by May 15 to 155 by June 22)	11, 43
130-150 lbs/A fix (NE)	49, 67
averages ~100	59
C:N Ratio:	
12-23	78
lbs/bu:	
60	2, 48, 55
seeds/lb:	
240000-260000	2, 48, 49, 55, 78
Re-seeding Characteristics:	
high (hard seed)	18, 43
Mix with:	
small grains, red clover	11
Soils:	
6.5-7	59
best loam soils, tolerate heavy clay-light sand	59
Shade Tolerance:	
intolerant	
Cost/lb (\$):	
1.00-3.00	11

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Triticale (*X Triticosecale*)

~annual cool season cereal crop

Planting Dates:	Source
Aug - Oct 15 (winter crop)	20,43,75,87
late Apr- mid May (spring crop)	48,73
Aug 25-Sept 25 (winter crop)	3
Mar-Apr or Aug-Oct	2
Seeding Rates (lbs/A):	
75-100	20, 48
80 dr; increase 30% if bc	3
90-120; 60-90 mix	2
Seeding Depth (in):	
1.25-2	2,3,48
Flowering Dates:	
48 days to heading	55
Root System:	
fibrous	
Winter-Kill Temp:	
Winter hardy	3
Competition with weeds:	
Moderate, not as good as rye	
Total Dry Matter Biomass (lbs/A):	
6000-7000 (planted Sept, harvested early June WI and in WY)	73, 93
4000-8000 flag leaf stage	3,43,56
2000 (late Aug planting)	87
7000 (harvested June 2 in Arlington, WI)	55
4000 (harvested between boot and dough in VT)	16

Additional Comments:

~use as a double crop and erosion control on highly erodible lands

~Good at reducing root rot in vegetables

~Advantage over wheat, can be sown earlier for more fall growth

Biomass of N (lbs/A):	
Kill before stems elongate for best N value	3
66.2	
C:N Ratio:	
20:1	
lbs/bu:	
48-50	2, 48
seeds/lb:	
15000-18000	2, 49,77
Re-seeding Characteristics:	
high	
Mix with:	
Other winter grains	
Soils:	
fertile, well drained	48
Shade Tolerance:	
Not tolerant	

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Wheat (*Triticum aestivum*)

~annual, winter cereal grain

Planting Dates:	Source
mid Sept-Oct 1	3, 42, 43, 51, 64
Aug 15-Spet 15	
Mar-Apr or Aug-Oct	2
Seeding Rates (lbs/A):	
90-120	42, 51
120-160 dr	87
60-120; 60-90 in a mix	2
80-110	64
Seeding Depth (in):	
1-2	2, 43, 51, 87
Flowering Dates:	
Spring (winter wheat)	
Root System:	
fibrous	
Winter-Kill Temp:	
winter hardy	3
Competition with weeds:	
Low, especially annual grasses	
Total Dry Matter Biomass (lbs/A):	
2500-4500 lbs/A	51,64, 87
3800 (harvested between boot and dough in VT)	16
4000-5500 (if planted in Aug, in CO)	11, 59
3000-7000	43
Root Biomass (lbs/A):	
1300	21

Additional Comments:

~good in rotation with veg crops

~excellent N scavenger

Percent N:	Source
1.67	8
N (lbs/A):	
40-45 lbs/A scavenges	26, 51
50 (tops)	29
C:N Ratio:	
20:1	26
Leaf: 15-29; stem: 31-65; root: 24-74; straw: 80-95 (end of season)	
lbs/bu:	
60	2
seeds/lb:	
11000-18000	2, 42, 77
Re-seeding Characteristics:	
later than ryes	18
Mix with:	
annual legumes, ryegrass, small grains	11
Soils:	
well drained, med texture,	
Shade Tolerance:	
tolerant	78
Cost/lb (\$);	
.10-.30	11

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White Clover (*Trifolium repens*)

~perennial, cool season legume

~'Ladino' is longer lived than 'Dutch' or 'New Zealand'

Planting Dates:	Source
Feb-May or Aug-Oct	2
early spring-late summer	59, 66
spring or Aug 15-Sept 10	3, 42
Feb 1-May 1 or July 20- Aug 20	77
Seeding Rates (lbs/A):	
4-6; 2-4 in a mix	2, 71
6-14	59, 66
5-9 dr; 7-14 bc	3
8-10; 1-2 mix	42
Seeding Depth (in):	
.25-5	2, 77, 87
Innoculant:	
Rhizobium leguminosarum biovar trifoli	
Flowering Dates:	
late spring- summer	78
Root System:	
shallow, taproot	71, 87
Winter-Kill Temp:	
winter hardy	71
Competition with weeds:	
high (once established)	71
Total Dry Matter Biomass (lbs/A):	
600-1400	90, 54
3000-6500	71
Root Biomass (lbs/A):	

Additional Comments:

~stoloniferous

~thrives in moist, shady condition

~causes bloat in horses

~poor summer growth, low yields

Percent N:	Source
2-3	90, 71
N (lbs/A):	
116 lbs/A to the system	71
ave 130 lbs/A (plow at bud or early flower stage and in PA)	11, 59, 66
C:N Ratio:	
13:1	90
12:1	71
lbs/ bu:	
60	2, 48
seeds/lb:	
711000-860000	2, 42, 48, 49, 77, 78, 87
Re-seeding Characteristics:	
yes under favorable conditions	71, 87
Also has creeping stolons	3
Mix with:	
grasses	71
Soils:	
6-7 pH	59, 87
tolerate wet, loam clay	.3
Shade Tolerance:	
tolerant	3, 11, 71
Cost/lb (\$):	
1.10-4.00	11
2.00-3.00	66

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Exhibit 6-6: North Dakota NRCS Specification for Design of Windbreaks

CONSERVATION PRACTICE SPECIFICATION

Windbreak/Shelterbelt Establishment – 380

This document provides conservation planners with the parameters, procedures, and requirements for developing site-specific plans for windbreak and shelterbelt systems for a variety of purposes. Where appropriate, specific references are cited to provide detailed information needed for a successful design. Note: FOTG refers to NRCS' Field Office Technical Guide.

The supporting documents needed to complete a windbreak design are:

- Windbreak Suitability Groups are found in county specific Interpretive Tables in FOTG – Section II – Soil Information.
- Tree Care and Management is located in FOTG Section I – Reference Subjects – Windbreaks and Woodland.
- Expected 20-Year Tree Heights by Windbreak Suitability Groups is located in FOTG Section II – Windbreaks and Forest.
- Tree and Shrub Characteristics table is located in FOTG Section I – Reference Subjects – Windbreaks and Woodland.

No matter the purpose of the planting, most plantings are simply modifications of two basic windbreak/shelterbelt designs.

1. Building site or livestock shelterbelts, which are multiple row plantings, designed to protect farmsteads, feedlots or other building sites. They may be designed to protect livestock or other animals wherever that protection is needed.
2. Field windbreaks that are single- or multiple-row plantings designed to prevent erosion, protect crops and roads, to harvest snow, to provide noise or visual screens or to supplement building site or livestock shelterbelts.

WINDBREAK SUITABILITY GROUPS

To determine which trees will grow satisfactorily on which soils and to determine the expected heights after 20 years, refer to Windbreak Suitability Groups found in county specific Interpretive Tables in FOTG – Section II – Soil Information for each soil component and Expected 20-Year Tree Heights, respectively.

WOODY PLANT STOCK

To determine which type of plant stock is appropriate for windbreak/shelterbelts refer Tree Care and Management, page 2.

STOCK STORAGE HANDLING AND CARE REQUIREMENTS

To determine proper stock storage, handling and care requirements, refer to Tree Care and Management pages 3-4.

SITE PREPARATION

To determine an appropriate method of site preparation, refer to Tree Care and Management pages 4-8.

PLANTING

To determine an appropriate planting technique for a particular stock used in a windbreak/shelterbelt system, refer to Tree Care and Management pages 8-11.

ORIENTATION, LOCATION, SETBACKS

When designing a windbreak, consider the effects of the surrounding topography and land management on the ability of the windbreak to perform its function. Conversely, consider the positive

and potentially negative impacts the windbreak may have on the surrounding land uses. A sample of the items to consider include: areas of snow drifts, water runoff from melting snow, water erosion potential, stifling of air flows during the summer, visibility hazards, ice blockage of drains, etc.

Orientation

Wherever possible the plantings should be oriented perpendicular to troublesome winds. Since winds rarely blow from the same direction all the time, base the design on the predominant wind direction during the time that the area needs protection. For snow control or harvest purposes and for winter livestock or farmstead protection in North Dakota, predominant winter winds come from the northwest, except in the Red River Valley where they generally come from the north-northwest.

However, not all damaging storms come from the predominant wind direction. Individual sites can vary considerably. Late season snowstorms could plug a road from a southeast direction or fragile crops could be blasted by a hot, dry wind from the southwest. Determine what needs protection and from where the damaging winds originate and locate the windbreak/shelterbelt accordingly.

Locations

All Windbreaks

Windbreak design is often based upon the downwind protection provided by the windbreak at 20 years of age. This distance is measured in multiples of windbreak height at 20 years and is referred to as H. H = height of tree or shrub, measured at 20 years unless otherwise noted. For certain situations H may be multiplied by values other than 10. (15-20 H for a snow spreading windbreak.)

On sloping land they should be located as near to the contour as possible to reduce erosion risks and water loss.

In western North Dakota or on droughty soils consider locating windbreaks to allow the diverting of water from adjacent areas into the windbreak for supplemental moisture.

Windbreaks to trap snow for supplemental water in stock ponds should be located in a position to dump the majority of the snow close to, or in, the stock pond or major tributaries. Avoid tree species such as cottonwood, willow etc. that are heavy water users. Windbreaks for this purpose should be as narrow and dense as possible (ex: twin-row conifer or twin-row shrub).

Windbreaks will be positioned to avoid causing visibility problems at road intersections, curves and driveway entrances. Generally speaking, the trees or shrubs at maturity should not spread into the right-of-ways of roads. Refer to Tree and Shrub Characteristics for the spread (width) of plants at maturity.

Maximum snow deposition will usually occur within a zone located 2-5 H from the most windward dense row. This relationship holds true for dense windbreaks as well as porous windbreaks. Differences in snowdrift depth are more pronounced on more dense windbreaks.

Tree and shrub plantings on native range and/or wetlands is permitted only after alternative treatments have been evaluated and then only to protect infrastructure (building sites, roads, livestock).

Primary Windbreaks

Windbreaks primarily for wind protection and snow control are usually located to the north and west of the area needing protection.

Windbreaks needed primarily for wind protection of crops shall be located in a manner that places them between the troublesome winds at the critical stage of the crop needing protection.

Snow traps located 50-150' upwind of the primary windbreak can increase effectiveness of the rest of the windbreak system by reducing the amount of snow needing to be stored in the primary windbreak. (MLRA 55 and 56).

Trapping of snow outside the primary windbreak in Major Land Resource Areas 53, 54, and 58 should be planned with caution, since the removal of snow moisture from the root zone of the main windbreak may adversely impact the life and effectiveness of the windbreak.

All areas needing protection should be located within the 10H - 15 H zone on the leeward side of the windbreak. Estimates of 20-year heights of trees and shrubs needed to calculate areas of protection can be found in [Expected 20-Year Tree Heights](#).

Field windbreaks designed for snow spreading may be spaced up to 20 H apart.

Secondary Windbreaks

Secondary windbreaks are located on the leeward sides, usually the south and east, of the area protected by the primary windbreak.

Secondary windbreaks usually consist of shrubs or short trees to stop the rare snowstorm from the south or east while allowing summer breezes to penetrate the protected area.

Setbacks

All Windbreaks

Windbreaks shall be located no closer than 16 feet away from any property line unless a signed agreement between both owners exists that would permit a closer planting.

According to North Dakota Century Code, no trees or shrubs may be placed within 33 feet of a section line unless written permission has first been secured from the county commissioners or township supervisors.

No trees shall be placed within the easement area of overhead transmission lines unless permission has been secured from the appropriate utility company.

As per international treaty, no trees or shrubs shall be planted in a location where the foliage, at maturity, will encroach upon the 20' wide (10' each side) line-of-site vista along the Canada-USA border.

Windbreaks that are adjacent to, or cross, legal and private drainage ways should be set back at least 100' to prevent snow and ice buildup that will restrict spring drainage.

In all cases, if local units of government have established more restrictive setback distances, then the more restrictive regulations will apply.

Primary Windbreaks

For windbreaks north and/or west of the area needing protection, the most windward row must be at least 200 feet from the area to be protected. See Figure 1.

When measuring from roadways, the measurement should begin at the edge of the road surface nearest to the proposed windbreak. See Figure 2. The most

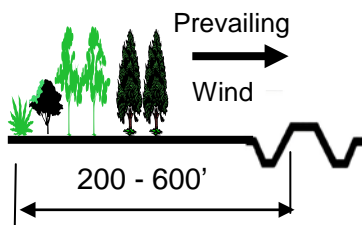


Figure 2

windward row of a snow trap can be used for setback measurement purposes. This setback distance also applies to the ends of windbreaks that are perpendicular to roads and areas needing protection.

The setback distances may be reduced by 50 feet if topography, healthy field windbreaks upwind, reduced fetch distances, or long term crop management practices can be expected to remove 50

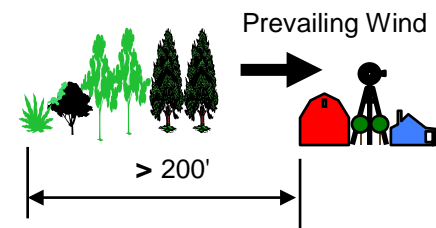


Figure 1

percent or more of the typical snow load before it reaches the main windbreak.

Leeward rows of primary windbreaks, located to the north or west of a road, even with the minimum 200-foot setback to the windward row, should be no closer than 100 feet to the nearest traveled portion of a public road. See Figure 3.

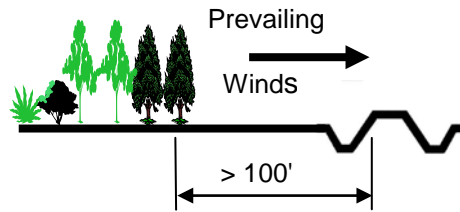


Figure 3

For snow control, windbreaks should not be placed farther from the area needing protection than 35 times the expected 20-year height of the tallest species to be planted or 600 feet, whichever is smaller.

Windbreaks planted to the south or east of roadways shall be located no closer to the road than 5 times (5H) the mature heights of the trees and/or shrubs in order to reduce upwind snow deposition and shading problems. Refer to [Tree and Shrub Characteristics](#) for mature plant heights. When measuring from roadways, measurements begin at the portion of the road surface nearest the proposed planting. See Figure 4.

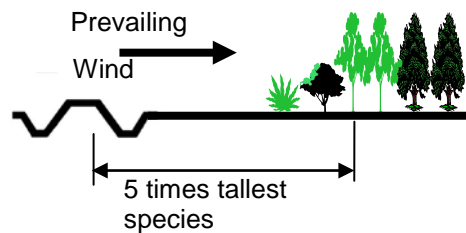


Figure 4

Secondary Windbreaks

In North Dakota, secondary windbreaks are usually located to the south and east of the areas needing protection. Secondary windbreaks should be located far enough away from the area needing protection to allow snow deposition where it won't be a problem and to provide year-round accessibility in and around the area protected.

The inside tree or shrub row in windbreaks on the south and east of areas needing protection shall not be any closer than 100 feet. Where solar gain during the winter is important, windbreaks on the south side of a building site shall be no closer than 3 times the mature height of the tallest plant. Exercise caution in utilizing tall trees in secondary windbreaks that may restrict summer breezes.

WINDBREAK DESIGN

General Information

Windbreak tree species shall be selected that are compatible with the soils on which they will be planted. Refer to the Expected 20-Year Tree Heights, located in FOTG – Section II – Windbreaks and Forest, to determine which plants will grow on which soils. Most soil map units contain small percentages of minor soil components. See [Windbreak Suitability Groups by County](#) in Section II FOTG to determine component soils within each map unit. Ensure that the species selected are compatible with these minor components as well. Changes in soil properties within the planting site may require a species change within the row. If there is any doubt, select species appropriate for the most limiting soil condition.

Unless otherwise noted, 20-year plant heights will be used to determine setback distances and the extent of protected areas. Expected 20-year heights of trees and shrubs, under good management, can be found in [Expected 20-Year Tree Heights](#).

Maximum snow depth can be expected within 2-5 H from the tallest tree or shrub row, under normal winter conditions. The deepest part of the snowdrift will be closest to dense windbreaks and will be located progressively farther away from the windbreak as windbreak density decreases.

Zones of protection will vary, depending upon density and height of the windbreak. Generally, the denser the windbreak the greater the wind speed reduction and the smaller the zone of protection.

No more than two rows in any windbreak system shall be of the same species unless site conditions restrict the number of available species.

Ends of windbreaks should extend at least 200' past the area needing protection to account for end effects and to allow for shifts in wind direction.

If there is insufficient space or suitable soils to install the normally required minimum number of rows, a narrower windbreak is permissible, though a minimum of 1 shrub row and 2 deciduous tree rows- or 2 coniferous rows- shall be established.

Design Purpose

All Windbreaks

Design living snow fences and farmstead and feedlot windbreaks, for circumstances worse than average. I.e.: Don't scrim on setbacks, number of rows or diversity of species.

Field windbreaks can be designed for average conditions for the time of year during which protection is needed.

The minimum number of rows for a primary windbreak will vary, depending upon the purpose of the planting. Refer to Table 1 for spacings to achieve targeted within-row densities.

Any design of one or more rows is acceptable for a secondary windbreak.

For Snow Control

Two or more rows of deciduous trees and/or non-suckering shrubs; or one or more rows of conifers and/or suckering shrubs. Multiple rows of different species are strongly encouraged. Refer to Table 1 for within-row and between-row spacings.

For Snow Spreading on Cropland, or Pastureland

Suckering shrubs, spruces, junipers, cedars or arborvitaes are not suitable.

The windbreak shall consist of one row of non-suckering shrubs, deciduous trees, larches or pines. Multiple rows of pines or shrubs may become too dense to effectively spread snow. Extra maintenance is required when relying upon a single row to ensure that no gaps develop in the windbreak.

Lower limbs may be pruned or plants thinned, especially on pines or shrubs respectively, to increase snow distribution, reduce drift height and subsequent delays in field operations near the windbreak. Refer to Table 1 for within-row and between-row spacings.

For Erosion Control

One or more rows of deciduous shrubs, trees or conifers are appropriate for erosion control windbreaks. See Table 1 for in-row spacings to achieve desired density. Use wind erosion formulas to determine windbreak spacing across a field to achieve desired soil protection. For some sensitive crops, any erosion, even if below soil loss limits, may be damaging to the crop. Windbreak systems shall be designed to limit the maximum of soil erosion to, or less than, the amount the planned crop will tolerate. To determine these tolerances, refer to table 502-4 – “Crop tolerance to blowing soil” in part 502 of the National Agronomy Manual. The National Agronomy Manual is located in FOTG – Section I – Erosion Prediction.

For Traditional Crop Protection

Plant one or more rows of deciduous shrubs, trees or conifers. Use 10 times the 20-year height, measured parallel to the problem wind to determine the protected area. This measurement- when combined with the results of the most current wind erosion calculations- will yield the appropriate windbreak spacings. To increase farmability between windbreaks, reduce the spacings between windbreaks to those of even tool bar widths. Increased windbreak density increases crop protection benefits but slightly reduces the overall area receiving benefits. Be alert to how increased density for

crop protection may result in delayed spring fieldwork because of narrow, deep snowdrifts. Refer to Table 1 for within-row and between-row spacings.

For Specialty Crop Protection

Usually, more than one row of non-suckering shrubs or deciduous trees will be needed to provide adequate wind protection. One or more rows of suckering shrubs or conifers may provide the desired protection. Refer to Table 1 for within-row and between-row spacings. Ensure that the planting has adequate density close to the ground. Assume that a planting achieving 60-80 percent density will reduce soil loss to zero within the 10H protective zone.

Depending upon requirements of the crop, additional secondary windbreaks may be needed to provide protection during critical crop stages.

Note: Be alert to creating frost pocket conditions by entirely encircling the crop field or by placing windbreaks downslope from specialty crop fields. Frost pocket conditions can be lessened by pruning the lower 3-4 feet of branches from trees as they mature to prevent cold air from concentrating on sensitive crops; however this will also reduce crop protection provided by the windbreak.

Livestock and Building Site Protection

6 rows of trees and shrubs, minimum, for Major Land Resource Areas (MLRA) 53, 54, 58.

8 rows of trees and shrubs, minimum, for MLRA 55, 56.

Assuming that proper setback distances have been observed in the design, then the number of rows in a livestock/building site windbreak may be reduced by one for each of the following that occurs:

- Spruce, juniper, redcedar, or a suckering shrub is planted in the most windward row.
- An effective field windbreak system is already established with the most leeward row no more than 300' from the proposed windbreak.
- A snowtrap of juniper, redcedar, closely spaced shrubs, or a twin-row high-density deciduous tree or shrub planting, is located 50-100' windward of the proposed windbreak.

Refer to Table 1 for within row and between row spacings.

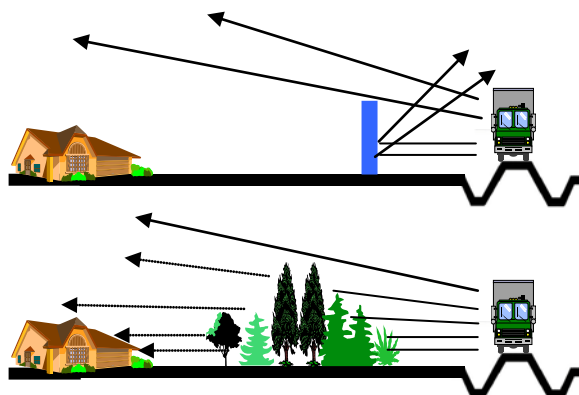


Figure 5: How Sound Barriers Work

For Noise Barriers

Noise barriers reduce noise by deflecting the noise away from the observer, by absorbing some of the noise before it reaches the observer or both. See Figure 5. They are most effective when they can be placed as close as possible to the noise source. Barriers should be placed within 50-80 feet of the nearest traffic lane. See Figure 6.

The amount of noise reduction attained is dependent upon the type of surface between the observer and the source over which the noise passes as well as the width, setback distance and composition of the noise barrier. Vegetation, especially standing vegetation, reduces and attenuates noise better than bare

or hard surfaces. Where year-round noise reduction is desired, conifers should constitute the majority of the planting. See Table 1 for spacings.

Deciduous trees or shrubs can be used where noise reduction is needed only during the growing season. See Table 1 for spacings.

Tree and/or shrub barriers, when combined with landforms, either earthen or constructed, show greater benefits in noise reduction than do landforms alone or trees alone. See Figure 7.

When landforms or constructed barriers are incorporated into the design they should be as tall as the vehicle or object making the noise and may be constructed of soil or other materials. If constructed of soil the landforms should be planted to tall grasses, shrubs or trees for maximum effectiveness.

Barriers for reducing high-speed truck noise must be at least 75' wide if only trees or shrubs are used or at least 50' wide if vegetation is combined with a landform.

Barriers for reducing moderate noise levels (cars) must be at least 40' wide if only trees or shrubs are used or at least 20' wide if vegetation is combined with a landform.

Noise barriers must be twice as long as the distance from the observer to the noise source.

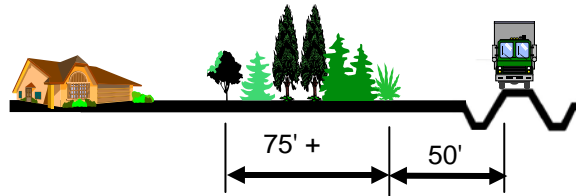


Figure 6: Vegetative Sound Barrier

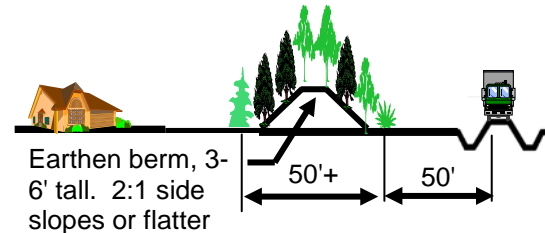


Figure 7: Vegetative Noise Barrier and Landform

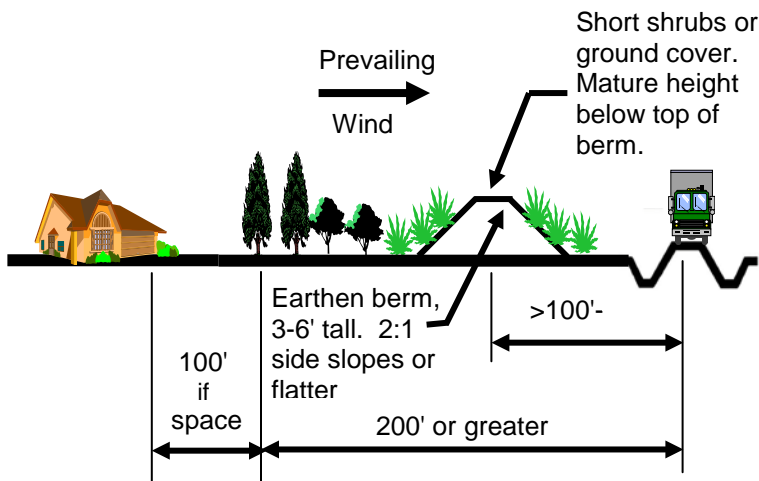


Figure 8 Where Sound and Snow are Problems

No matter how severe the noise, noise barriers shall not be positioned where the barriers will cause snow deposition or drifting on the road sufficient to create a safety hazard to the traveling public. For many of these situations a living snow fence system is often needed upwind from the observer, thereby reducing the amount of snow that could cause a problem. See Figure 8 for one alternative to address this problem where there is no room to establish a living snowfence system upwind from the observer.

Information for designing noise barriers was obtained from an

article by David I Cook and David Van Haverbeke in the Journal of Soil and Water Conservation, November-December 1972, pages 259-261.

For Visual Screens

Rows of trees or shrubs shall be placed between the observer and the undesirable view needing to be screened. Plantings shall be at least one row of conifers or at least 3 rows of deciduous trees or shrubs or a combination of deciduous and coniferous plants. Increasing the number of rows in the planting will increase the effectiveness in blocking unsightly vistas.

Often visual screens will be designed with species that are aesthetically pleasing to the observer or landowner. Refer to [Tree and Shrub Characteristics](#) for species-specific information.

Plantings may be established immediately adjacent to the sight to be screened, which allows more open spaces around the observer. The plantings may be placed closer to the observer to site-specific needs or landowner objectives. See Table 1 for in-row and between-row spacings.

Where visual screens may cause snow problems on roads or building sites, the more restrictive setback distances for snow control must be followed.

For Wildlife

When the primary purpose of a planting is to improve conditions for wildlife, it is best to refer to the Upland Wildlife Habitat Management-645 Standard for specific details appropriate for the wildlife specie(s) of interest. All conservation practices are located in FOTG – Section IV – Conservation Practices. However, the designs of windbreaks for other purposes can be modified to make the practice more beneficial to wildlife while still addressing the original windbreak purposes. Considerations for improving the wildlife value of windbreaks include, but are not limited to:

1. Provide dense areas (thickets) of suckering shrubs or conifers, especially spruce and juniper for winter thermal protection.
2. Choose a variety of plants that will provide food throughout the growing season, especially during mid and late winter. Refer to Tree and Shrub Characteristics for individual species value as a food source.
3. Using tall grasses, standing corn, trees or shrubs, establish a snow trap 50-100 feet upwind to prevent snow from covering the food sources and shelter areas.
4. Add additional rows that provide food or cover on the lee side of the planting.
5. Add a secondary windbreak to protect food and cover from storms from the south or east.
6. Connect isolated plantings by providing travel corridors of 3-4 rows of trees/shrubs between established woody plantings.

For Boundary Delineation

Adhere to all appropriate Setbacks, All Windbreaks, on page 3 of this document when using trees or shrubs to delineate property boundaries.

When using trees or shrubs to delineate field boundaries, be aware of the impact that the mature plant might have on toolbar spacings, machinery operation, or adjacent fences. Avoid creating a future nuisance for the landowner.

Any within-row spacing is appropriate for this purpose. See Table 1. Be aware of how different spacings affect snow distribution and depth, timeliness of field operations, summer breezes, crop protection, moisture harvest, etc.

Boundary plantings can be made more valuable for wildlife by adding additional rows, alternating compatible species within the row, and/or using a variety of plants valuable to wildlife. See Table 2.

For Reducing Chemical Drift

Windbreaks reduce chemical drift hazards in two ways - by reducing the wind velocities across the field where the chemicals are applied and by intercepting chemicals that have moved off site onto the leaves, twigs, and bark of the windbreak plants.

The minimum requirement for this purpose is one row of shrubs, deciduous trees or conifers. Use the appropriate within-row spacing found in Table 1. Where appropriate, use the tallest trees appropriate for the site. Tall trees can intercept more of the laterally moving air mass. Multiple rows of tall trees provide additional benefits since they provide more surface area that can intercept drift.

When installing a system of belts to reduce drift, space each belt at 10 times the expected 20-year tree height. Spacings between belts may be decreased downward to fit even multiples of toolbar widths.

Encourage landowners to use methods and machinery that minimize drift, thereby reducing the amount of chemical moving offsite that must be trapped by the windbreak.

The most difficult part of designing windbreaks for reducing chemical drift is determining what species of tree or shrub will be resistant to the chemical drift 20 years from now. Based on nearly 50 years of herbicide application in North Dakota, phenoxy-type herbicides have been the most damaging to trees. Conifers are most resistant to these types of herbicides, except during periods of rapid, succulent growth.

For Irrigation Efficiency

Windbreaks can improve irrigation efficiency by reducing evaporation at the sprinkler head, reducing evaporation from the plants and soil surface and by reducing transpiration through the plant. Plantings of tall trees just outside the arc of the sprinklers can provide some of the benefits listed, as long as they intercept the troublesome winds.

Another way to address irrigation efficiency is by installing a system of narrow shrub rows that are short enough to allow the sprinklers to pass overhead. These shrub rows can reduce transpiration from the growing crop and provide a microclimate that yields greater production. Preliminary data would indicate that economically the shrub rows would use about the same amount of water that would be saved by the growing crop. Benefits to the crop primarily accrue through stress reduction on the growing crop, protection during critical stages, and erosion reduction.

Aesthetics

Aesthetics are in the eye of the beholder. Use any of the spacings listed in Table 1. Be alert to the effects the windbreak will have on snowdrift locations and depths; alterations of airflow; impacts on visibility, especially at roads; and maintenance requirements of the planting design.

Refer to Tree and Shrub Characteristics for individual species characteristics.

Carbon Storage

Carbon sequestration can be realized through several different mechanisms; cessation of soil tillage, accumulation of carbon in roots and upper tree material, and accumulation of a duff layer. Generally speaking, maximum carbon sequestration can be expected through:

- Close row spacings maximizing plants per acre without unduly causing plant stress that would lead to early mortality. Use the minimum between-row and within-row spacing from Table 1. When different species require different spacings, use the larger of the minimum spacings.
- Establishing long-lived trees.
- Planting trees that will grow large with extensive and deep root systems.
- Harvest of woody material for lumber or fossil fuel substitution.

For maximum carbon storage, minimize amount of tillage within the planting to that necessary for establishment.

For long-term carbon sequestration, establish and maintain adequate firebreaks to prevent catastrophic loss of the planting.

Composition

For sustainability and long-term effectiveness, try for a diversity of species within the planting, and where compatible with plant forms and owner objectives, within the row. Refer to table 2 for acceptable plant alternation schemes.

At a minimum, no more than two rows within any windbreak system shall be of the same species, unless site conditions limit the number of available species.

For multirow plantings, consider at least one or more rows of conifers.

Often a single species will be planted in each row. Generally, this makes subsequent maintenance and renovation easier. However, single-row, single-species plantings are considerably more prone to failure from drought, disease, and/or insects.

Mixing compatible species within the row can reduce the severity and spread of some insect and disease infestations. Refer to Table 2 for acceptable plant alterations. Aside from potential benefits, such mixing will usually complicate the management of the windbreak.

Appropriate selections of species and spacings can allow a planting to meet multiple purposes at the same time.

For most situations a shrub or conifer will be used in the most windward row of a multiple row planting to provide additional snow (moisture) for the growing plants within the planting and to "park" the snowdrift in an area that is out of the way.

Species selection that allows for the production of nuts and fruits for human consumption, woody materials such as grape vines for floral arrangements, nutraceuticals, or other agroforestry products are appropriate for windbreaks, where production of these products does not hinder the primary purpose of the windbreak.

Refer to Design Purposes, pages 5-9, for considerations specific to each purpose that may affect composition of the planting.

Design Spacing

In-Row Spacing

Refer to Table 1 for in-row spacing of the appropriate type of plant to meet a particular purpose.

Between-Row Spacing

To provide adequate growing space, between-row spacings shall be at least 1½ times the within-row spacing for each type of plant, or wide enough to meet the minimum square footage per plant, except for twin-row high-density windbreaks. Use the wider determination when two adjacent rows each have different spacings. Ex: When a tree is adjacent to a shrub, use 1½ times the tree spacing. See table 1 for general within-row spacings.

Several species require specific row spacing recommendations due to rapid growth rates and form. Rows of conifers and deciduous trees should not be established within 25 feet of cottonwoods, hybrid poplars, and tree willows nor should they be alternated with these species within the row. Rows of conifers and deciduous trees should not be established within 20 feet of Siberian elm.

Closer spacing can increase disease potential and cause pines to self-prune lower limbs. Between-row spacings can be modified upward to fit machinery widths. Row spacings wider than 30 feet are usually inappropriate for the species suited to North Dakota. Obviously, this prohibition does not apply to the area between twin-row pairs, snow traps, etc.

Wider spacings are permissible and will usually provide better growing conditions for the tree but will increase the time before canopy closure, if closure happens at all. Canopy closure in the eastern part of the State can be fairly effective at controlling unwanted herbaceous vegetation. In the western part of the State, moisture stress and the presence of brome grass and quack grass limits the effectiveness of canopy closure as a weed control method.

If spacings must be increased because of landowner desires or to provide adequate growing space, it is best to increase the between-row spacing rather than the within-row spacing. Closer within-row spacing, as recommended in Table 1, will provide quicker closure and more effective barrier to the wind.

Table 1: In-row Spacing by Plant Type for Specific Purposes (feet)

(Assumes vigorously growing, single row of species type listed.)

Purpose	Suckering Shrubs	Non - Suckering Shrubs	Short / Medium Decid-uous Trees	Tall Decid-uous Trees**	Spruce	Junipers Cedars Arbor-vitae	Larches	Pines
Snow Control / Stoppage, Noise Barriers Carbon Storage 80% + Density	3 – 6	3 - 4	Not with one row	Not with one row	8 - 14	6 - 10	Not with one row	8 -14
Snow Spreading 35 -60% Density	Not Suitable	5 - 8	6 - 10	10 - 16	Not Suitable	Not Suitable	10 - 14	10 - 16
Erosion Control, Intercepting Chemical Drift 40 - 70% Density	4 – 8	4 - 6	6 - 10	8 - 14	8 - 16	6 - 10	8 - 12	10 - 16
Traditional Crop Protection 40 - 70% Density	4 – 8	4 - 6	6 - 10	8 - 14	8 - 16	6 - 10	8 - 12	10 - 16
Specialty Crop Protection, Visual Screens 60 - 80% Density	3 – 6	3 - 4	5 - 8	8 - 14	8 - 12	6 - 10	8 - 12	8 - 14
Livestock Protection 60 - 80% Density	3 – 6	Not with one row	Not with one row	Not with one row	8 - 14	6 - 10	8 - 12	8 - 14
Building Site Protection, Visual Screens 60 - 80% Density	3 – 6	Not with one row	Not with one row	Not with one row	8 - 14	6 - 10	8 - 12	8 - 14
Minimum Square Footage Per Plant*	15	15	80	144	144	144	144	192

* The minimum square footage per plant means that a design using a minimum within-row spacing will often require a wider between-row spacing in order to ensure enough growing space for each plant. Adequate growing space per plant will maintain a healthy, vigorously growing plant, with a reduced chance of disease incidence, and a strong likelihood that lower limbs will be maintained throughout the life of the planting.

** Rows of conifers or deciduous trees should not be planted within 25 feet of cottonwoods, hybrid poplars or tree willows, nor should these plants be alternated within the row.

These within-row and between-row spacings are specific to the varied purposes of windbreaks only. Other forestry practices such as riparian forest buffers and tree/shrub establishment, etc. will likely have different spacing requirements.

Within-Row Plant Alternation

To meet landowner needs, to improve aesthetics or function, or to reduce disease potential, compatible plants may be alternated within the row. Such a planting scheme increases the complexity of subsequent maintenance operations. See Table 2 for acceptable alternations.

Table 2 - Acceptable Plant Alterations Within The Row

	Short Shrubs ≤ 6' tall	Tall Shrubs >6'	Small/medium deciduous trees < 25'	Tall Deciduous Trees ≥ 25'	Pines	Larches * or Spruces	Juniper or Redcedar
Short Shrubs < 6' tall	YES	INSERT	INSERT	INSERT	NO	NO	NO
Tall Shrubs ≥ 6 feet tall	INSERT	YES	INSERT	INSERT	NO	NO	NO
Small Deciduous Trees < 25'	INSERT	INSERT	YES	NO	NO	NO	NO
Tall Deciduous Trees ≥ 25'	INSERT	INSERT	NO	YES	NO	NO	NO
Pines	NO	NO	NO	NO	YES	NO	NO
Larches * or Spruces	NO	NO	NO	NO	NO	YES	YES
Juniper or Redcedar	NO	NO	NO	NO	NO	YES	YES

Legend:

Yes = Using the within-row spacings from Table 1, replace every other plant with another plant of similar size and type. Ex: A green ash windbreak designed with 12 feet between plants could be altered to become a green ash, bur oak, hackberry windbreak with 12 feet between plants

Insert = Using Table 1 above, select the appropriate between-plant spacing for the tallest plant of the intended alternation scheme. (Select the upper end of the spacing range.) Plant the shorter plant midway between the tall plants. Ex: A green ash planting designed with 12 feet between trees could be altered to become a green ash, caragana, green ash, lilac planting with 6 feet between plants.

No = The listed alternation scheme is not acceptable due to incompatible plant characteristics that could affect form, survival, filling in, shade tolerance, disease etc.

Note: When determining whether a species is short or tall, refer to the maximum height listed in Tree and Shrub Characteristics.

* When alternating larch, ensure landowner is aware that this species loses its needles in the fall. This attribute will result in a windbreak with apparently dead trees throughout the fall and winter.

Specialty Designs

Twin-row, High-density Windbreaks

Each pair of twin rows will be planted to the same species.

Twin-row, high-density windbreaks for snow control/stoppage and livestock/building site protection shall consist of at least three pairs of twin-rows. The most windward row of the most windward pair must be at least 200' from the area needing protection. See Figure 8.

Within-row spacing for each pair of a twin-row, high-density windbreak will generally be the same as the within-row spacing. See Figure 9. Spacing between paired rows shall be 30-50 feet.

Windbreak Stubs for Snow Control

To reduce end effects- where existing windbreaks are creating unwanted snowdrifts on roads or other areas needing protection- establish short windbreak stubs. These 300-400' stubs shall consist of 1-3 rows designed as a snow stoppage windbreak (See Table 1) and oriented perpendicular to the problem legs of the existing windbreak. See Figure 10.

For non-cropland sites, the stubs may be planted immediately adjacent to the existing tree rows. With no access gaps, the stubs may be placed as close as 200 feet from the near edge of the area needing protection.

For cropland sites, leave a 50-80 foot machinery access gap between the existing trees and the new trees. When access gaps are a part of the design, the stub rows should be located 400 feet from the near edge of the area needing protection. Access gaps may be

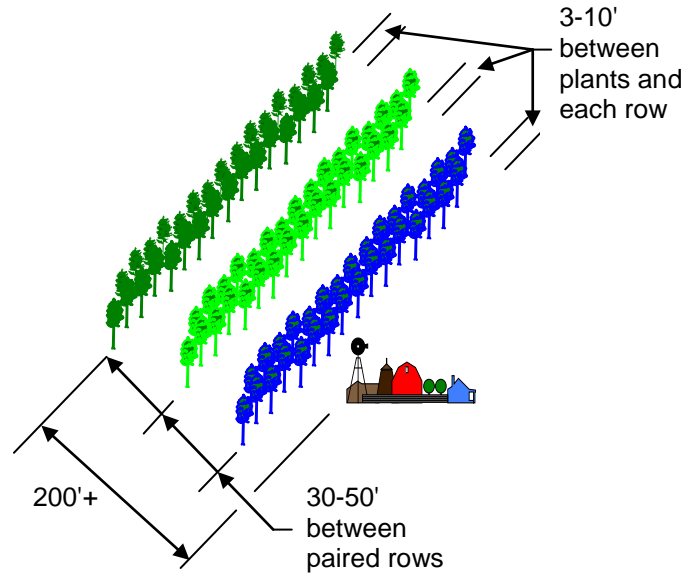


Figure 9: Twin-Row, High-density Windbreak

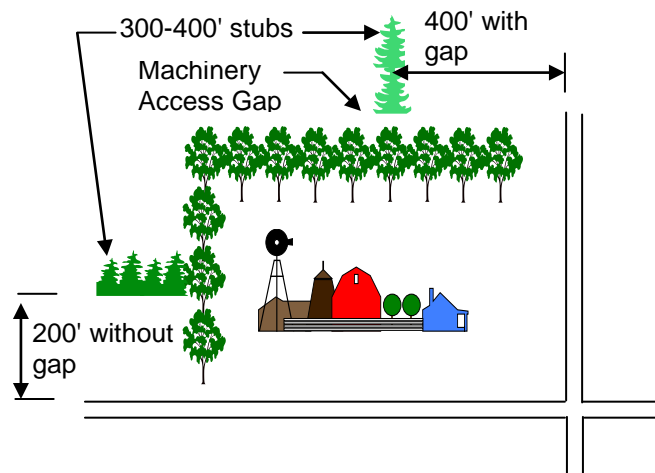


Figure 10: Windbreak Stubs for Snow Control

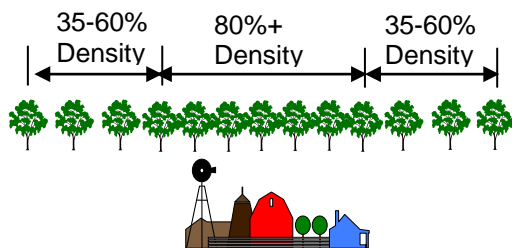


Figure 11: Feathered Windbreak Ends to Reduce End Effect Drifting

incorporated into designs on non-cropland also, based on landowner desires, but the greater setback distance will apply. See Figure 10.

Alternative End Effect Reduction

Another way to minimize adverse effects (snow drifts and increased wind velocities) around the ends of dense windbreaks is to change the design of the last 200' from a snow stoppage windbreak to

a snow-spreading windbreak. See Figure 11 for details.

Temporary Windbreaks

For more immediate protection, temporary windbreaks shall be planted at the time the main windbreak is established. Temporary windbreaks will consist of a twin-row high density planting. To be effective, temporary windbreaks must grow at least 1 foot per year faster than the fastest growing species within the main windbreak.

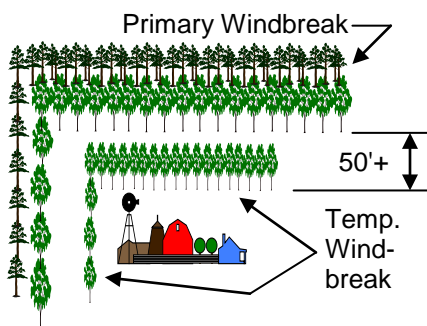


Figure 12: Temporary Windbreaks

Temporary windbreaks may only be used to supplement a properly designed and located primary windbreak. They do not count towards the minimum number of row requirements. See Figure 12 for one possible location.

Locate temporary windbreaks at least 50 feet windward or leeward from the primary windbreak to allow access for harvest or removal. Be alert to how a temporary windbreak will affect snow deposition. Leeward locations will protect the area quicker but may cause problems with snow deposition. Windward locations will eliminate snow problems, but may be too far away to provide protection to the building site any sooner than would the primary windbreak.

Temporary windbreaks are inappropriate if anticipated growth rates of the species in the temporary windbreak do not exceed 2 feet per year on the proposed site. Refer to [Tree and Shrub Characteristics](#) for growth rates of individual species. In areas of reduced growth rates, constructed temporary windbreaks may be an appropriate solution.

Effective temporary windbreak designs will often be a twin-row, high-density planting of hybrid poplars or some other fast growing tree or shrub. Once the main windbreak is up and functioning, usually after 10-20 years, the temporary windbreak can be harvested or removed. Properly managed twin-row plantings of poplars can yield a large amount of good quality lumber or firewood.

OPERATION AND MAINTENANCE

Weed Control

To determine an appropriate form of weed control refer to [Tree Care and Management](#), pages 10-14

Replanting

Any tree or shrub that fails within three years should be replaced with a similar plant. Replants shall maintain the intended function of the planting and be compatible with soils and climate. Growth rates of replants (within 3 years) are usually such that little, if any, size difference is noted after 10 years.

After three years a windbreak/shelterbelt shall have at least 85% of the trees planted in a healthy condition with no two adjacent plants missing.

Disease, Insects, Weather and Animals

To determine ways to prevent or control damage due to disease, insects, weather or animals, refer to [Tree Care and Management](#) pages 14-16. These pages also list several links that provide more in-depth guidance.

Fire Protection

Windbreaks can be damaged or destroyed by wildfires. In some situations, windbreaks can aggravate the fire risk to a building site. Refer to Firebreak-394 for information on constructing and maintaining effective firebreaks.

OPERATION AND MAINTENANCE FOR LANDOWNERS

To guide landowners in operation and management of their windbreak, provide a copy of pages 11-19 of Tree Care and Management or University of Nebraska pamphlet "Windbreak Management" <http://www.ianr.unl.edu/pubs/Forestry/ec1768.htm>.

OPTIONAL INFORMATION FOR LANDOWNER USE

1. How Windbreaks Work <http://www.ianr.unl.edu/pubs/Forestry/ec1763.htm>
2. Windbreak Establishment <http://www.ianr.unl.edu/pubs/Forestry/ec1764.htm>
3. Windbreaks in Sustainable Ag <http://www.ianr.unl.edu/pubs/Forestry/ec1772.htm>
4. Windbreaks and Wildlife <http://www.ianr.unl.edu/pubs/Forestry/ec1771.htm>
5. Windbreaks for Rural Living <http://www.ianr.unl.edu/pubs/Forestry/ec1767.htm>
6. Windbreaks for Livestock Operations <http://www.ianr.unl.edu/pubs/Forestry/ec1766.htm>
7. Windbreaks for Snow Management <http://www.ianr.unl.edu/pubs/Forestry/ec1770.htm>
8. Windbreak Management <http://www.ianr.unl.edu/pubs/Forestry/ec1768.htm>
9. Windbreak Renovation, <http://www.unl.edu/nac/brochures/ec1777/ec1777.pdf>
10. Field Windbreaks <http://www.ianr.unl.edu/pubs/Forestry/ec1778.htm>
11. Fruit Bearing Shrubs for Multi-Use Shelterbelts and Orchards
<http://www.agr.gc.ca/pfra/shbpub/fruitshr.htm>

Exhibit 6-7: Conservation Tree/shrub Plantings Suitability Groups for Kansas

CONSERVATION TREE/SHRUB PLANTINGS SUITABILITY GROUPS FOR KANSAS

INTRODUCTION

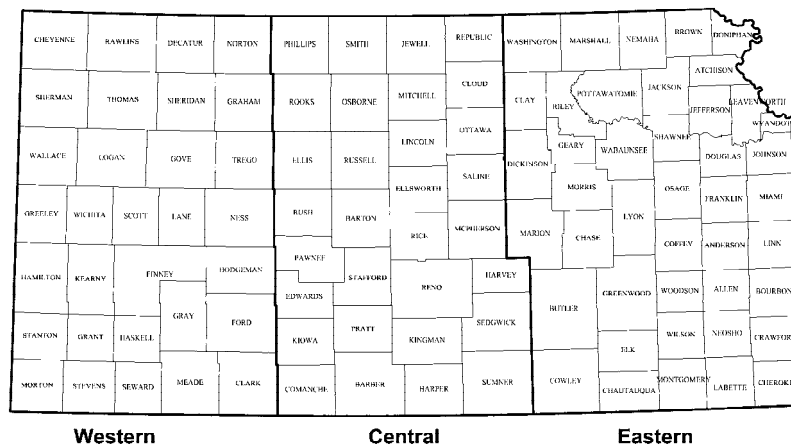
The purpose of this document is to provide guidance for tree and shrub adaptability based on soils. Each tree or shrub species has climatic and physiographic limitations. Within these parameters, a tree or shrub may be well or poorly adapted because of soil characteristics. Additionally, some introduced species may pose a problem because of spreading (by seed or root suckering) or displacing native species. Care should be taken to select materials adapted to the specific planting site and will address the identified resource concern. The species listed within the Conservation Tree/Shrub Plantings and Attributes (Attachment 2) are for conservation tree plantings. Refer to Kansas Forest Service (KFS) preferred tree lists located at <http://www.kansasforests.org/pubs/community/index.shtml> for Trees recommended for urban or landscape plantings

Windbreak Suitability Groups (Attachment 3) have been developed considering individual species performance under specific conditions of soil, climate, physiography, and management. These groups provide a guide for species best adapted for the soils within your county and for predicting height, growth, and effectiveness. They may be used when selecting woody plants for windbreaks, wildlife plantings, riparian buffers, reforestation, other environmental plantings, recreation, landscaping, wetland restoration or enhancement, and critical area plantings.

A number of attributes are included in the table for each species. These attributes were rated subjectively and assigned a relative value to further assist those unfamiliar with individual species characteristics or desirability for the intended use.

Explanation of Terms for Conservation Tree/Shrub Plantings and Attributes Table: Species are grouped by plant type (shrubs, deciduous, and conifer) and arranged in alphabetical order by common name.

Kansas Tree/Shrub Zones



1. **Suitability Group** - A windbreak suitability value given to each soil that reflects soil productivity. Explanation of the Conservation Tree and Shrub Suitability Groups can be found in the National Forestry Manual, Section 537.22(1). Identify soil in the planting site to determine suitability group value. A designation of Not Suited (NS) means that the tree/shrub is not suited for that zone.
2. **Average Height 20 Years** - Heights represent expected performance of the individual plant species.
3. **Growth Rate** - Represented by a value relating to plant growth. F=Fast, M=Medium, S=Slow.
4. **Native Species** - N=Native to Kansas, I=Introduced to Kansas
5. **Windbreak Value** - H=High, M=Medium, L=Low. A general rating (H, M, L) of species for windbreaks rated on their ability to provide a useful component in the windbreak. An H rating would indicate that the trees or shrubs are capable of developing a row that is uniform, dense, or tall enough to provide the windbreak component for which it is planned.
6. **Wildlife Value** - A general rating of H, M, or L of a plant's composite of food and cover values for wildlife. Criteria include basal area, season of growth, longevity of fruit, and suitability for nests. Species with an H rating would provide food and cover for many wildlife species.
7. **Lumber Products** - Y=Yes, N=No. A rating of Y indicates that the species may have commercial value as timber.
8. **Fuelwood Product** - A Y rating indicates that the species has fuelwood value.
9. **Drought Tolerance** - The plant's capability to grow in droughty or dry soil conditions. H=Plant can withstand or has physiology to survive droughty periods, M=Some tolerance to drought or dry conditions, L=Little or no tolerance for dry soil conditions.
10. **Soil Texture** - Adaptation to different soil textures. 1=Fine textured soil, 2=Medium textured soil, 3=Coarse texture soils.
11. **Soil Saturation** - The plant's capability to grow in saturated soil conditions. H=Plant can withstand saturated soil conditions, M=Some tolerance to saturated conditions, L=Little tolerance of water-saturated soil, N=No tolerance to water saturation.
12. **Salinity Tolerance** - The plant's ability to tolerate soil salinity. H=Can tolerate high levels of salinity, M=Some tolerance to salinity, L=Little tolerance to salinity, N=No tolerance to salinity.
13. **pH Range** - The range in soil pH values that the plant species can be expected to grow successfully.

Soil Suitability Groups

Suitability Group 1

Description - These are deep, well drained to somewhat poorly, drained soils that receive beneficial moisture from favorable landscape positions, flooding, runoff from adjacent land, or they have a beneficial seasonal high water table during the spring. Soils within this group are generally fine sandy loam to silty clay loam.

Limitations - High pH will have an effect on the selection of species on some soils in this group. Competition from grass and weeds is the principal concern in establishing the managing trees and shrubs. Occasionally, somewhat poorly drained soils may have excessive water for some species.

Suitability Group 2

Description - Soils in this group are deep, poorly drained or very poorly drained, and excessively wet or ponded during the spring or overflow periods. Wetness limits the selection of species suitable for planting on these soils and may reduce the growth rate.

Limitations - Wetness, high pH, and drainage will have an effect on the selection of tree and shrub species for soils in this group. Competition from grass and weeds is the principal concern in establishing and managing trees and shrubs. Spring planting may be delayed because of wet conditions. Soil blowing is a concern on the sandy and organic soils.

Suitability Group 3

Description - Soils in this group are deep, well drained, loamy-textured soils with moderate and moderately slow permeability on uplands.

Limitations - Competition from grass and weeds is the principal concern in establishing and managing trees and shrubs on these soils. Water erosion is a concern on the gently sloping to moderately steep areas.

Suitability Group 4

Description - Soils are moderately deep to very deep and have loamy surface textures with clayey subsoils, have slow or very slow permeability, and occur on uplands.

Limitations - High clay content and water availability have an effect on the selection of tree and shrub species for these soils. Competition from grass and weeds is the principal concern in establishing and managing trees and shrubs. Water erosion is a concern on the gently sloping to moderately steep areas.

Suitability Group 5

Description - Soils in this group are deep with loamy and sandy texture. This group typically includes soils that normally have adequate soil moisture.

Limitations - Competition from grass and weeds and abrasion from soil blowing are the principal concerns in establishing and managing trees and shrubs on these soils.

Suitability Group 6

Description - Soils are well drained, mostly loamy textures, and moderately deep over sand, gravel, bedrock, and other layers that can severely restrict root growth. Soils have low or moderate available water capacity.

Limitations - Droughtiness will have an effect on the selection of tree and shrub species for use on these soils. Competition from grass and weeds is the principal concern in establishing and managing trees and shrubs. Water erosion is a concern on gently sloping to moderately steep areas. Supplemental watering and/or weed fabric barrier may be needed for establishment.

Suitability Group 7

Description - Soils in this group are deep, excessively to moderately well drained, sandy in texture, typically have low or very low available water-holding capacity, and do not normally have adequate moisture.

Limitations - Drought conditions and abrasion from soil blowing are the principal concerns in establishing and managing trees and shrubs on these soils. Specialized site preparation (due to hummocky sand that is subject to blowouts) and specialized planting methods (vegetation between rows is normally left undisturbed) are needed to establish trees and shrubs. Supplemental watering and/or weed fabric barrier may be essential for successful establishment.

Suitability Group 8

Description - Soils are calcareous at or near the surface. They do not receive beneficial moisture from run-in, flooding, or seasonal high water tables.

Limitations - High calcium content and competition from grass and weeds are the principal concerns in establishing the managing trees and shrubs on these soils. Water erosion is a concern on gently sloping to moderately steep areas.

Suitability Group 9

Description - Soils are affected by salinity and/or sodicity.

Limitations - Concentrations of salt and/or restrictive layers will severely affect the establishment, vigor, and growth of trees and shrubs on these soils.

Suitability Group 10

Description - Soils have one or more characteristics such as soil depth, texture, drainage, available water capacity, slope, or salts which severely limit planting, survival, or growth of trees and shrubs.

Limitations - Soils are usually not recommended for farmstead and feedlot windbreaks, field windbreaks, and plantings for recreation and wildlife. However, onsite investigations may reveal that tree and shrub plantings can be made with special treatments (hand-planting, scalp planting, specialized site preparation, drainage, or other specialized treatments). The selection of species must be tailored to the soil conditions existing at each site. **Limiting conditions and the specialized treatments required to overcome these limitations must be documented on the planting plan.**

Conservation Tree/Shrub Plantings and Attributes

Tree/Shrub	Suitability Group			Average Height (feet) 20 yrs.			Attributes						Soil Adaptation				
	1. Eastern Zone	1. Central Zone	1. Western Zone	2. Eastern Zone	2. Central Zone	2. Western Zone	3. Growth Rate	4. Native Species	5. Windbreak Value	6. Wildlife Value	7. Lumber Products	8. Fuelwood Product	9. Drought Tolerance	10. Texture	11. Soil Saturation	12. Salinity Tolerance	13. pH Range
Shrubs																	
Blackhaw	1, 3-6	NS	NS	6-8	NS	NS	S	N	L	H	N	N	M	1, 2	N	N	4.8-7.5
Buttonbush	1, 2	1, 2	1, 2	12-15	8-12	6-8	M	N	L	M	N	N	M	1,2,3	H	L	5.3-8.5
Cherry, Choke	1, 3-8	1, 3-7	1, 3-7	12-14	10-12	6-10	F	N	H	H	N	N	H	1,2,3	M	H	5.2-8.4
Cherry, Sand (<i>Prunus besseyii</i>)	1, 3	1, 3	1, 3	4-6	4-6	4-6	S	N	M	H	N	N	H	2, 3	N	N	5.9-7
Cotoneaster, Peking	1, 3-6	1, 3-6	1, 3-6	6-10	6-8	5-7	M	I	H	H	N	N	H	1,2,3	N	H	5.5-7.5
Currant, Golden	1, 3-8	1, 3-8	1, 3-8	3-5	3-5	3-5	M	N	H	H	N	N	H	2	N	N	6-8
Dogwood, Redosier	1, 3-5	1, 3-5	1, 3-5	6-8	6-8	6-8	F	I	M	M	N	N	L	1,2,3	H	M	4.8-7
Dogwood, Roughleaf or Gray	1, 3-6	1, 3-5	1, 3-5	6-8	6-8	6-8	F	N	H	M	N	N	H	1, 2	L	L	4.5-7.5
Elderberry	1, 3	NS	NS	5-7	NS	NS	F	N	L	H	N	N	M	2	N	N	5-7
Euonymus, Eastern Wahoo	1, 3-4	1	NS	6-8	6-8	NS	M	N	L	M	N	N	M	1,2,3	N	N	6.1-7.8
Euonymus, Winterberry	1, 3-5	1, 3-5	NS	12-18	12-16	NS	F	I	H	L	N	N	M	1,2,3	N	L	4.7-7.5
Forsythia	1, 3-5	1, 3-5	1, 3-5	6-8	6-8	6-8	F	I	M	M	N	N	M	1,2,3	N	L	4.7-7.5
Hazel, American (hazelnut)	1, 3-5	NS	NS	3-5	NS	NS	M	N	L	H	N	N	L	2, 3	M	N	5-7
Honeysuckle, Freedom 1/	NS	NS	1-6,8,9	NS	NS	6-8	F	I	H	H	N	N	M	1,2,3	N	N	6-7.5
Indigobush (<i>Amorpha fuiticosa</i>)	2	2	2	4-6	4-6	4-6	M	N	L	L	N	N	L	1,2,3	M	M	5-8.5
Lilac	1, 3-5	1, 3-5	1,3-5,9	8-10	8-10	6-8	S	I	H	M	N	N	H	1,2,3	N	L	5.8-7.8
New Mexico Forestiera	NS	NS	1, 3-6	NS	NS	6-8	M	N	H	H	N	N	H	1,2,3	N	M	5-7.5
Peashrub (<i>Caragana</i>), Siberian	1, 3-5	1, 3-5	1, 3-5	12-14	10-12	6-10	F	I	H	M	N	N	H	2, 3	L	M	6-9
Plum, American	1,3-6,8	1, 3-5	1, 3-5	8-10	6-8	6-8	M	N	H	H	N	N	M	2, 3	M	L	5-7
Plum, Sandhill	1,3-7,9	1,3-5,7	1,3-5,7	6-8	6-8	4-6	M	N	H	H	N	N	H	2, 3	L	L	5-7.5
Russian Almond	NS	1, 3-6	1, 3-6	NS	3-5	3-5	M	I	H	M	N	N	H	1,2,3	N	N	5-7.5
Saltbush, Fourwing	9	9	1,3-7,9	6-8	4-6	4-6	S	N	H	H	N	N	H	1,2,3	N	H	6.6-9
Sumac, Fragrant	1, 3-8	1, 3-8	1, 3-8	5-8	5-8	4-7	M	N	H	H	N	N	H	1,2,3	L	L	5-8

Conservation Tree/Shrub Plantings and Attributes

Tree/Shrub	Suitability Group			Ave. Height (feet) 20 yrs.			Attributes						Soil Adaptation				
	1. Eastern Zone	1. Central Zone	1. Western Zone	2. Eastern Zone	2. Central Zone	2. Western Zone	3. Growth Rate	4. Native Species	5. Windbreak Value	6. Wildlife Value	7. Lumber Products	8. Fuelwood Product	9. Drought Tolerance	10. Texture	11. Saturation	12. Salinity Tolerance	13. pH Range
Deciduous Trees																	
American Hop Hornbeam	1	NS	NS	13-18	NS	NS	S	N	L	M	N	Y	L	2, 3	L	N	4-7.4
Ash, Green	1-5	1, 2	1, 2	28-32	24-28	24-26	F	N	H	M	Y	Y	M	1,2,3	H	L	5-8
Baldcypress	1-5	1, 2	1, 2	15-20	15-20	15-18	M	I	L	M	Y	Y	M	1,2,3	H	N	4.5-6
Basswood, American	1-5	NS	NS	26-30	NS	NS	M	N	M	M	Y	Y	M	2, 3	L	N	4.5-7.5
Birch, River	1, 2	NS	NS	35-50	NS	NS	F	N	L	L	Y	Y	L	1, 2	L	L	3-6
Catalpa, Northern	1, 3-6	1, 3-6	1, 3-6	26-28	26-28	24-26	F	I	M	H	Y	Y	H	2, 3	M	L	5.3-7
Cherry, Black	1	NS	NS	26-30	NS	NS	F	N	L	M	Y	Y	M	2, 3	N	N	5-7.5
Coffeetree, Kentucky	1, 3-6	1, 3-6	1, 2	26-28	26-28	24-26	M	N	M	M	Y	Y	M	1,2,3	M	M	4.8-7.5
Cottonwood, Eastern	1, 2	1, 2	1, 2	55-65	50-60	45-55	F	N	H	H	Y	Y	M	1,2,3	H	L	5.5-7.5
Elm, Lacebark	1, 3-8	1, 3-8	1, 3-5	24-28	22-26	20-24	F	I	H	M	N	Y	H	1,2,3	N	N	4.8-7
Elm, Siberian	NS	NS	1, 3-8	NS	NS	25-28	F	I	H	L	Y	Y	M	1,2,3	N	N	5.5-8
Hackberry	1-5	1-5	1	28-30	26-28	29-26	F	N	H	H	Y	Y	H	1,2,3	M	M	4.5-8
Hawthorn	1, 3-6	1, 3-6	1, 3-6	20-24	20-24	18-22	M	N	M	H	N	Y	H	1, 2	N	N	4.5-7.2
Hickory	1-5	NS	NS	24-30	NS	NS	S	N	M	H	Y	Y	M	1,2,3	M	N	4-7.4
Honeylocust	3-8	3-8	3-8	30-36	28-32	26-28	F	N	H	M	Y	Y	H	1,2,3	H	L	6-8
Locust, Black	3-8	3-8	NS	26-30	24-26	NS	F	N	M	M	N	Y	M	1,2,3	L	N	4.8-7.5
Maple, Silver	1-3	1, 2	NS	36-38	32-36	NS	F	N	M	M	Y	Y	M	1,2,3	H	L	4-6.5
Maple, Sugar	1, 3-5	NS	NS	24-30	NS	NS	S	N	M	M	Y	Y	L	2, 3	L	N	3.7-7.5
Mulberry, Red/White 2/	1-6	1-8	1-8	20-22	20-22	18-20	M	N/I	H	H	Y	Y	H	1,2,3	M	M	5-8
Oak, White	1	NS	NS	24-28	NS	NS	S	N	H	H	Y	Y	M	2, 3	L	N	4.5-6.8
Oak, Black	1, 3-6	NS	NS	26-30	NS	NS	M	N	M	H	Y	Y	M	1,2,3	L	N	4.5-6.8.
Oak, Bur	1-8	1-8	1-5	24-28	24-26	24-26	S	N	H	H	Y	Y	H	1,2,3	H	L	4.5-8
Oak, Chinquapin	1, 3-6	1, 3-6	NS	24-28	22-26	NS	M	N	M	H	Y	Y	H	2	N	N	6.5-8
Oak, English	3-5	1, 3-5	1, 3-5	40-60	40-60	30-50	M	I	M	H	Y	Y	M	1, 2	M	L	4.5-7
Oak, Northern Red	1, 3-5	1	NS	60-75	55-70	NS	M	Y	M	H	Y	Y	M	1, 2	M	N	4.5-6.5

Conservation Tree/Shrub Plantings and Attributes

Tree/Shrub	Suitability Group			Ave. Height (feet) 20 yrs.			Attributes						Soil Adaptation				
	1. Eastern Zone	1. Central Zone	1. Western Zone	2. Eastern Zone	2. Central Zone	2. Western Zone	3. Growth Rate	4. Native Species	5. Windbreak Value	6. Wildlife Value	7. Lumber Products	8. Fuelwood Product	9. Drought Tolerance	10. Texture	11. Saturation	12. Salinity Tolerance	13. pH Range
Oak, Pin	1-5	1, 2	NS	26-28	24-26	NS	F	N	H	H	Y	Y	M	1, 2	Y	N	4.5-6.5
Oak, Sawtooth	1, 3-5	1, 3-5	NS	26-30	24-28	NS	M	I	H	H	N	Y	M	1,2,3	N	N	4.9-7.0
Oak, Shumard	1, 3-5	1, 3-5	NS	26-30	24-28	NS	M	N	H	H	Y	Y	M	1,2,3	N	N	5.5-7.5
Oak, Swamp White	1-5	1	NS	24-28	24-26	NS	F	N	H	H	Y	Y	M	1,2,3	M	N	4.3-6.5
Osage Orange	1-9	1-9	1-9	18-22	18-22	16-20	M	I	H	M	N	Y	H	2, 3	M	L	4.5-8
Pawpaw	1, 2	1, 2	NS	18-22	15-18	NS	M	N	L	M	N	N	L	2, 3	L	N	5.1-7.2
Pecan	1-5	NS	NS	26-30	NS	NS	S	N	M	H	Y	Y	M	1,2,3	H	N	4.5-7.5
Persimmon	1, 3-5	NS	NS	20-25	NS	NS	M	N	H	H	Y	Y	M	1,2,3	N	L	4-7
Redbud, Eastern	1, 3-6	1, 3-5	1, 3	14-18	10-14	7-10	M	N	M	M	N	N	M	1, 2	N	N	4.5-7.5
Soapberry, Western	1, 3-6	1, 3-6	1, 3-6	22-28	22-26	18-22	M	N	M	M	N	Y	H	2, 3	N	N	5-7
Sycamore, American	1, 2	1, 2	NS	32-36	30-34	NS	F	N	L	M	Y	Y	M	2, 3	H	N	4.9-6.5
Walnut, Black	1, 3	1	1	26-28	24-26	18-22	M	N	H	H	Y	Y	M	2	N	N	5.5-7.5
Willow	1, 2	1, 2	1, 2	25-30	22-28	18-22	F	N	L	M	Y	Y	L	2,3	H	N	6-8
Conifer Trees																	
Arborvitae, Oriental	1-5	1-5	NS	15-20	14-18	NS	F	I	H	M	N	N	M	1,2,3	N	M	4.7-6.8
Juniper, Chinese	1, 3-7	1, 3-7	1, 3-7	15-20	15-20	15-20	F	I	N	M	N	N	M	1,2,3	N	Y	4.8-8
Juniper, Rocky Mountain	NS	NS	1, 3-9	NS	NS	14-18	M	I	H	H	N	N	H	2,3	N	N	5-8
Pine, Austrian	1, 3-7	1, 3-7	1, 3-5	24-28	20-24	18-22	M	I	H	M	N	N	M	2	N	Y	6.5-7.5
Pine, Eastern White	1, 3-5	NS	NS	30-34	NS	NS	F	I	H	M	Y	N	L	2	N	N	4-6.5
Pine, Ponderosa	1, 3-8	1, 3-8	1, 3-8	18-22	16-20	14-18	M	I	H	M	Y	N	H	2,3	N	N	6-7
Pine, Southwestern White	1, 3-5	1, 3-5	1, 3-5	18-22	16-20	14-18	M	I	H	M	N	N	H	2,3	N	Y	5-7.5
Redcedar, Eastern	1, 3-9	1, 3-9	1, 3-9	14-18	12-15	10-12	M	N	H	H	Y	N	H	1,2,3	N	N	4.7-8

Footnote:

1/ Freedom Honeysuckle is a introduced shrub that can become invasive in some locations.

2/ White mulberry is a introduced tree that can become invasive in some locations.

Exhibit 6-8: Conservation Tree/shrub Plantings Suitability Groups for Nebraska

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Soil Names by Group Number	Includes a list of all soils series by CTSG group number	pp. 15-24
Vegetative Zone Map	Map showing vegetative zones within Nebraska (formerly rainfall zones)	p. 25
Descriptions of each CTSG	Describes characteristics of each of the 22 soils groups	pp. 26-29
Plants recommended for each CTSG	Each table lists species adapted to each CTSG by vegetative zone, including 20-year heights and mature height/spread	CTSG 1 pp. 30-36
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continued... Plants recommended for each CTSG	Each table lists species adapted to each CTSG by vegetative zone, including 20-year heights and mature height/spread	CTSG 9L p. 92
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Summary - List of Attributes by Species for Conservation Tree/Shrub Plantings in Nebraska	Includes a complete listing of tree and shrub species and their attributes. This list can be used to select species based on their attributes and the purpose of the planting (e.g., shade tolerance, flooding tolerance, wildlife value, density, wood products, and suckering, other attributes/concerns).	

Each field office/DC shall list individual soils that are included in each CTSG for your service area. It is recommended that this task be accomplished using the reports in Web Soil Survey, under the Soil Data Explorer tab. The following table shows where these reports are located in Web Soil Survey.

Soil Interpretation	Map or Table Name	Tab of Soil Data Explorer	Menu	Map (M) or Table (T)	User Options		Notes
					Minor Soils	Depth Range	
Windbreaks	Windbreaks and Environmental Plantings	Soil Reports	Soil Erosion	T	●		Lists Tree and Shrub Species By Soil
	Conservation Tree and Shrub Group	Suitabilities and Limitations for Use	Land Classifications	M,T			Rates Dominant Soil In Map Unit
	Conservation Tree and Shrub Group	Soil Reports	Land Classifications	T	●		Rates Individual Soils in Map Unit

Conservation Tree/Shrub Groups (CTSGs)

Introduction

A Conservation Tree/Shrub Group (CTSG) is a physiographic unit or area having similar climatic and edaphic or soils-related characteristics that control the selection and height growth of trees and shrubs. Each Conservation Tree/Shrub Group is based on two soil-related elements: 1) Major Land Resource Area (13 in NE), and 2) Soil Group (22 in NE).

- 1) Major Land Resource Area (MLRA) refines the list of woody plant species selected and adapted to a specified geographic area with similarities in climate. See USDA Agricultural Handbook 296 (2006) for a definition of a MLRA:
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053624.

States can further subdivide a MLRA by varying elevations (i.e., hardiness zones) and diverse ranges of average annual precipitation that influence species selection and performance.

- 2) Soil Group further refines the list of woody plants based on groupings of soil-related conditions. Rather than try to correlate plant data for each and every soil component, a component is evaluated against criteria and placed in one of the 22 Nebraska soil groups. Woody plants are then correlated to a specific soil group within the identified MLRA. If needed, local custom criteria can be used to override the calculated soil group, as well as recognize additional local soil groups.

The correlation and display of adapted woody species, height performance, other attributes, and associated practices and measures using the CTSG system need to be clearly understood by clients. The performance of species is expressed as the expected height at a base age (usually 20 years in continental U.S. and Alaska and 10 years for tropical and subtropical areas). Other attributes may be correlated to each species, such as longevity, wildlife value, crown shape and spread. In addition to height performance and other attributes, the CTSG, MLRA, and soil group may be used to determine facilitating practices and measures that can enhance survival and growth of woody species for correlated soil components. For example, a soil component in Soil Group 7 (sandy) in an agricultural area in MLRA 67A will likely have blowing sand that will damage new seedlings in a zone of low precipitation. Permanent irrigation (i.e., Irrigation System – Micro-Irrigation, 441) and moisture-conserving “weed barrier” (i.e., Mulching, 484) in combination with small physical barriers on the windward side of planted seedlings (e.g., straw bales or snow- fence) could offer mitigating actions to insure better survival and establishment.

States are responsible for developing CTSG interpretations for MLRAs that occur wholly within their state. For MLRAs that cross state boundaries, the individual state with the greatest extent of the MLRA is responsible for developing CTSG interpretations but must coordinate with adjacent states having the MLRA. States make periodic reviews and updates to such displays so that information and data are current in section II of the eFOTG, the Web Soil Survey, and other applicable documents. Although the CTSG designation is very helpful in conservation planning, it does not override the need for on-site evaluation for properly selecting trees and shrubs and estimating design heights and other planning requirements (190-V-NFM, Dec. 15, 2008).

All soil series mapped in the state have been placed with similar soils into one of the 22 CTSGs. Refer to Conservation Tree/Shrub Group Descriptions for a brief description of the characteristics of each soil group. Each tree or shrub species has certain climatic and physiographic limits. Within these parameters trees and shrubs may be well or poorly suited because of climate, site and soil characteristics. These 22 groups are derived from splitting out additional soil characteristics, such as calcareousness, dryness, soil texture, soil depth, water holding capacity, depth to water table, salinity, and pH. Individual species performance will vary under specified conditions of climate, physiography, and management. Factors such as weed competition, moisture conservation, spacing, and arrangement must also be considered.

A map of Nebraska Vegetation Zones is included for your reference. It may also be found in the Nebraska Field Office Technical Guide, Section I-Maps. Each county in Nebraska is included in one of four vegetative zones, based on precipitation ranges. Because vegetative zones are large, climatic differences within a zone should also be considered when recommending species. Some species adapted to the eastern end of a zone may not be as adequately adapted to the western end due to rainfall generally varying from “more” in the east to “less” in the west.

This information provides guidance for selecting species best suited within each vegetative zone for each of the 22 groups of soils. It can also be used for predicting survival, height, growth, species attributes and effectiveness for the purpose of the planting. It can be used to select plants for windbreaks, riparian plantings, recreation and wildlife plantings, ornamental or environmental plantings, reforestation, and critical area plantings.

The expected 20-year tree or shrub height and height/spread at maturity is listed in individual tables by CTSG and vegetative zone. This information should be employed when determining: the spacing and placement of tree/shrub plantings, the area to be protected by the windbreak, the species components, the effectiveness of the planting purpose, and other planting design considerations.

Named varieties of plants cooperatively released through the NRCS/USDA Plant Materials Program have been included in the tables. These varieties have proven superior and should be used when they are available. Native plant species should receive higher preference than non-native (introduced) species when planning a tree or shrub planting.

SOIL NAMES ALPHABETICALLY

Component Name	CTSG	phase
Ackmore	1	
Aksarben	4	
Albaton	2K	
Albaton variant	2K	
Albinas	6	
Alcester	3	
Alda	1S	
Alda	10	channeled, frequently flooded
Alice	5	
Alliance	5	
Almeria	10	
Altvan	6	
Angora	3	
Anselmo	5	
Anselmo	3	very fine sandy loam
Aowa	1	
Aowa	10	channeled, frequently flooded
Arvada	10	
Ascalon	5K	
Ashollow	8	
Ashollow	10	> 30 percent slopes
Badland	10	
Bahl	4CK	
Baltic	2K	
Bankard	10	
Bankard variant	10	
Barney	10	
Barney variant	10	
Bayard	5	
Bazile	5	
Beckton	9W	
Before	3	
Benfield	10	
Benkelman	1	
Betts	8	
Betts	10	> 30 percent slopes
Bigbend	10	
Bigwinder	1S	
Birdwood	10	
Blackloup	10	
Blackwood	3	
Blake	1	
Blanche	6	
Blencoe	2	
Blendon	5	
Blendon variant	5	
Blownout land	10	
Blueridge	10	
Blyburg	3	
Boel	1S	
Boel	10	channeled, occasionally flooded
Boelus	5	
Bolent	2	
Bolent	10	channeled, occasionally flooded

SOIL NAMES ALPHABETICALLY

Boone	10	
Boyd	10	
Bridget	3	
Bristow	10	
Broadwater	10	
Brocksburg	6	
Brownson	10	
Brunswick	7	
Buffington	4	
Bufton	4	
Burchard	3	
Busher	5	
Bushman	5K	
Butler	2	
Calamus	7	
Calamus	10	channeled, occasionally flooded
Calco	2	
Campus	6	
Canlon	10	
Canyon	10	
Carr	1	
Caruso	2	
Caruso variant	6	
Cass	5	
Cass	10	channeled, frequently flooded
Cass variant	5	
Chappell	6	
Chase	2	
Cheyenne	6	
Clamo	2	
Clarno	2	
Clawhammer	10	
Coleridge	1	
Colfer	7	
Colo	2	
Colo	10	channeled, frequently flooded
Coly	8	
Coly	10	> 30 percent slopes
Contrary	3	
Cooper	1	
Cortland	5	
Cozad	3	
Cozad	9L	saline-alkali
Cozad variant	3	
Craft	8	
Craft	10	channeled, frequently flooded
Craft	9L	
Creighton	3	
Crete	4	
Crete variant	9L	
Crofton	8	
Crofton	10	
Crowther	10	
Cullison	10	
Cutcomb	10	

SOIL NAMES ALPHABETICALLY

Dailey	7	
Dankworth	7	
Darr	6	
Deroin	3	
Detroit	4	
Dickinson	5	
Dix	10	
Doger	7	
Doughboy	8	
Dow	3	
Draknab	5	
Duda	10	
Dudley	9L	
Dunday	7	
Dunn	5	
Duroc	3	
Dwyer	7	
Eckley	10	
Edalgo	10	
Els	1S	
Els	1SK	calcareous
Elsmere	1S	
Elsmere	1SK	calcareous
Eltree	3	
Enning	10	
Epping	10	
Eudora	1	
Filbert	2	
Filley	5	
Fillmore	10	
Fillmore	2	drained
Fillmore variant	10	
Fishberry	10	
Fluvaquents	10	
Fluvaquents, loamy	10	
Fluvaquents, sandy	10	
Fluvaquents, silty	10	
Fonner	6	
Fonner variant	6	
Fontanelle	2	
Forney	2K	
Gannett	10	
Gannett variant	10	
Gates	3	
Gates	10	> 30 percent slopes
Gavins	10	
Gayville	9L	
Gayville variant	9L	
Geary	3	
Geary variant	3	
Gering	9L	
Gibbon	2	
Gibbon	9L	saline-alkali
Gibbon variant	2	
Gilliam	1	

SOIL NAMES ALPHABETICALLY

Glenberg	5K	
Glenberg	10	channeled, frequently flooded
Goshen	3	
Gosper	1	
Gosper	9L	saline-alkali
Gothenburg	10	
Grable	5K	
Grable variant	5K	
Graybert	3	
Grigston	3	
Gullied land	10	
Gus	10	
Gymer	4	
Hadar	5	
Haigler	9L	
Hall	3	
Harney	3	
Hastings	3	
Hastings variant	3	
Haverson	8	
Haxtun	5	
Haynie	8	
Haynie	10	channeled, occasionally flooded
Haynie variant	8	
Hedville	10	
Hemingford	5	
Hennings	5	
Hennings	7	loamy fine sands
Hersh	5	
Hersh	7	loamy fine sands
Hersh	10	> 30 percent slopes
Hisle	10	
Histosols	10	
Hobbs	1	
Hobbs	10	channeled, frequently flooded
Hoffland	10	
Holder	3	
Holder variant	3	
Holdrege	3	
Holdrege variant	3	
Holly Springs	10	
Holt	7	
Holt variant	7	
Hord	3	
Hord variant	3	
Humbarger	3	
Humbarger variant	3	
Ida	8	
Ida	10	> 30 percent slopes
Imlay	10	
Inavale	7	
Inavale	10	channeled, frequently flooded
Inglewood	7	
Inglewood	10	channeled, occasionally flooded
Interior	10	

SOIL NAMES ALPHABETICALLY

Ipage	7	
Janise	9W	
Jankosh	9W	
Jansen	6	
Jansen variant	6	
Janude	3	
Jayem	5	
Jayem	7	loamy fine sands
Johnstown	3	
Josburg	3	
Judson	3	
Kadoka	6D	
Kanorado	4CK	
Keith	3	
Keith variant	9L	
Kenesaw	3	
Kennebec	1	
Kennebec	10	channeled, frequently flooded
Kenridge	1	
Keota	10	
Keota	8	
Keya	3	
Kezan	2	
Kezan	10	channeled, frequently flooded
Kipson	10	
Kipson variant	10	
Kuma	3	
Kyle	4C	
Labu	4C	
Labu	10	> 30 percent slopes
Laird	10	
Lamo	1K	
Lamo variant	1K	
Lancaster	6D	
Lancaster variant	6D	
Las	1SK	
Las Animas	1SK	
Las Animas	10	channeled, frequently flooded
Lawet	1K	
Lawet	9L	
Lawet variant	3	
Leisy	3	
Lemoyne	5	
Leshara	1	
Lewellen	9W	
Lex	1SK	
Lex	9W	saline-alkali
Lex variant	1SK	
Lexsworth	9W	
Libory	1	
Lisco	10	
Lockton	1S	
Lodgepole	10	
Lohmiller	10	channeled, frequently flooded
Lohmiller	4K	

SOIL NAMES ALPHABETICALLY

Longford	4	
Longpine	10	
Loretto	3	
Lossing	1K	
Loup	2	
Loup	10	frequently ponded
Lute	9W	
Luton	2K	
Lynch	10	
Mace	6D	
Malcolm	3	
Malmo	4C	
Manter	5	
Manvel	8	
Mariaville	10	
Marlake	10	
Marshall	3	
Maskell	3	
Massie	10	
Mayberry	4C	
McCash	3	
McConaughy	3	
McCook	8	
McCook	10	channeled, occasionally flooded
McCook variant	8	
McCuligan	2K	
McGrew	1K	
McGrew	9W	saline-alkali
McKelvie	7	
McKelvie	10	
McPaul	1	
Meadin	10	
Meckling	1K	
Medihemists	10	
Melia	3	
Merrick	3	
Minatare	10	
Minnequa	9L	
Minnequa	10	saline-alkali
Mitchell	8	
Mitchell variant	8	
Modale	1	
Monona	3	
Monona	10	> 30 percent slopes
Monona variant	3	
Moody	3	
Morrill	3	
Morrill variant	3	
Moville	1	
Muir	3	
Mullen	5	
Munjor	5K	
Munjor	10	channeled, frequently flooded
Munjor variant	5K	
Muscotah	2	

SOIL NAMES ALPHABETICALLY

Napa	10	
Napier	3	
Nenzel	7	
Nimbro	8	
Niobrara	10	
Nishna	2K	
Nodaway	1	
Nodaway	10	channeled, frequently flooded
Nora	3	
Nora variant	3	
Norrest	4	
Norway	10	
Norwest	1K	
Novina	1	
Nuckolls	3	
Nuckolls variant	3	
Obert	10	
Obert	2K	
Oglala	3	
Olbut	9W	
Olmitz	3	
Olney	5K	
Omadi	1	
Onawa	1	
Onawet	2K	
O'Neill	6	
Onita	4	
Ord	1S	
Ord variant	1S	
Orella	10	
Orpha	7	
Orpha	10	> 30 percent slopes
Ortello	5	
Ortello	7	loamy fine sands
Orwet	2	
Otero	8	
Otero variant	8	
Otoe	4C	
Overlake	5	
Ovina	1	
Owego	2K	
Padonia	4C	
Pahuk	7	
Paka	10	> 30 percent slopes
Paka	3	
Pathfinder	9L	
Pawnee	4C	
Pawnee variant	4C	
Percival	1K	
Phiferson	6DK	
Phiferson	10	> 30 percent slopes
Pierre	4C	
Pivot	7	
Pivot	10	> 17 percent slopes
Platte	1S	

SOIL NAMES ALPHABETICALLY

Platte	10	channeled, frequently flooded
Pohocco	3	
Pohocco	10	> 30 percent slopes
Ponca	3	
Ponderosa	5	
Ponderosa	3	very fine sandy loam
Ponderosa	10	> 30 percent slopes
Promise	4C	
Ralton	6K	
Redstoe	10	
Ree	3	
Reliance	4K	
Richfield	3	
Ringgold	5	
Riverwash	10	
Rock outcrop	10	
Ronson	10	
Rosebud	6D	
Rosebud	10	> 17 percent slopes
Roxbury	1	
Rusco	2	
Rusco variant	2	
Rushcreek	6K	
Salix	1K	
Salmo	9W	
Salmo	10	channeled, frequently flooded
Saltillo	10	
Saltine	10	
Samsil	10	
Sanborn	10	
Sandose	5	
Sansarc	10	
Sarben	10	> 30 percent slopes
Sarben	5	
Sarben	7	loamy fine sands
Sardak	7	
Sarpy	7	
Satanta	3	
Satanta	6	gravelly substratum
Savo	4	
Schamber	10	
Scott	10	
Scott variant	10	
Scoville	5	
Scroll	6K	
Selia	10	
Shale outcrop	10	
Sharpsburg variant	10	
Shelby	3	
Shelby	10	> 30 percent slopes
Shell	1	
Shell variant	3	
Shingle	8	
Sidney	5K	
Silver Creek	9W	

SOIL NAMES ALPHABETICALLY

Simeon	7	
Skilak	9L	
Skilak	10	> 17 percent slopes
Slickspots	10	
Smithland	1	
Sogn	10	
Solomon	2	
Steinauer	8	
Steinauer	10	> 30 percent slopes
Sulco	8	
Sulco	10	> 30 percent slopes
Sully	8	
Talmo	10	
Tassel	10	
Thirtynine	3	
Thurman	7	
Ticonic	5	
Tieville	2	
Tomek	3	
Trent	3	
Tripp	3	
Tryon	2	
Tryon	10	frequently ponded
Tuthill	5	
Udarents	10	
Udorthents	10	
Uly	3	
Uly	10	> 30 percent slopes
Uly variant	3	
Ulysses	3	
Urban land	10	
Ustipsamments	10	
Ustorthents	10	
Valent	7	
Valent	10	> 30 percent slopes
Valentine	7	
Valentine	10	> 30 percent slopes
Verdel	4C	
Verdigre	4	
Vetal	5	
Wabash	2	
Wakeen	6D	
Wakeen	10	> 17 percent slopes
Wakeen variant	6D	
Wann	1S	
Wann	10	channeled, occasionally flooded
Wann	9L	saline-alkali
Wann variant	1S	
Wann variant	9L	saline-alkali
Wathena	1S	
Waubonsie	1	
Wewela	7	
Whitelake	10	
Wildhorse	10	
Wood River	9L	saline-alkali

SOIL NAMES ALPHABETICALLY

Wood River	10	
Woodbury	2	
Woodly	3	
Wymore	4C	
Yockey	10	
Yockey	9W	saline-alkali
Yutan	3	
Zoe	9W	
Zook	2	

SOIL NAMES BY GROUP NUMBER

Component Name	CTSG	Phase
Ackmore	1	
Aowa	1	
Benkelman	1	
Blake	1	
Carr	1	
Coleridge	1	
Cooper	1	
Eudora	1	
Gilliam	1	
Gosper	1	
Hobbs	1	
Kennebec	1	
Kenridge	1	
Leshara	1	
Libory	1	
McPaul	1	
Modale	1	
Moville	1	
Nodaway	1	
Novina	1	
Omadi	1	
Onawa	1	
Ovina	1	
Roxbury	1	
Shell	1	
Smithland	1	
Waubonsie	1	
Blencoe	2	
Bolent	2	
Butler	2	
Calco	2	
Caruso	2	
Chase	2	
Clamo	2	
Clarno	2	
Colo	2	
Filbert	2	
Fillmore	2	drained
Fontanelle	2	
Gibbon	2	
Gibbon variant	2	
Kezan	2	
Loup	2	
Muscotah	2	
Orwet	2	
Rusco	2	
Rusco variant	2	
Solomon	2	
Tieville	2	
Tryon	2	
Wabash	2	
Woodbury	2	
Zook	2	
Alcester	3	

SOIL NAMES BY GROUP NUMBER

Angora	3	
Anselmo	3	very fine sandy loam
Before	3	
Blackwood	3	
Blyburg	3	
Bridget	3	
Burchard	3	
Contrary	3	
Cozad	3	
Cozad variant	3	
Creighton	3	
Deroin	3	
Dow	3	
Duroc	3	
Eltree	3	
Gates	3	
Geary	3	
Geary variant	3	
Goshen	3	
Graybert	3	
Grigston	3	
Hall	3	
Harney	3	
Hastings	3	
Hastings variant	3	
Holder	3	
Holder variant	3	
Holdrege	3	
Holdrege variant	3	
Hord	3	
Hord variant	3	
Humbarger	3	
Humbarger variant	3	
Janude	3	
Johnstown	3	
Josburg	3	
Judson	3	
Keith	3	
Kenesaw	3	
Keya	3	
Kuma	3	
Lawet variant	3	
Leisy	3	
Loretto	3	
Malcolm	3	
Marshall	3	
Maskell	3	
McCash	3	
McConaughy	3	
Melia	3	
Merrick	3	
Monona	3	
Monona variant	3	
Moody	3	
Morrill	3	

SOIL NAMES BY GROUP NUMBER

Morrill variant	3	
Muir	3	
Napier	3	
Nora	3	
Nora variant	3	
Nuckolls	3	
Nuckolls variant	3	
Oglala	3	
Olmitz	3	
Paka	3	
Pohocco	3	
Ponca	3	
Ponderosa	3	very fine sandy loam
Ree	3	
Richfield	3	
Satanta	3	
Shelby	3	
Shell variant	3	
Thirtynine	3	
Tomek	3	
Trent	3	
Tripp	3	
Uly	3	
Uly variant	3	
Ulysses	3	
Woodly	3	
Yutan	3	
Aksarben	4	
Buffington	4	
Buften	4	
Crete	4	
Detroit	4	
Gymer	4	
Longford	4	
Norrest	4	
Onita	4	
Savo	4	
Verdigre	4	
Alice	5	
Alliance	5	
Anselmo	5	
Bayard	5	
Bazile	5	
Blendon	5	
Blendon variant	5	
Boelus	5	
Busher	5	
Cass	5	
Cass variant	5	
Cortland	5	
Dickinson	5	
Draknab	5	
Dunn	5	
Filley	5	
Hadar	5	

SOIL NAMES BY GROUP NUMBER

Haxtun	5	
Hemingford	5	
Hennings	5	
Hersh	5	
Jayem	5	
Lemoynes	5	
Manter	5	
Mullen	5	
Ortello	5	
Overlake	5	
Ponderosa	5	
Ringgold	5	
Sandose	5	
Sarben	5	
Scoville	5	
Ticonic	5	
Tuthill	5	
Vetal	5	
Albinas	6	
Altvan	6	
Blanche	6	
Brocksburg	6	
Campus	6	
Caruso variant	6	
Chappell	6	
Cheyenne	6	
Darr	6	
Fonner	6	
Fonner variant	6	
Jansen	6	
Jansen variant	6	
O'Neill	6	
Satanta	6	gravelly substratum
Brunswick	7	
Calamus	7	
Colfer	7	
Dailey	7	
Dankworth	7	
Doger	7	
Dunday	7	
Dwyer	7	
Hennings	7	loamy fine sands
Hersh	7	loamy fine sands
Holt	7	
Holt variant	7	
Inavale	7	
Inglewood	7	
Ipage	7	
Jayem	7	loamy fine sands
McKelvie	7	
Nenzel	7	
Orpha	7	
Ortello	7	loamy fine sands
Pahuk	7	
Pivot	7	

SOIL NAMES BY GROUP NUMBER

Sarben	7	loamy fine sands
Sardak	7	
Sarpy	7	
Simeon	7	
Thurman	7	
Valent	7	
Valentine	7	
Wewela	7	
Ashollow	8	
Betts	8	
Coly	8	
Craft	8	
Crofton	8	
Doughboy	8	
Haverson	8	
Haynie	8	
Haynie variant	8	
Ida	8	
Keota	8	
Manvel	8	
McCook	8	
McCook variant	8	
Mitchell	8	
Mitchell variant	8	
Nimbro	8	
Otero	8	
Otero variant	8	
Shingle	8	
Steinauer	8	
Sulco	8	
Sully	8	
Alda	10	channeled, frequently flooded
Almeria	10	
Aowa	10	channeled, frequently flooded
Arvada	10	
Ashollow	10	> 30 percent slopes
Badland	10	
Bankard	10	
Bankard variant	10	
Barney	10	
Barney variant	10	
Benfield	10	
Betts	10	> 30 percent slopes
Bigbend	10	
Birdwood	10	
Blackloup	10	
Blownout land	10	
Blueridge	10	
Boel	10	channeled, occasionally flooded
Bolent	10	channeled, occasionally flooded
Boone	10	
Boyd	10	
Bristow	10	
Broadwater	10	
Brownson	10	

SOIL NAMES BY GROUP NUMBER

Calamus	10	channeled, occasionally flooded
Canlon	10	
Canyon	10	
Cass	10	channeled, frequently flooded
Clawhammer	10	
Colo	10	channeled, frequently flooded
Coly	10	> 30 percent slopes
Craft	10	channeled, frequently flooded
Crofton	10	
Crowther	10	
Cullison	10	
Cutcomb	10	
Dix	10	
Duda	10	
Eckley	10	
Edalgo	10	
Enning	10	
Epping	10	
Fillmore	10	
Fillmore variant	10	
Fishberry	10	
Fluvaquents	10	
Fluvaquents, loamy	10	
Fluvaquents, sandy	10	
Fluvaquents, silty	10	
Gannett	10	
Gannett variant	10	
Gates	10	> 30 percent slopes
Gavins	10	
Glenberg	10	channeled, frequently flooded
Gothenburg	10	
Gullied land	10	
Gus	10	
Haynie	10	channeled, occasionally flooded
Hedville	10	
Hersh	10	> 30 percent slopes
Hisle	10	
Histosols	10	
Hobbs	10	channeled, frequently flooded
Hoffland	10	
Holly Springs	10	
Ida	10	> 30 percent slopes
Imlay	10	
Inavale	10	channeled, frequently flooded
Inglewood	10	channeled, occasionally flooded
Interior	10	
Kennebec	10	channeled, frequently flooded
Keota	10	
Kezan	10	channeled, frequently flooded
Kipson	10	
Kipson variant	10	
Labu	10	> 30 percent slopes
Laird	10	
Las Animas	10	channeled, frequently flooded
Lisco	10	

SOIL NAMES BY GROUP NUMBER

Lodgepole	10	
Lohmiller	10	channeled, frequently flooded
Longpine	10	
Loup	10	frequently ponded
Lynch	10	
Mariaville	10	
Marlake	10	
Massie	10	
McCook	10	channeled, occasionally flooded
McKelvie	10	
Meadin	10	
Medihemists	10	
Minatare	10	
Minnequa	10	saline-alkali
Monona	10	> 30 percent slopes
Munjor	10	channeled, frequently flooded
Napa	10	
Niobrara	10	
Nodaway	10	channeled, frequently flooded
Norway	10	
Obert	10	
Orella	10	
Orpha	10	> 30 percent slopes
Paka	10	> 30 percent slopes
Phiferson	10	> 30 percent slopes
Pivot	10	> 17 percent slopes
Platte	10	channeled, frequently flooded
Pohocco	10	> 30 percent slopes
Ponderosa	10	> 30 percent slopes
Redstoe	10	
Riverwash	10	
Rock outcrop	10	
Ronson	10	
Rosebud	10	> 17 percent slopes
Salmo	10	channeled, frequently flooded
Saltillo	10	
Saltine	10	
Samsil	10	
Sanborn	10	
Sansarc	10	
Sarben	10	> 30 percent slopes
Schamber	10	
Scott	10	
Scott variant	10	
Selia	10	
Shale outcrop	10	
Sharpsburg variant	10	
Shelby	10	> 30 percent slopes
Skilak	10	> 17 percent slopes
Slickspots	10	
Sogn	10	
Steinauer	10	> 30 percent slopes
Sulco	10	> 30 percent slopes
Talmo	10	
Tassel	10	

SOIL NAMES BY GROUP NUMBER

Tryon	10	frequently ponded
Udarents	10	
Udorthents	10	
Uly	10	> 30 percent slopes
Urban land	10	
Ustipsamments	10	
Ustorthents	10	
Valent	10	> 30 percent slopes
Valentine	10	> 30 percent slopes
Wakeen	10	> 17 percent slopes
Wann	10	channeled, occasionally flooded
Whitelake	10	
Wildhorse	10	
Wood River	10	
Yockey	10	
Lamo	1K	
Lamo variant	1K	
Lawet	1K	
Lossing	1K	
McGrew	1K	
Meckling	1K	
Norwest	1K	
Percival	1K	
Salix	1K	
Alda	1S	
Bigwinder	1S	
Boel	1S	
Els	1S	
Elsmere	1S	
Lockton	1S	
Ord	1S	
Ord variant	1S	
Platte	1S	
Wann	1S	
Wann variant	1S	
Wathena	1S	
Els	1SK	calcareous
Elsmere	1SK	calcareous
Las	1SK	
Las Animas	1SK	
Lex	1SK	
Lex variant	1SK	
Albaton	2K	
Albaton variant	2K	
Baltic	2K	
Forney	2K	
Luton	2K	
McCuligan	2K	
Nishna	2K	
Obert	2K	
Onawet	2K	
Owego	2K	
Kyle	4C	
Labu	4C	
Malmo	4C	

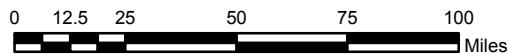
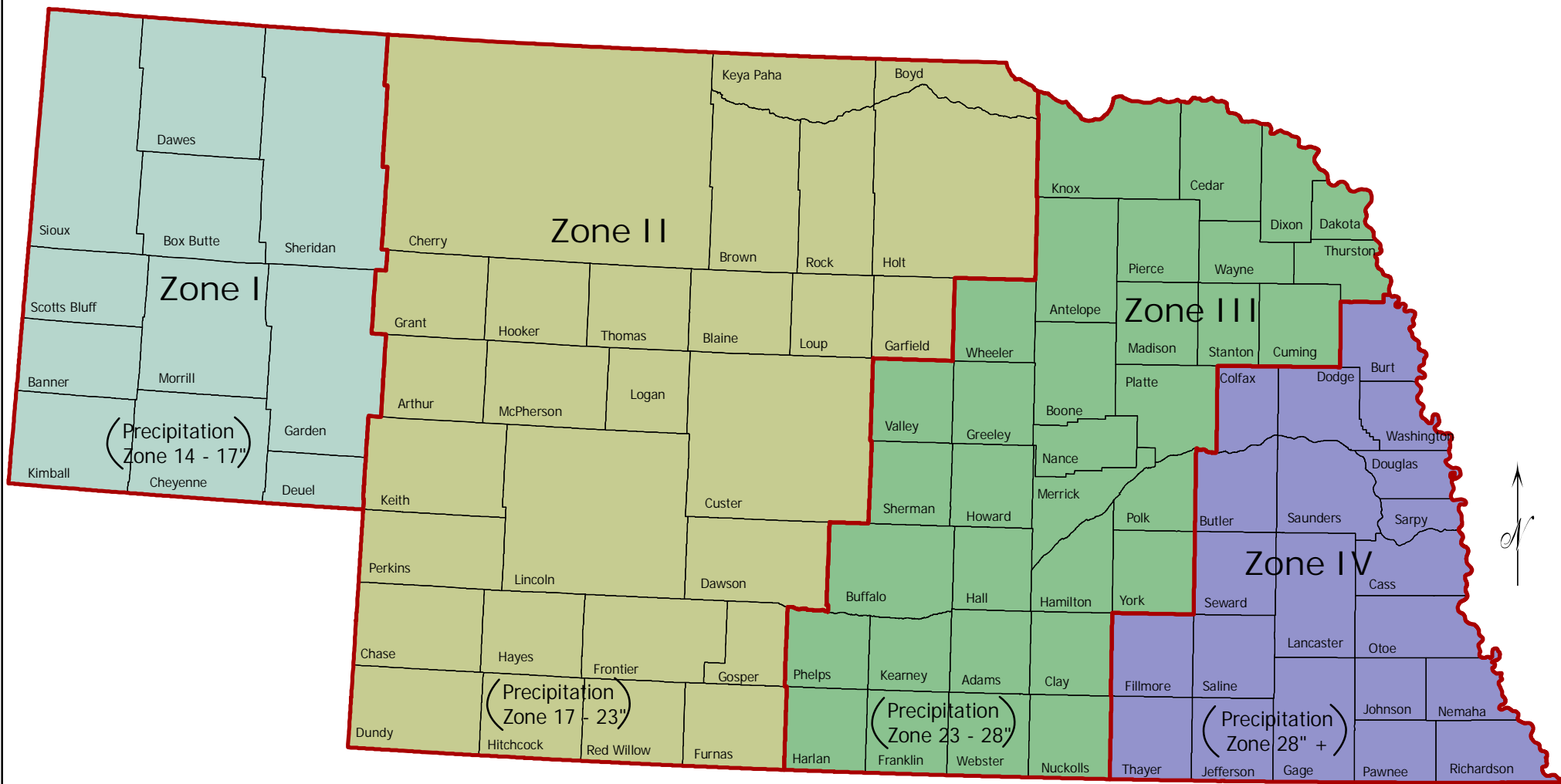
SOIL NAMES BY GROUP NUMBER

Mayberry	4C	
Otoe	4C	
Padonia	4C	
Pawnee	4C	
Pawnee variant	4C	
Pierre	4C	
Promise	4C	
Verdel	4C	
Wymore	4C	
Bahl	4CK	
Kanorado	4CK	
Lohmiller	4K	
Reliance	4K	
Ascalon	5K	
Bushman	5K	
Glenberg	5K	
Grable	5K	
Grable variant	5K	
Munjor	5K	
Munjor variant	5K	
Olney	5K	
Sidney	5K	
Kadoka	6D	
Lancaster	6D	
Lancaster variant	6D	
Mace	6D	
Rosebud	6D	
Wakeen	6D	
Wakeen variant	6D	
Phiferson	6DK	
Ralton	6K	
Rushcreek	6K	
Scroll	6K	
Cozad	9L	saline-alkali
Craft	9L	
Crete variant	9L	
Dudley	9L	
Gayville	9L	
Gayville variant	9L	
Gering	9L	
Gibbon	9L	saline-alkali
Gosper	9L	saline-alkali
Haigler	9L	
Keith variant	9L	
Lawet	9L	
Minnequa	9L	
Pathfinder	9L	
Skilak	9L	
Wann	9L	saline-alkali
Wann variant	9L	saline-alkali
Wood River	9L	saline-alkali
Beckton	9W	
Janise	9W	
Jankosh	9W	
Lewellen	9W	

SOIL NAMES BY GROUP NUMBER

Lex	9W	saline-alkali
Lexsworth	9W	
Lute	9W	
McGrew	9W	saline-alkali
Olbut	9W	
Salmo	9W	
Silver Creek	9W	
Yockey	9W	saline-alkali
Zoe	9W	

NEBRASKA VEGETATIVE ZONES



Conservation Tree/Shrub Groups (CTSGs)

Descriptions

Group 1 (Wet Favorable)

Soil depth to a restrictive layer is at least 40 inches (100 cm). The depth to a water table during the growing season is at least 1.5 feet (45 cm) but less than 4 feet (120 cm). If the soil is frequently or occasionally flooded for 2 or more months during the growing season, with duration of brief, long, or very long, then the depth to a water table during the growing season may exceed 4 feet. The available water capacity is greater than 9 inches (22.5 centimeters). In the upper 12 inches (30 cm) of the soil profile free carbonates do not exceed a concentration of 5 percent calcium carbonate equivalent, the range of pH is between 5.6 and 8.4, and electrical conductivity is 4 mmhos/cm or less.

Subgroup 1K (Wet Favorable-Calcareous)

Soil criteria is the same as Group 1 except:

_ In the upper 12 inches (30 cm) of the soil profile free carbonates range between 5 and 15 percent calcium carbonate equivalent and the range of pH is between 6.5 and 8.4.

Subgroup 1S (Wet Favorable-Droughty)

Soil criteria is the same as Group 1 except:

_ The available water capacity is between 6 and 9 inches (15 and 22.5 cm).

Subgroup 1SK (Wet Favorable-Droughty-Calcareous)

Soil criteria is the same as Group 1 except:

_ The available water capacity is between 6 and 9 inches (15 and 22.5 cm)

_ In the upper 12 inches (30 cm) of the soil profile free carbonates range between 5 and 15 percent calcium carbonate equivalent and the range of pH is between 6.5 and 8.4.

Group 2 (Wet)

Soil depth to a restrictive layer is at least 40 inches (100 cm). The depth to a water table during the growing season is at least 0.5 feet (15 cm) but less than 1.5 feet (45 cm). The available water capacity is greater than 3 inches (8 cm).

In the upper 12 inches (30 cm) of the soil profile free carbonates do not exceed a concentration of 5 percent calcium carbonate equivalent, the range of pH is between 5.6 and 8.4, and electrical conductivity is 4 mmhos/cm or less.

Subgroup 2K (Wet-Calcareous)

Soil criteria is the same as Group 2 except:

_ In the upper 12 inches (30 cm) of the soil profile free carbonates range between 5 and 15 percent calcium carbonate equivalent and the range of pH is between 6.5 and 8.4.

Group 3 (Loamy)

Soil depth to a restrictive layer is at least 40 inches (100 cm). The depth to a water table during the growing season is at least 4 feet (120 cm). If the soil is frequently or occasionally flooded with duration of brief, long, or very long, it must be for less than 2 months during the growing season. The available water capacity is at least 9 inches (22.5 cm). In the upper 12 inches (30 cm) of the soil profile free carbonates do not exceed a concentration of 5 percent calcium carbonate equivalent, the range of pH is between 5.6 and 8.4, and electrical conductivity is 2 mmhos/cm or less. The texture is non-clayey between 8 inches (20 cm) and 48 inches (120 cm).

Group 4 (Clayey Favorable)

Soil depth to a restrictive layer is at least 20 inches (50 cm). The depth to a water table during the growing season is at least 4 feet (120 cm). The depth to a water table may be less than 4 feet (120 cm) if it is for less than 2 months during the growing season. The available water capacity is at least 6 inches (15 cm). In the upper 12 inches (30 cm) of the soil profile free carbonates do not exceed a concentration of 5 percent calcium carbonate equivalent, the range of pH is between 5.6 and 8.4, and electrical conductivity is 4 mmhos/cm or less. The texture between 8 inches (20cm) and 20 inches (50 cm) is non-clayey over >35% clay.

Subgroup 4K (Clayey Favorable-Calcareous)

Soil criteria is the same as Group 4 except:

_ In the upper 12 inches (30 cm) of the soil profile free carbonates range between 5 and 15 percent calcium carbonate equivalent and the range of pH is between 6.5 and 8.4.

Subgroup 4C (Clayey)

Soil depth to a restrictive layer is at least 20 inches (50 cm). The depth to a water table during the growing season is at least 4 feet (120 cm). The depth to a water table may be less than 4 feet (120 cm) if it is for less than 2 months during the growing season. The available water capacity is at least 6 inches (15 cm). In the upper 12 inches (30 cm) of the soil profile free carbonates do not exceed a concentration of 5 percent calcium carbonate equivalent, the range of pH is between 5.6 and 8.4, and electrical conductivity is 4 mmhos/cm or less. The whole soil profile is >35% clay, but the 0 to 8 inches (20 cm) can be non-clayey

Subgroup 4CK (Clayey-Calcareous)

Soil criteria is the same as Group 4C except:

_ In the upper 12 inches (30 cm) of the soil profile free carbonates range between 5 and 15 percent calcium carbonate equivalent and the range of pH is between 6.5 and 8.4.

Group 5 (Droughty)

Soil depth to a restrictive layer is at least 40 inches (100 cm). The depth to a water table during the growing season is at least 4 feet (120 cm). If the soil is frequently or occasional flooded with duration of brief, long, or very long, it is for less than 2 months during the growing season. The available water capacity is at between 6 and 9 inches (15 and 23 cm). In the upper 12 inches (30 cm) of the soil profile free carbonates do not exceed a concentration of 5 percent calcium carbonate equivalent, the range of pH is between 5.6 and 8.4, and electrical conductivity is 4 mmhos/cm or less. The whole soil profile is non-sandy or loamy or loamy-skeletal.

Subgroup 5K (Droughty-Calcareous)

Soil criteria is the same as Group 5 except:

_ In the upper 12 inches (30 cm) of the soil profile free carbonates range between 5 and 15 percent calcium carbonate equivalent and the range of pH is between 6.5 and 8.4.

Group 6 (Very Droughty)

Soil depth to a restrictive layer is at least 20 inches (50 cm). The depth to a water table during the growing season is at least 4 feet (120 cm). The depth to a water table may be less than 4 feet (120 cm) if it is for less than 2 months during the growing season. The available water capacity is between 3 and 6 inches (8 and 15 cm). In the upper 12 inches (30 cm) of the soil profile free carbonates do not exceed a concentration of 5 percent calcium carbonate equivalent, the range of pH is between 5.6 and 8.4, and electrical conductivity is 4 mmhos/cm or less. The soil has a non-sandy surface, and is loamy/loamy skeletal over sands/gravels. The drainage class for the soil is excessively, somewhat excessively, or well drained.

Subgroup 6K (Very Droughty-Calcareous)

Soil criteria is the same as Group 6 except:

_ In the upper 12 inches (30 cm) of the soil profile free carbonates range between 5 and 15 percent calcium carbonate equivalent and the range of pH is between 6.5 and 8.4.

Subgroup 6D (Droughty-Moderately deep)

Soil depth to a restrictive layer is between 20 and 40 inches (50 and 100 cm). The depth to a water table during the growing season is at least 4 feet (120 cm). The depth to a water table may be less than 4 feet (120 cm) if it is for less than 2 months during the growing season. The available water capacity is at least 6 inches (15 cm). In the upper 12 inches (30 cm) of the soil profile free carbonates do not exceed a concentration of 5 percent calcium carbonate equivalent, the range of pH is between 5.6 and 8.4, and electrical conductivity is 4 mmhos/cm or less. The soil has a non-sandy surface, and is loamy/loamy skeletal over impervious layer.

Subgroup 6DK (Droughty-Moderately deep-Calcareous)

Soil criteria is the same as Group 6D except:

_ In the upper 12 inches (30 cm) of the soil profile free carbonates range between 5 and 15 percent calcium carbonate equivalent and the range of pH is between 6.5 and 8.4.

Group 7 (Sandy)

Soil depth to a restrictive layer is at least 40 inches (100 cm). The depth to a water table during the growing season is at least 4 feet (120 cm). The depth to a water table may be less than 4 feet (120 cm) if it is for less than 2 months during the growing season. The available water capacity is at least 3 inches (8 cm). In the upper 12 inches (30 cm) of the soil profile free carbonates do not exceed a concentration of 5 percent calcium carbonate equivalent, the range of pH is between 5.6 and 8.4, and electrical conductivity is 2 mmhos/cm or less. All horizons have a sandy texture.

Group 8 (Loamy-Calcareous)

Soil depth to a restrictive layer is at least 40 inches (100 cm). The depth to a water table during the growing season is at least 4 feet (120 cm). The depth to a water table may be less than 4 feet (120 cm) if it is for less than 2 months during the growing season. The available water capacity is at least 9 inches (22.5 cm). In the upper 12 inches (30 cm) of the soil profile free carbonates range between 5 and 15 percent calcium carbonate equivalent, the range of pH is between 6.5 and 8.4, and electrical conductivity is 4 mmhos/cm or less. The texture is non-clayey between 8 inches (20 cm) and 48 inches (120 cm).

Subgroup 9L (Dry-Saline/Alkaline)

Soil depth to a restrictive layer is at least 20 inches (50 cm). The depth to a water table during the growing season is > 1.5 feet (45 cm). The depth to a water table may be less than 1.5 feet (45 cm) if it is for less than 2 months during the growing season. The available water capacity is at least 3 inches (8 cm). In the upper 12 inches (30 cm) of the soil profile, the range of electrical conductivity is between 4 and 16 mmhos/cm. Sodium Adsorption Ratio (SAR) will be > 13. Soil texture will vary, and will be saline and/or sodic.

Subgroup 9W (Wet-Saline/Alkaline)

Soil depth to a restrictive layer is at least 20 inches (50 cm). The depth to a water table during the growing season is between 1.5 and 5 feet (45 and 150 cm). The available water capacity is at least 2 inches (5 cm). In the upper 12 inches (30 cm) of the soil profile electrical conductivity is between 4 and 16 mmhos/cm. Sodium Adsorption Ratio (SAR) will be > 13. Soil texture will vary, and will be saline and/or sodic. These soils are poorly or very poorly drained.

Group 10 (On-site Evaluation)

Soils have one or more characteristics that are severely imitating to the planting and growth of trees and shrubs: soil depth is less than 20 inches (50 cm); available water capacity is less than 3 inches (8.0 cm); depth to a water table during the growing season is less than 0.5 feet (15 cm) or occurs for longer than 3 months during the growing season; in the upper 12 inches (30 cm) of the soil profile free carbonates are greater than 40 percent calcium carbonate equivalent, pH is less than 4.0 or greater than 8.4, electrical conductivity is greater than 16 mmhos/cm, or sodium adsorption ratio is 25 percent or greater. Slopes > 30%. All channeled phases that are frequently or occasionally flooded. Soils that occasionally or frequently pond for long or very long duration.

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
1	CONIFEROUS TREES	Arborvitae, American or Northern White Cedar <i>Thuja occidentalis</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	25-30/20	15-20	25-30/20
1	CONIFEROUS TREES	Arborvitae, Oriental 1/ <i>Thuja orientalis</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	15-20/15
1	CONIFEROUS TREES	Baldcypress <i>Taxodium distichum</i>	Not Recommended	Not Recommended	20-25	25-30/20	20-25	30-35/20	20-30	40-50/20
1	CONIFEROUS TREES	Fir, Douglas <i>Pseudotsuga menziesii</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-25	30-35/20	20-30	40-50/20
1	CONIFEROUS TREES	Fir, White <i>Abies concolor</i>	Not Recommended	Not Recommended	20-25	30-45/30	20-25	30-45/25	20-30	40-50/25
1	CONIFEROUS TREES	Juniper, Rocky Mountain 1/ <i>Juniperus scopulorum</i>	10-20	15-25/15	10-20	15-25/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended
1	CONIFEROUS TREES	Pine, Austrian <i>Pinus nigra</i>	5-20	30-50/20-30	15-30	30-55/20	20-30	35-50/20	20-35	40-60/20
1	CONIFEROUS TREES	Pine, Eastern White <i>Pinus strobus</i>	Not Recommended	Not Recommended	25-30	35-40/20	20-25	40-50/20	30-35	40-60/20
1	CONIFEROUS TREES	Pine, Jack <i>Pinus banksiana</i>	15-20	30-40/15	15-20	35-45/15	20-30	35-45/15	20-30	35-45/15-20
1	CONIFEROUS TREES	Pine, Limber 1/ <i>Pinus flexilis</i>	10-15	25-40/15	10-15	25-45/15-20	15-20	30-45/15-20	20-25	35-55/15-20
1	CONIFEROUS TREES	Pine, Ponderosa 1/ <i>Pinus ponderosa</i>	15-25	30-50/20	15-30	30-55/20	20-30	35-55/20	20-35	40-60/20
1	CONIFEROUS TREES	Pine, Southwestern White 1/ <i>Pinus strobiformis</i>	15-25	30-50/20	15-30	30-55/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended
1	CONIFEROUS TREES	Redcedar, Eastern 1/ <i>Juniperus virginiana</i>	10-20	20-25/15	10-20	20-25/15	10-25	25-35/15-20	15-25	30-40/20
1	CONIFEROUS TREES	Spruce, Colorado Blue <i>Picea pungens</i>	15-20	25-35/20-30	15-20	30-40/20-30	20-25	30-45/20-30	15-20	40-60/25-30
1	CONIFEROUS TREES	Spruce, Norway <i>Picea abies</i>	Not Recommended	Not Recommended	25-30	30-40/20	25-30	30-45/20	25-35	45-60/25

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
1	CONIFEROUS TREES	Spruce, White <i>Picea glauca</i> (variety Black Hills)	15-20	25-35/15	20-25	30-40/20	20-25	30-45/20	20-30	30-45/20
1	DECIDUOUS TREES	Apricot, Manchurian <i>Prunus armeniaca</i>	Not Recommended	Not Recommended	5-10	10-15/10	10-15	10-15/10	10-20	10-20/10
1	DECIDUOUS TREES	Ash, Green 1/, 3/ <i>Fraxinus pennsylvanica</i>	15-20	25-35/25	20-25	30-40/30	20-30	35-50/3	25-30	40-60/30-40
1	DECIDUOUS TREES	Aspen, Quaking 1/ <i>Populus tremuloides</i>	15-20	30-40	15-20	30-40	15-20	30-40	15-20	30-40
1	DECIDUOUS TREES	Basswood/ Linden, American <i>Tilia americana</i>	20-25	30-40/30	20-30	30-40/30	20-30	35-45/30	25-35	50-70/30-40
1	DECIDUOUS TREES	Birch, Paper 4/ <i>Betula papyrifera</i>	Not Recommended	Not Recommended	20-30 (Niobrara Valley only)	15-25/45	20-30 15-25/45		20-30	15-25/50
1	DECIDUOUS TREES	Birch, River 4/ <i>Betula nigra</i>	Not Recommended	Not Recommended	20-30 (Niobrara Valley only)	15-25/45	20-30 15-25/45		20-30	15-25/50
1	DECIDUOUS TREES	Boxelder <i>Acer negundo</i>	15-20	25-35/20	15-20	25-35/20	20-25	30-35/20	20-25	35-40/20
1	DECIDUOUS TREES	Catalpa, Northern 1/ <i>Catalpa speciosa</i>	Not Recommended	Not Recommended	25-30	25-30/20	25-30	30-40/20	25-30	40-50/25
1	DECIDUOUS TREES	Cherry, Black <i>Prunus serotina</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	35-40/20	20-30	30-50/20
1	DECIDUOUS TREES	Cottonwood, Eastern 1/ <i>Populus deltoides</i> Recom. cultivars: Might Mo, Noreaster, Platte	30-55	60-80/40	30-55	65-85/40	45-55	65-85/40-50	50-60	70-90/40-60
1	DECIDUOUS TREES	Crabapple <i>Malus sp.</i> Recom. cultivars: Radiant, Siberian, Midwest 1/, Roselow Sargent	8-12	10-15/15	10-15	10-15/15	10-15	10-15/15	5-20	15-20/15
1	DECIDUOUS TREES	Crabapple, Prairie <i>Malus ionensis</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	5-20	15-20/15	5-20	15-20/15
1	DECIDUOUS TREES	Elm, American 1/ <i>Ulmus americana</i>	15-30	15-35/20	15-35	20-40/20	25-40	25-40/20	25-40	55-60/30

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
1	DECIDUOUS TREES	Elm, Siberian 1/ <i>Ulmus pumila</i>	15-30	15-35/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
1	DECIDUOUS TREES	Hackberry 1/ <i>Celtis occidentalis</i>	15-20	30-40/20	20-25	40-50/20	20-30	45-55/20	20-30	50-60/30
1	DECIDUOUS TREES	Hawthorn, Cockspur 1/ <i>Crataegus crusgalli</i>	15-20	15-20/15	15-20	15-20/15	15-20	15-20/15	15-20	15-20/15
1	DECIDUOUS TREES	Hawthorn, Washington1/ <i>Crataegus phaenopyrum</i>	15-20	15-20/15	15-20	15-20/15	15-20	15-20/15	15-20	15-20/15
1	DECIDUOUS TREES	Hickory, Bitternut <i>Carya cordiformis</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	45-55/20
1	DECIDUOUS TREES	Hickory, Shagbark <i>Carya ovata</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	45-55/20
1	DECIDUOUS TREES	Honeylocust 1/ <i>Gleditsia triacanthos</i>	15-25	30-40/20	20-30	30-40/20	25-30	35-45/20	25-35	40-50/25-30
1	DECIDUOUS TREES	Hophornbeam, Eastern <i>Ostrya virginiana</i>	Not Recommended	Not Recommended	10-15 15-20/10		10-20	20-25/10	15-20	20-25/10-20
1	DECIDUOUS TREES	Kentucky Coffeetree <i>Gymnocladus dioicus</i>	20-25	30-40/15	25-30	30-40/20	25-30	35-45/20	25-30	45-70/25-30
1	DECIDUOUS TREES	Locust, Black 1/, 2/ <i>Robinia pseudoacacia</i>	20-25	25-35/15	25-30	25-35/15	25-30	35-45/20	25-30	40-50/20
1	DECIDUOUS TREES	Maple, Amur <i>Acer ginnala</i> Recommended cultivar: Flame	10-15	10-15/15	10-15	10-15/15	15-20	15-20/15	15-20	15-20/15
1	DECIDUOUS TREES	Maple, Silver <i>Acer saccharinum</i>	25-30	30-40/20-25	25-30	35-45/20-25	30-35	40-60/30-40	35-40	50-70/30-50
1	DECIDUOUS TREES	Maple, Sugar <i>Acer saccharum</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-25	40-50/30
1	DECIDUOUS TREES	Mulberry, Red 1/ <i>Morus rubra</i>	15-20	15-25/15	15-20	30-35/15-20	20-25	35-40/20	20-25	40-45/25-30
1	DECIDUOUS TREES	Mulberry, Russian or White 1/ <i>Morus alba var. tatarica</i>	15-20	15-25/15	15-20	30-35/15-20	20-25	35-40/20	20-25	40-45/25-30

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
1	DECIDUOUS TREES	Oak, Black <i>Quercus velutina</i>	Not Recommended	Not Recommended	15-20	35-50/20-25	20-25	40-50/30	25-30	40-60/30-40
1	DECIDUOUS TREES	Oak, Bur 1/ <i>Quercus macrocarpa</i>	15-20	25-35/20-25	15-25	30-40/20-30	20-25	45-55/40-50	25-30	60-80/40-60
1	DECIDUOUS TREES	Oak, Chinkapin <i>Quercus muhlenbergii</i>	Not Recommended	Not Recommended	15-20	35-50/20-25	20-25	40-50/30	25-30	40-60/30-40
1	DECIDUOUS TREES	Oak, English <i>Quercus robur</i>	Not Recommended	Not Recommended	25-35	45-55	25-35	50-60	30-40	55-65
1	DECIDUOUS TREES	Oak, Gambel 1/ <i>Quercus gambelii</i>	5-10	15-20	10-15	25	Not Recommended	Not Recommended	Not Recommended	Not Recommended
1	DECIDUOUS TREES	Oak, Northern Red <i>Quercus rubra</i>	Not Recommended	Not Recommended	15-20	35-50/20-25	20-25	40-50/30	25-30	40-60/30-40
1	DECIDUOUS TREES	Oak, Pin <i>Quercus palustris</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	25-30	40-60/30-40
1	DECIDUOUS TREES	Oak, Swamp White <i>Quercus bicolor</i>	Not Recommended	Not Recommended	15-20 30-40/20		15-25	30-45/20	20-30	40-50/20-30
1	DECIDUOUS TREES	Oak, White <i>Quercus alba</i>	Not Recommended	Not Recommended	15-20 35-50/20-25		20-25	40-50/30	25-30	40-60/30-40
1	DECIDUOUS TREES	Osage-orange 1/ <i>Maclura pomifera</i>	Not Recommended	Not Recommended	15-20	20-25/15	15-20	25-30/15	15-20	30-40/20-25
1	DECIDUOUS TREES	Pawpaw <i>Asimina Adans.</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	15-25/10-20
1	DECIDUOUS TREES	Pear, Chinese (Harbin) <i>Pyrus ussuriensis</i> Recommended cultivar: McDermand	Not Recommended	Not Recommended	15-20	15-20/15	15-20	15-25/15	20-25	20-25/15
1	DECIDUOUS TREES	Pecan, Northern <i>Carya illinoensis</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended		60-70 (South of Platte River only)		70-80 (South of Platte River only)
1	DECIDUOUS TREES	Redbud, Eastern 1/ <i>Cercis canadensis</i>	Not Recommended	Not Recommended	10-15	10-15/10	10-20	10-15/10	15-20	15-20/10-20
1	DECIDUOUS TREES	Sycamore, American <i>Platanus occidentalis</i>	Not Recommended	Not Recommended	30	40/50	30-35	40-45/20	35-40	50-70/30-40

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
1	DECIDUOUS TREES	Walnut, Black <i>Juglans nigra</i>	Not Recommended	Not Recommended	20-25	30-40/30	20-25	40-50/30	25-30	40-60/30
1	DECIDUOUS TREES	Willow, Black 1/ <i>Salix nigra</i>	20-25	25-35/20	20-25	30-35/20	25-30	30-35/20	25-30	35-50/20
1	DECIDUOUS TREES	Willow, Peachleaf 1/ <i>Salix amygdaloides</i>	20-25	20-30/20	20-25	20-30/20	20-25	20-30/20	20-25	20-30/20
1	DECIDUOUS TREES	Willow, White or Golden 1/ <i>Salix alba</i> (Cultivars Vitellina or Tristis; often called Golden Willow)	20-30	25-35/20	20-25	30-35/20	25-30	30-35/20	25-30	35-40/20
1	CONIFEROUS SHRUBS	Juniper, Common (Prostrate) 1/ <i>Juniperus communis</i>	4-7	4-7/15	4-7	4-7/15	4-7	4-7/15	4-7	4-7/15
1	DECIDUOUS SHRUBS	Antelope Bitterbrush <i>Purshia tridentate</i>	2-10		Not Recommended		Not Recommended		Not Recommended	
1	DECIDUOUS SHRUBS	Blackhaw, Rusty <i>Viburnum rufidulum</i>	Not Recommended		Not Recommended		15-20		20-30	
1	DECIDUOUS SHRUBS	Buffaloberry, Silver 1/ <i>Shepherdia argentea</i>	5-8		10-12		10-12		10-12	
1	DECIDUOUS SHRUBS	Buttonbush <i>Cephalanthus occidentalis</i>	Not Recommended		Not Recommended		Not Recommended		8-10	
1	DECIDUOUS SHRUBS	Cherry, Nanking <i>Prunus tomentosa</i>	Not Recommended		4-5		4-5		5-7	
1	DECIDUOUS SHRUBS	Chokeberry, Black <i>Aronia melanocarpa</i>	Not Recommended		4-8		5-8		6-8	
1	DECIDUOUS SHRUBS	Chokecherry, Common 1/ <i>Prunus virginiana</i>	5-8		6-12		6-12		8-14	
1	DECIDUOUS SHRUBS	Coralberry <i>Symphoricarpos orbiculatus</i>	Not Recommended		Not Recommended		2-3		2-3	
1	DECIDUOUS SHRUBS	Cotoneaster, Peking <i>Cotoneaster acutifolia</i>	4-5		5-6		5-8		5-10	

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
1	DECIDUOUS SHRUBS	Cranberry, Highbush <i>Viburnum trilobum</i>	Not Recommended		Not Recommended		6-12		10-12	
1	DECIDUOUS SHRUBS	Currant, Buffalo 1/ <i>Ribes odoratum</i>	3-6		3-6		3-6		3-6	
1	DECIDUOUS SHRUBS	Currant, Golden 1/ <i>Ribes aureum</i>	2-4		2-4		4-6		4-6	
1	DECIDUOUS SHRUBS	Dogwood, Gray <i>Cornus racemosa</i>	4-6		6-8		6-8		6-10	
1	DECIDUOUS SHRUBS	Dogwood, Redosier <i>Cornus sericea</i>	5-6		5-7		6-8		8-10	
1	DECIDUOUS SHRUBS	Elderberry <i>Sambucus canadensis</i>	Not Recommended		4-6		4-6		4-8	
1	DECIDUOUS SHRUBS	Euonymus, Winterberry <i>Euonymus bungeanus</i> Recommended cultivar: Pink Lady Winterberry	5-10		5-10		8-14		8-14	
1	DECIDUOUS SHRUBS	Hazelnut, American <i>Corylus americana</i>	Not Recommended		6-8		6-8		6-10	
1	DECIDUOUS SHRUBS	Indigo, False <i>Amorpha fruticosa</i>	4-6		6-8		6-8		8-10	
1	DECIDUOUS SHRUBS	Lilac 1/ <i>Syringa vulgaris</i>	5-6		5-6		5-8		6-10	
1	DECIDUOUS SHRUBS	Mahogany, Mountain 1/ <i>Cercocarpus montana</i>	5-10		Not Recommended		Not Recommended		Not Recommended	
1	DECIDUOUS SHRUBS	Nannyberry 1/ <i>Viburnum lentago</i>	Not Recommended		Not Recommended		15-25		15-25	
1	DECIDUOUS SHRUBS	Peashrub, Siberian 1/ <i>Caragana arborescens</i>	3-6		4-8		6-10		8-12	
1	DECIDUOUS SHRUBS	Plum, American 1/ <i>Prunus americana</i>	5-7		5-8		5-8		6-10	
1	DECIDUOUS SHRUBS	Rose, Arkansas (Prairie) <i>Rosa arkansana</i>	1-2		1-2		1-2		1-2	

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
1	DECIDUOUS SHRUBS	Rose, Hansen Hedge <i>Rosa</i> Sp. <i>Rosa rugosa</i> x <i>R. woodsii</i>	4-6		4-6		4-8		6-8	
1	DECIDUOUS SHRUBS	Rose, Woods <i>Rosa woodsii</i>	3-5		3-5		4-5		4-5	
1	DECIDUOUS SHRUBS	Sagebrush, Big <i>Artemisia tridentata</i>	3-6		Not Recommended		Not Recommended		Not Recommended	
1	DECIDUOUS SHRUBS	Sagebrush, Silver <i>Artemisia cana</i>	3-6		Not Recommended		Not Recommended		Not Recommended	
1	DECIDUOUS SHRUBS	Saltbush, Fourwing 1/ <i>Atriplex canescens</i>	2-5		Not Recommended		Not Recommended		Not Recommended	
1	DECIDUOUS SHRUBS	Sandcherry, Western <i>Prunus besseyi</i>	2-3		2-3		2-4		3-6	
1	DECIDUOUS SHRUBS	Serviceberry, Saskatoon 1/ <i>Amelanchier alnifolia</i> (Nutt)	5-7		5-7		6-10		6-10	
1	DECIDUOUS SHRUBS	Snowberry, Common <i>Symphoricarpos albus</i>	Not Recommended		Not Recommended		3-4		3-4	
1	DECIDUOUS SHRUBS	Snowberry, Western <i>Symphoricarpos occidentalis</i>	3-4		3-4		3-4		3-4	
1	DECIDUOUS SHRUBS	Sumac, Skunkbush 1/ <i>Rhus trilobata</i> Recommended cultivars: Big Horn, Konza Fragrant	3-5		4-6		4-6		4-8	
1	DECIDUOUS SHRUBS	Willow, Sandbar <i>Salix exigua</i>	10-15		10-15		10-15		10-15	

1/ Adapted to calcareous soils

2/ Black locust can be severely impacted by insect damage; recommend limiting use to wildlife and pollinator plantings, rather than for windbreaks

3/ Green Ash - only to be used in diverse tree and shrub plantings, **not in windbreaks**

4/ Conservation mulch improves growth and survival

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
1K	CONIFEROUS TREES	Arborvitae, American or Northern White Cedar 1/ <i>Thuja occidentalis</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	25-30/20	15-20	25-30/20
1K	CONIFEROUS TREES	Arborvitae, Oriental 1/ <i>Thuja orientalis</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	15-20/15
1K	CONIFEROUS TREES	Juniper, Rocky Mountain 1/ <i>Juniperus scopulorum</i>	10-20	15-25/15	10-20	15-25/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended
1K	CONIFEROUS TREES	Pine, Bristlecone 1/ <i>Pinus aristata</i>	5-10	25-30/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
1K	CONIFEROUS TREES	Pine, Limber 1/ <i>Pinus flexilis</i>	10-15	25-40/15	10-15	25-45/15-20	15-20	30-45/15-20	20-25	35-55/15-20
1K	CONIFEROUS TREES	Pine, Ponderosa 1/ <i>Pinus ponderosa</i>	15-25	30-50/20	15-30	30-55/20	20-30	35-55/20	20-35	40-60/20
1K	CONIFEROUS TREES	Pine, Southwestern White 1/ <i>Pinus strobiformis</i>	15-25	30-50/20	15-30	30-55/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended
1K	CONIFEROUS TREES	Redcedar, Eastern 1/ <i>Juniperus virginiana</i>	10-20	20-25/15	10-20	20-25/15	10-25	25-35/15-20	15-25	30-40/20
1K	DECIDUOUS TREES	Apricot, Manchurian <i>Prunus armeniaca</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	10-110	10-20	10-20/10
1K	DECIDUOUS TREES	Ash, Green 1/, 3/ <i>Fraxinus pennsylvanica</i>	15-20	25-35/25	20-25	30-40/30	20-30	35-50/3	25-30	40-60/30-40
1K	DECIDUOUS TREES	Aspen, Quaking 1/ <i>Populus tremuloides</i>	15-20	30-40	15-20	30-40	15-20	30-40	15-20	30-40
1K	DECIDUOUS TREES	Catalpa, Northern 1/ <i>Catalpa speciosa</i>	Not Recommended	Not Recommended	25-30	25-30/20	25-30	30-40/20	25-30	40-50/25
1K	DECIDUOUS TREES	Cottonwood, Eastern 1/ <i>Populus deltoides</i> Recom. cultivars: Might Mo, Noreaster, Platte	30-55	60-80/40	30-55	65-85/40	45-55	65-85/40-50	50-60	70-90/40-60
1K	DECIDUOUS TREES	Crabapple <i>Malus sp.</i> Recom. cultivars: Radiant, Siberian, Midwest 1/, Roselow Sargent	8-12	10-15/15	10-15	10-15/15	10-15	10-15/15	5-20	15-20/15
1K	DECIDUOUS TREES	Crabapple, Prairie <i>Malus ionensis</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	5-20	15-20/15	5-20	15-20/15
1K	DECIDUOUS TREES	Elm, American 1/ <i>Ulmus americana</i>	15-30	15-35/20	15-35	20-40/20	25-40	25-40/20	25-40	55-60/30

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
1K	DECIDUOUS TREES	Elm, Siberian 1/ <i>Ulmus pumila</i>	15-30	15-35/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
1K	DECIDUOUS TREES	Hackberry 1/ <i>Celtis occidentalis</i>	15-20	30-40/20	20-25	40-50/20	20-30	45-55/20	20-30	50-60/30
1K	DECIDUOUS TREES	Hawthorn, Cockspur 1/ <i>Crataegus crusgalli</i>	15-20	15-20/15	15-20	15-20/15	15-20	15-20/15	15-20	15-20/15
1K	DECIDUOUS TREES	Hawthorn, Washington 1/ <i>Crataegus phaenopyrum</i>	15-20	15-20/15	15-20	15-20/15	15-20	15-20/15	15-20	15-20/15
1K	DECIDUOUS TREES	Honeylocust 1/ <i>Gleditsia triacanthos</i>	15-25	30-40/20	20-30	30-40/20	25-30	35-45/20	25-35	40-50/25-30
1K	DECIDUOUS TREES	Locust, Black 1/, 2/ <i>Robinia pseudoacacia</i>	20-25	25-35/15	25-30	25-35/15	25-30	35-45/20	25-30	40-50/20
1K	DECIDUOUS TREES	Mulberry, Red 1/ <i>Morus rubra</i>	15-20	15-25/15	15-20	30-35/15-20	20-25	35-40/20	20-25	40-45/25-30
1K	DECIDUOUS TREES	Mulberry, Russian or White 1/ <i>Morus alba var. tatarica</i>	15-20	15-25/15	15-20	30-35/15-20	20-25	35-40/20	20-25	40-45/25-30
1K	DECIDUOUS TREES	Oak, Bur 1/ <i>Quercus macrocarpa</i>	15-20	25-35/20-25	15-25	30-40/20-30	20-25	45-55/40-50	25-30	60-80/40-60
1K	DECIDUOUS TREES	Oak, English 1/ <i>Quercus robur</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	25-35	50-60	30-40	55-65
1K	DECIDUOUS TREES	Oak, Gambel 1/ <i>Quercus gambelii</i>	5-10	15-20	10-15	25	Not Recommended	Not Recommended	Not Recommended	Not Recommended
1K	DECIDUOUS TREES	Osage-orange 1/ <i>Maclura pomifera</i>	Not Recommended	Not Recommended	15-20	20-25/15	15-20	25-30/15	15-20	30-40/20-25
1K	DECIDUOUS TREES	Redbud, Eastern 1/ <i>Cercis canadensis</i>	Not Recommended	Not Recommended	10-15	10-15/10	10-20	10-15/10	15-20	15-20/10-20
1K	DECIDUOUS TREES	Willow, Black 1/ <i>Salix nigra</i>	20-25	25-35/20	20-25	30-35/20	25-30	30-35/20	25-30	35-50/20
1K	DECIDUOUS TREES	Willow, Peachleaf 1/ <i>Salix amygdaloides</i>	20-25	20-30/20	20-25	20-30/20	20-25	20-30/20	20-25	20-30/20
1K	DECIDUOUS TREES	Willow, White or Golden 1/ <i>Salix alba</i> (Cultivars Vitellina or Tristis; often called Golden Willow)	20-30	25-35/20	20-25	30-35/20	25-30	30-35/20	25-30	35-40/20

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
1K	CONIFEROUS SHRUBS	Juniper, Common 1/ <i>Juniperus communis</i>	4-7	4-7/15	4-7	4-7/15	4-7	4-7/15	4-7	4-7/15
1K	DECIDUOUS SHRUBS	Antelope Bitterbrush 1/ <i>Purshia tridentate</i>	2-10		Not Recommended		Not Recommended		Not Recommended	
1K	DECIDUOUS SHRUBS	Buffaloberry, Silver 1/ <i>Shepherdia argentea</i>	5-8		10-12		10-12		10-12	
1K	DECIDUOUS SHRUBS	Chokecherry, Common 1/ <i>Prunus virginiana</i>	5-8		6-12		6-12		8-14	
1K	DECIDUOUS SHRUBS	Currant, Buffalo 1/ <i>Ribes odoratum</i>	3-6		3-6		3-6		3-6	
1K	DECIDUOUS SHRUBS	Currant, Golden 1/ <i>Ribes aureum</i>	2-4		2-4		4-6		4-6	
1K	DECIDUOUS SHRUBS	Lilac 1/ <i>Syringa vulgaris</i>	5-6		5-6		5-8		6-10	
1K	DECIDUOUS SHRUBS	Mahogany, Mountain 1/ <i>Cercocarpus montana</i>	5-10		Not Recommended		Not Recommended		Not Recommended	
1K	DECIDUOUS SHRUBS	Nannyberry 1/ <i>Viburnum lentago</i>	Not Recommended		Not Recommended		15-25		15-25	
1K	DECIDUOUS SHRUBS	Peashrub, Siberian 1/ <i>Caragana arborescens</i>	3-6		4-8		6-10		8-12	
1K	DECIDUOUS SHRUBS	Plum, American 1/ <i>Prunus americana</i>	5-7		5-8		5-8		6-10	
1K	DECIDUOUS SHRUBS	Saltbush, Fourwing 1/ <i>Atriplex canescens</i>	2-5		Not Recommended		Not Recommended		Not Recommended	
1K	DECIDUOUS SHRUBS	Serviceberry, Saskatoon 1/ <i>Amelanchier alnifolia (Nutt)</i>	5-7		5-7		6-10		6-10	
1K	DECIDUOUS SHRUBS	Sumac, Skunkbush 1/ <i>Rhus trilobata</i> Recommended cultivars: Big Horn, Konza Fragrant	3-5		4-6		4-6		4-8	

1/ Adapted to calcareous soils

2/ Black locust can be severely impacted by insect damage; recommend limiting use to wildlife and pollinator plantings, rather than for windbreaks

3/ Green Ash - only to be used in diverse tree and shrub plantings, **not in windbreaks**

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
1S	CONIFEROUS TREES	Arborvitae, American or Northern White Cedar <i>Thuja occidentalis</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	25-30/20	15-20	25-30/20
1S	CONIFEROUS TREES	Arborvitae, Oriental <i>Thuja orientalis</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	15-20/15
1S	CONIFEROUS TREES	Juniper, Rocky Mountain <i>Juniperus scopulorum</i>	10-20	15-25/15	10-20	15-25/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended
1S	CONIFEROUS TREES	Pine, Austrian <i>Pinus nigra</i>	5-25	30-50/20	15-30	30-520	20-30	35-50/20	20-35	40-60/20
1S	CONIFEROUS TREES	Pine, Eastern White <i>Pinus strobus</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	25-25	40-50/20	30-35	40-60/20
1S	CONIFEROUS TREES	Pine, Jack <i>Pinus banksiana</i>	15-20	25-315	15-20	30-40/15	15-30	30-40/15	20-30	40-415
1S	CONIFEROUS TREES	Pine, Limber <i>Pinus flexilis</i>	10-15	25-40/15	10-15	25-415-20	15-20	30-415-20	20-25	35-515-20
1S	CONIFEROUS TREES	Pine, Pinyon [Two needle Pinyon] <i>Pinus edulis</i>	5-10	15-20/15-20	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
1S	CONIFEROUS TREES	Pine, Ponderosa <i>Pinus ponderosa</i>	15-25	30-50/20	15-30	30-520	20-30	35-520	20-35	40-60/20
1S	CONIFEROUS TREES	Pine, Southwestern White <i>Pinus strobiformis</i>	15-25	30-50/20	15-30	30-520	Not Recommended	Not Recommended	Not Recommended	Not Recommended
1S	CONIFEROUS TREES	Redcedar, Eastern <i>Juniperus virginiana</i>	10-20	20-215	10-20	20-215	10-25	25-315-20	15-25	30-40/20
1S	CONIFEROUS TREES	Spruce, Colorado Blue <i>Picea pungens</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-25	30-420-25	20-30	40-60/25
1S	CONIFEROUS TREES	Spruce, Norway <i>Picea abies</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	25-30	30-420	25-30	45-60/25
1S	CONIFEROUS TREES	Spruce, White <i>Picea glauca</i> (variety Black Hills)	15-20	25-315	20-25	30-40/20	20-25	30-420	25-30	30-420
1S	DECIDUOUS TREES	Apricot, Manchurian <i>Prunus armeniaca</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	10-110	10-20	10-20/10
1S	DECIDUOUS TREES	Ash, Green 1/ <i>Fraxinus pennsylvanica</i>	15-20	25-325	20-25	30-40/30	20-30	35-50/3	25-30	40-60/30-40
1S	DECIDUOUS TREES	Aspen, Quaking <i>Populus tremuloides</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	20-30	15-20	20-30

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
1S	DECIDUOUS TREES	Basswood/ Linden, American <i>Tilia americana</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	25-30	35-430	25-30	40-50/30
1S	DECIDUOUS TREES	Birch, Paper <i>Betula papyrifera</i>	Not Recommended	Not Recommended	20-30 (Niobrara Valley only)	415-25	Not Recommended	Not Recommended	Not Recommended	Not Recommended
1S	DECIDUOUS TREES	Birch, River <i>Betula nigra</i>	Not Recommended	Not Recommended	20-30 (Niobrara Valley only)	15-25/45	Not Recommended	Not Recommended	Not Recommended	Not Recommended
1S	DECIDUOUS TREES	Boxelder <i>Acer negundo</i>	15-20	25-30-20	15-20	25-30/20	20-25	30-35/20	20-25	35-40/20
1S	DECIDUOUS TREES	Catalpa, Northern <i>Catalpa speciosa</i>	Not Recommended	Not Recommended	25-30	25-30/20	25-30	30-40/20	25-30	40-50/25
1S	DECIDUOUS TREES	Cottonwood, Eastern <i>Populus deltoides</i> Recommended cultivars: Might Mo, Noreaster, Platte	30-55	60-80/40	30-55	65-80/40	45-55	65-80/40-50	50-60	70-90/40-50
1S	DECIDUOUS TREES	Elm, Siberian <i>Ulmus pumila</i>	20-25	20-320	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
1S	DECIDUOUS TREES	Hackberry <i>Celtis occidentalis</i>	15-20	30-40/20	20-25	40-50/20	20-30	45-50/20	20-30	50-60/30
1S	DECIDUOUS TREES	Hawthorn, Cockspur <i>Crataegus crusgalli</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	15-20/15	15-20	15-20/15
1S	DECIDUOUS TREES	Hawthorn, Washington <i>Crataegus phaenopyrum</i>	Not Recommended	Not Recommended	10-15	15-20/15	10-15	15-20/15	15-20	15-20/15
1S	DECIDUOUS TREES	Honeylocust <i>Gleditsia triacanthos</i>	15-25	30-40/20	20-30	30-40/20	25-30	35-420	25-35	40-50/25-30
1S	DECIDUOUS TREES	Kentucky Coffeetree <i>Gymnocladus dioicus</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	25-30	35-420	25-30	45-70/25-30
1S	DECIDUOUS TREES	Locust, Black 2/ <i>Robinia pseudoacacia</i>	20-25	25-30/15	25-30	25-30/15	25-30	35-40/20	25-30	40-50/20
1S	DECIDUOUS TREES	Maple, Amur <i>Acer ginnala</i> Recommended cultivar:	10-15	10-115	10-15	10-115	15-20	15-20/15	15-20	15-20/15
1S	DECIDUOUS TREES	Maple, Silver <i>Acer saccharinum</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	30-35	40-50/30-40	35-40	50-60/30-40
1S	DECIDUOUS TREES	Mulberry, Red <i>Morus rubra</i>	15-20	15-20/15	15-20	30-35/15-20	20-25	35-40/20	20-25	40-45/25-30

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
1S	DECIDUOUS TREES	Mulberry, Russian or White <i>Morus alba var. tatarica</i>	15-20	15-20/15	15-20	30-35/15-20	15-20	35-40/20	20-25	40-45/25-30
1S	DECIDUOUS TREES	Oak, Bur <i>Quercus macrocarpa</i>	15-20	25-30/15-20	20-25	30-40/20	20-25	35-40/30	25-30	40-60/30-40
1S	DECIDUOUS TREES	Oak, Gambel <i>Quercus gambelii</i>	5-10	15-20	10-15	25	Not Recommended	Not Recommended	Not Recommended	Not Recommended
1S	DECIDUOUS TREES	Oak, Swamp White <i>Quercus bicolor</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-25	30-40/20	25-30	40-50/20-30
1S	DECIDUOUS TREES	Osage-orange <i>Maclura pomifera</i>	Not Recommended	Not Recommended	15-20	20-25/15	15-20	25-30/15	15-20	30-35/20-25
1S	CONIFEROUS SHRUBS	Juniper, Common 1/ <i>Juniperus communis</i>	4-7	4-7/15	4-7	4-7/15	4-7	4-7/15	4-7	4-7/15
1S	DECIDUOUS SHRUBS	Currant, Buffalo <i>Ribes odoratum</i>	3-6		3-6		3-6		3-6	
1S	DECIDUOUS SHRUBS	Currant, Golden <i>Ribes aureum</i>	2-4		2-4		4-6		4-6	
1S	DECIDUOUS SHRUBS	Dogwood, Gray <i>Cornus racemosa</i>	Not Recommended		6-8		6-8		6-8	
1S	DECIDUOUS SHRUBS	Dogwood, Redosier <i>Cornus sericea</i>	5-6		5-7		6-8		8-10	
1S	DECIDUOUS SHRUBS	Elderberry <i>Sambucus canadensis</i>	Not Recommended		4-6		4-6		4-8	
1S	DECIDUOUS SHRUBS	Euonymus, Winterberry <i>Euonymus bungeanus</i> Recommended cultivar: Pink Lady Winterberry	6-10		6-10		8-14		8-14	
1S	DECIDUOUS SHRUBS	Indigo, False <i>Amorpha fruticosa</i>	4-6		6-8		6-8		8-10	
1S	DECIDUOUS SHRUBS	Lilac <i>Syringa vulgaris</i>	5-6		5-6		5-8		6-10	
1S	DECIDUOUS SHRUBS	Mahogany, Mountain <i>Cercocarpus montana</i>	5-10		Not Recommended		Not Recommended		Not Recommended	
1S	DECIDUOUS SHRUBS	Nannyberry <i>Viburnum lentago</i>	Not Recommended		Not Recommended		15-25		15-25	

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
1S	DECIDUOUS SHRUBS	Peashrub, Siberian <i>Caragana arborescens</i>	6-8		6-8		6-10		8-10	
1S	DECIDUOUS SHRUBS	Plum, American <i>Prunus americana</i>	5-7		5-8		5-8		6-10	
1S	DECIDUOUS SHRUBS	Rose, Arkansas (Prairie) <i>Rosa arkansana</i>	1-2		1-2		1-2		1-2	
1S	DECIDUOUS SHRUBS	Rose, Hansen Hedge <i>Rosa</i> Sp. <i>Rosa rugosa x R. woodsii</i>	4-6		4-6		4-8		6-8	
1S	DECIDUOUS SHRUBS	Rose, Woods <i>Rosa woodsii</i>	3-5		3-5		4-5		4-5	
1S	DECIDUOUS SHRUBS	Sagebrush, Big <i>Artemisia tridentata</i>	3-6		Not Recommended		Not Recommended		Not Recommended	
1S	DECIDUOUS SHRUBS	Sagebrush, Silver <i>Artemisia cana</i>	3-6		Not Recommended		Not Recommended		Not Recommended	
1S	DECIDUOUS SHRUBS	Saltbush, Fourwing <i>Atriplex canescens</i>	2-5		Not Recommended		Not Recommended		Not Recommended	
1S	DECIDUOUS SHRUBS	Sandcherry, Western <i>Prunus besseyi</i>	2-3		2-3		2-4		3-6	
1S	DECIDUOUS SHRUBS	Serviceberry, Saskatoon 1/ <i>Amelanchier alnifolia</i> (Nutt)	5-7		5-7		6-10		6-10	
1S	DECIDUOUS SHRUBS	Snowberry, Common <i>Symphoricarpos albus</i>	Not Recommended		Not Recommended		3-4		3-4	
1S	DECIDUOUS SHRUBS	Snowberry, Western <i>Symphoricarpos occidentalis</i>	3-4		3-4		3-4		3-4	
1S	DECIDUOUS SHRUBS	Sumac, Skunkbush 1/ <i>Rhus trilobata</i> Recommended cultivars: Big horn, Konza fragrant	3-5		4-6		4-6		4-8	

1/ Green Ash - only to be used in diverse tree and shrub plantings; **not windbreaks**

2/ Black Locust - for wildlife and pollinators (refer to table 11)

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
1SK	CONIFEROUS TREES	Juniper, Rocky Mountain <i>Juniperus scopulorum</i>	10-20	15-25/15	10-20	15-25/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended
1SK	CONIFEROUS TREES	Pine, Bristlecone <i>Pinus aristata</i>	5-10	25-30/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
1SK	CONIFEROUS TREES	Pine, Limber <i>Pinus flexilis</i>	10-15	25-40/15	10-15	25-40/15-20	15-20	30-40/15-20	20-25	35-50/15-20
1SK	CONIFEROUS TREES	Pine, Ponderosa <i>Pinus ponderosa</i>	15-25	30-50/20	15-30	30-50/20	20-30	35-50/20	20-35	40-60/20
1SK	CONIFEROUS TREES	Pine, Southwestern White <i>Pinus strobiformis</i>	15-25	30-50/20	15-30	30-50/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended
1SK	CONIFEROUS TREES	Redcedar, Eastern <i>Juniperus virginiana</i>	10-20	20-25/15	10-20	20-25/15	10-25	25-35/15-20	15-25	30-40/20
1SK	CONIFEROUS SHRUBS	Juniper, Common (Prostrate) <i>Juniperus communis</i>	4-7	4-7/15	4-7	4-7/15	4-7	4-7/15	4-7	4-7/15
1K	DECIDUOUS TREES	Apricot, Manchurian <i>Prunus armeniaca</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	10-15/10	10-20	10-20/10
1SK	DECIDUOUS TREES	Ash, Green 1/ <i>Fraxinus pennsylvanica</i>	15-20	25-325	20-25	30-40/30	20-30	35-50/3	25-30	40-60/30-40
1SK	DECIDUOUS TREES	Aspen, Quaking <i>Populus tremuloides</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	20-30	15-20	20-30
1SK	DECIDUOUS TREES	Catalpa, Northern <i>Catalpa speciosa</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	30-35/20	15-20	30-35/20
	DECIDUOUS TREES	Cottonwood, Eastern <i>Populus deltoides</i> Recommended cultivars: Might Mo, Noreaster, Platte	30-55	60-80/40	30-55	65-80/40	45-55	65-80/40-50	50-60	70-90/40-50
1SK	DECIDUOUS TREES	Elm, Siberian <i>Ulmus pumila</i>	15-20	30-35/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
1SK	DECIDUOUS TREES	Hackberry <i>Celtis occidentalis</i>	10-15	25-30/20	10-15	25-30/20	10-15	25-30/20	10-15	30-35/30
1SK	DECIDUOUS TREES	Honeylocust <i>Gleditsia triacanthos</i>	Not Recommended	Not Recommended	10-15	20-25/15-20	10-15	20-25/20	25-35	40-50/25-30
1SK	DECIDUOUS TREES	Locust, Black 2/ <i>Robinia pseudoacacia</i>	Not Recommended	Not Recommended	25-30	25-30/15	25-30	35-40/20	25-30	40-50/20

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
1SK	DECIDUOUS TREES	Oak, Bur <i>Quercus macrocarpa</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	25-30/30	15-20	40-60/30-40
1SK	DECIDUOUS TREES	Oak, English <i>Quercus robur</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	25-35	50-60	30-40	55-65
1SK	DECIDUOUS TREES	Oak, Gambel <i>Quercus gambelii</i>	5-10	15-20	10-15	25	Not Recommended	Not Recommended	Not Recommended	Not Recommended
1SK	DECIDUOUS TREES	Osage-orange <i>Maclura pomifera</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	20-25/15-20	10-15	30-35/20-25
1SK	DECIDUOUS SHRUBS	Antelope Bitterbrush <i>Purshia tridentate</i>	2-3		Not Recommended		Not Recommended		Not Recommended	
1SK	DECIDUOUS SHRUBS	Buffaloberry, Silver <i>Shepherdia argentea</i>	5-8		10-12		10-12		10-12	
1SK	DECIDUOUS SHRUBS	Chokecherry, Common <i>Prunus virginiana</i>	5-8		6-12		6-12		8-14	
1SK	DECIDUOUS SHRUBS	Currant, Buffalo <i>Ribes odoratum</i>	2-4		2-4		3-6		3-6	
1SK	DECIDUOUS SHRUBS	Currant, Golden <i>Ribes aureum</i>	2-4		2-4		4-6		4-6	
1SK	DECIDUOUS SHRUBS	Lilac <i>Syringa vulgaris</i>	5-6		5-6		5-8		6-10	
1SK	DECIDUOUS SHRUBS	Mahogany, Mountain <i>Cercocarpus montana</i>	5-10		Not Recommended		Not Recommended		Not Recommended	
1SK	DECIDUOUS SHRUBS	Peashrub, Siberian <i>Caragana arborescens</i>	6-8		6-8		8-10		8-12	
1SK	DECIDUOUS SHRUBS	Plum, American <i>Prunus americana</i>	5-7		5-8		5-8		6-10	
1SK	DECIDUOUS SHRUBS	Sumac, Skunkbush <i>Rhus trilobata</i> Recommended cultivars: Big horn, Konza fragrant	3-5		4-6		4-6		4-8	

1/ Green Ash - only to be used in diverse tree and shrub plantings; **not windbreaks**

2/ Black Locust - for wildlife and pollinators (refer to table 11)

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
2	CONIFEROUS TREES	Baldcypress <i>Taxodium distichum</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-25	30-320	20-30	40-50/20
2	DECIDUOUS TREES	Ash, Green 1/, 4/ <i>Fraxinus pennsylvanica</i>	15-20	25-35/25	20-25	30-40/30	20-30	35-50/3	25-30	40-60/30-40
2	DECIDUOUS TREES	Birch, Paper 5/ <i>Betula papyrifera</i>	Not Recommended	Not Recommended	20-30 (Niobrara Valley only)	40/15-25	20-30 (Niobrara Valley only)	40/15-25	20-30	50/15-25
2	DECIDUOUS TREES	Birch, River 5/ <i>Betula nigra</i>	Not Recommended	Not Recommended	20-30 (Niobrara Valley only)	40/15-25	20-30 (Niobrara Valley only)	40/15-25	20-30	50/15-25
2	DECIDUOUS TREES	Boxelder <i>Acer negundo</i>	15-20	25-35/20	15-20	25-35/20	15-20	30-35/20	20-25	35-40/20
2	DECIDUOUS TREES	Cottonwood, Eastern 1/ <i>Populus deltoides</i> Recommended cultivars: Might Mo, Noreaster, Platte	30-55	60-80/40	30-55	65-80/40	45-55	65-80/40-50	50-60	70-90/40-60
2	DECIDUOUS TREES	Maple, Silver <i>Acer saccharinum</i>	Not Recommended	Not Recommended	25-30	35-40/20-25	30-35	40-60/30-40	35-40	50-70/30-50
2	DECIDUOUS TREES	Oak, Pin <i>Quercus palustris</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	25-30	40-60/30-40
2	DECIDUOUS TREES	Oak, Swamp White <i>Quercus bicolor</i>	Not Recommended	Not Recommended	15-20	30-40/20	15-25	30-40/20	20-30	40-50/20-30
	DECIDUOUS TREES	Sycamore, American <i>Platanus occidentalis</i>	Not Recommended	Not Recommended	30	40/50	30-35	40-45/20	35-40	50-70/30-40
2	DECIDUOUS TREES	Willow, Black 1/ <i>Salix nigra</i>	20-25	25-35/20	20-25	30-35/20	25-30	30-35/20-25	25-30	40-60/30
2	DECIDUOUS TREES	Willow, Peachleaf 1/ <i>Salix amygdaloides</i>	20-25	20-30/20	20-25	20-30/20	20-25	20-30/20/25	20-25	20-30/30
2	DECIDUOUS TREES	Willow, White or Golden 1/ <i>Salix alba</i> (Cultivars Vitellina or Tristis often called Golden Willow)	20-25	25-35/20	20-25	30-35/20	25-30	30-35/20	25-30	35-45/20-25
2	DECIDUOUS SHRUBS	Dogwood, Redosier <i>Cornus sericea</i>	5-6		5-7		6-8		8-10	
2	DECIDUOUS SHRUBS	Elderberry <i>Sambucus canadensis</i>	Not Recommended		4-6		4-6		4-8	
2	DECIDUOUS SHRUBS	Indigo, False <i>Amorpha fruticosa</i>	4-6		6-8		6-8		8-10	

1/ Adapted to calcareous soils

4/ Green Ash - only to be used in diverse tree and shrub plantings; **not windbreaks.**

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
2K	DECIDUOUS TREES	Ash, Green 1/2/ <i>Fraxinus pennsylvanica</i>	15-20	25-35/25	20-25	30-40/30	20-30	35-50/3	25-30	40-60/30-40
2K	DECIDUOUS TREES	Cottonwood, Eastern 1/ <i>Populus deltoides</i> Recommended cultivars: Might Mo, Noreaster, Platte	30-55	60-80/40	30-55	65-80/40	45-55	65-80/40-50	50-60	70-90/40-60
2K	DECIDUOUS TREES	Sycamore, American <i>Platanus occidentalis</i>	Not Recommended	Not Recommended	30	40/50	30-35	40-45/20	35-40	50-70/30-40
2K	DECIDUOUS TREES	Willow, Black 1/ <i>Salix nigra</i>	20-25	25-30/20	20-25	30-35/20	25-30	30-35/20	25-30	35-50/20
2K	DECIDUOUS TREES	Willow, Peachleaf 1/ <i>Salix amygdaloides</i>	20-25	20-30/20	20-25	20-30/20	20-25	20-30/20	20-25	20-30/20
2K	DECIDUOUS TREES	Willow, White or Golden 1/ <i>Salix alba</i> (Cultivars Vitellina or Tristis often called Golden Willow)	20-30	25-30/20	20-25	30-35/20	25-30	30-35/20	25-30	35-40/20

1/ Adapted to calcareous soils

2/ Green Ash - only to be used in diverse tree and shrub plantings; **not windbreaks**

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
3	CONIFEROUS TREES	Arborvitae, American or Northern White Cedar <i>Thuja occidentalis</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	25-30/20	15-20	25-30/20
3	CONIFEROUS TREES	Arborvitae, Oriental 1/ <i>Thuja orientalis</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	15-20/15
3	CONIFEROUS TREES	Baldcypress <i>Taxodium distichum</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-25	30-35/20	20-30	40-50/20
3	CONIFEROUS TREES	Fir, Douglas <i>Pseudotsuga menziesii</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-25	30-35/20	20-30	40-50/20
3	CONIFEROUS TREES	Fir, White <i>Abies concolor</i>	Not Recommended	Not Recommended	20-25	30-45/30	20-25	30-45/25	20-30	40-50/25
3	CONIFEROUS TREES	Juniper, Rocky Mountain 1/ <i>Juniperus scopulorum</i>	10-20	15-25/15	10-20	15-25/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended
3	CONIFEROUS TREES	Pine, Austrian <i>Pinus nigra</i>	5-20	30-50/20-30	15-30	30-50/20	20-30	35-50/20	20-35	40-60/20
3	CONIFEROUS TREES	Pine, Eastern White <i>Pinus strobus</i>	Not Recommended	Not Recommended	25-30	35-40/20	20-25	40-50/20	30-35	40-60/20
3	CONIFEROUS TREES	Pine, Jack <i>Pinus banksiana</i>	15-20	30-40/15	15-20	35-45/15	20-30	35-45/15	20-30	35-45/15-20
3	CONIFEROUS TREES	Pine, Limber 1/ <i>Pinus flexilis</i>	10-15	25-40/15	10-15	25-45/15-20	15-20	30-45/15-20	20-25	35-55/15-20
3	CONIFEROUS TREES	Pine, Pinyon [Two needle Pinyon] <i>Pinus edulis</i>	5-10	15-20/15-20	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
3	CONIFEROUS TREES	Pine, Ponderosa 1/ <i>Pinus ponderosa</i>	15-25	30-50/20	15-30	30-55/20	20-30	35-55/20	20-35	40-60/20
3	CONIFEROUS TREES	Pine, Southwestern White <i>Pinus strobiformis</i>	15-25	30-50/20	15-30	30-55/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended
3	CONIFEROUS TREES	Redcedar, Eastern 1/ <i>Juniperus virginiana</i>	10-20	20-25/15	10-20	20-25/15	10-25	25-35/15-20	15-25	30-40/20
3	CONIFEROUS TREES	Spruce, Colorado Blue <i>Picea pungens</i>	15-20	25-35/20-30	15-20	30-40/20-30	20-25	30-45/20-30	15-20	40-60/25-30
3	CONIFEROUS TREES	Spruce, Norway <i>Picea abies</i>	Not Recommended	Not Recommended	25-30	30-40/20	25-30	30-40/20	25-35	45-60/25

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
3	CONIFEROUS TREES	Spruce, White <i>Picea glauca</i> (variety Black Hills)	15-20	25-35/15	20-25	30-40/20	20-25	30-45/20	20-30	30-45/20
3	DECIDUOUS TREES	Apricot, Manchurian <i>Prunus armeniaca</i>	Not Recommended	Not Recommended	5-10	10-15/10	10-15	10-15/10	10-20	10-20/10
3	DECIDUOUS TREES	Ash, Green 1/, 3/ <i>Fraxinus pennsylvanica</i>	15-20	25-35/25	20-25	30-40/30	20-30	35-45/30	25-30	40-50/30-40
3	DECIDUOUS TREES	Aspen, Quaking 1/ <i>Populus tremuloides</i>	15-20	30-40	15-20	30-40	15-20	30-40	15-20	30-40
3	DECIDUOUS TREES	Basswood/ Linden, American <i>Tilia americana</i>	15-25	30-40/30	20-30	30-40/30	20-30	35-45/30	25-35	50-70/30-40
3	DECIDUOUS TREES	Birch, Paper 4/ <i>Betula papyrifera</i>	Not Recommended	Not Recommended	20-30 (Niobrara Valley only)	15-25/45	20-30 15-25/45		20-30	15-25/50
3	DECIDUOUS TREES	Birch, River 4/ <i>Betula nigra</i>	Not Recommended	Not Recommended	20-30 (Niobrara Valley only)	15-25/45	20-30	15-25/45	20-30 15-25/50	
3	DECIDUOUS TREES	Boxelder <i>Acer negundo</i>	15-20	25-35/20	15-20	25-35/20	15-20	30-35/20	20-25	35-40/20
3	DECIDUOUS TREES	Catalpa, Northern 1/ <i>Catalpa speciosa</i>	Not Recommended	Not Recommended	25-30	25-30/20	25-30	30-40/20	25-30	40-50/25
3	DECIDUOUS TREES	Cherry, Black <i>Prunus serotina</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	35-40/20	20-30	30-50/20
3	DECIDUOUS TREES	Cottonwood, Eastern 1/ <i>Populus deltoides</i> Recommended cultivars: Might Mo, Noreaster, Platte	30-55	60-80/40	30-55	65-85/40	45-55	65-85/40-50	50-60	70-90/40-60
3	DECIDUOUS TREES	Crabapple 1/ <i>Malus sp.</i> Recommended cultivars: Radiant, Siberian, Midwest, Roselow Sargent	8-12	10-15/15	10-15	10-15/15	10-15	10-15/15	5-20	15-20/15
3	DECIDUOUS TREES	Crabapple, Prairie <i>Malus ionensis</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	5-20	15-20/15 5-20		15-20/15
3	DECIDUOUS TREES	Elm, Siberian 1/ <i>Ulmus pumila</i>	15-30	15-35/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
3	DECIDUOUS TREES	Hackberry 1/ <i>Celtis occidentalis</i>	15-20	30-40/20	20-25	40-50/20	20-30	45-55/20	20-30	50-60/30
3	DECIDUOUS TREES	Hawthorn, Cockspur 1/ <i>Crataegus crusgalli</i>	15-20	15-20/15	15-20	15-20/15	15-20	15-20/15	15-20	15-20/15
3	DECIDUOUS TREES	Hawthorn, Washington 1/ <i>Crataegus phaenopyrum</i>	15-20	15-20/15	15-20	15-20/15	15-20	15-20/15	15-20	15-20/15
3	DECIDUOUS TREES	Hickory, Bitternut <i>Carya cordiformis</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	45-55/20
3	DECIDUOUS TREES	Hickory, Shagbark <i>Carya ovata</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	45-55/20
3	DECIDUOUS TREES	Honeylocust 1/ <i>Gleditsia triacanthos</i>	15-25	30-40/20	20-30	30-40/20	25-30	35-45/20	25-35	40-50/25-30
3	DECIDUOUS TREES	Hophornbeam, Eastern <i>Ostrya virginiana</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-20	20/10	15-20	20-25/10-20
3	DECIDUOUS TREES	Kentucky Coffeetree <i>Gymnocladus dioicus</i>	Not Recommended	Not Recommended	25-30	30-40/20	25-30	35-40/20	25-30	45-70/25-30
3	DECIDUOUS TREES	Locust, Black 1/, 2/ <i>Robinia pseudoacacia</i>	20-25	25-35/15	25-30	25-35/15	25-30	35-45/20	25-30	40-50/20
3	DECIDUOUS TREES	Maple, Amur <i>Acer ginnala</i> Recommended cultivar: Flame	10-15	10-15/15	10-15	10-15/15	15-20	15-20/15	15-20	15-20/15
3	DECIDUOUS TREES	Maple, Silver <i>Acer saccharinum</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	30-35	40-60/30-40	35-40	50-70/30-50
3	DECIDUOUS TREES	Maple, Sugar <i>Acer saccharum</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-25	40-50/30
3	DECIDUOUS TREES	Mulberry, Red 1/ <i>Morus rubra</i>	15-20	15-25/15	15-20	30-35/15-20	20-25	35-40/20	20-25	40-45/25-30
3	DECIDUOUS TREES	Mulberry, Russian or White 1/ <i>Morus alba var. tatarica</i>	15-20	15-25/15	15-20	30-35/15-20	15-20	35-40/20	20-25	40-45/25-30
3	DECIDUOUS TREES	Oak, Black <i>Quercus velutina</i>	Not Recommended	Not Recommended	15-20	35-50/20-25	20-25	40-50/30	25-30	40-60/30-40
3	DECIDUOUS TREES	Oak, Bur 1/ <i>Quercus macrocarpa</i>	15-20	25-35/20-25	15-25	30-40/20-30	20-25	45-50/40-50	25-30	60-80/40-60

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
3	DECIDUOUS TREES	Oak, Chinkapin <i>Quercus muhlenbergii</i>	Not Recommended	Not Recommended	15-20	35-50/20-25	20-25	40-50/30	25-30	40-60/30-40
3	DECIDUOUS TREES	Oak, English <i>Quercus robur</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	25-35	50-60	30-40	55-65
3	DECIDUOUS TREES	Oak, Gambel 1/ <i>Quercus gambelii</i>	5-10	15-20	10-15	25	Not Recommended	Not Recommended	Not Recommended	Not Recommended
3	DECIDUOUS TREES	Oak, Northern Red <i>Quercus rubra</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-25	40-50/30	25-30	40-60/30-40
3	DECIDUOUS TREES	Oak, Pin <i>Quercus palustris</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	25-30	40-60/30-40
3	DECIDUOUS TREES	Oak, Swamp White <i>Quercus bicolor</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-25	30-40/20	20-30	40-50/20-30
3	DECIDUOUS TREES	Oak, White <i>Quercus alba</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-25	40-50/30	25-30	40-60/30-40
3	DECIDUOUS TREES	Osage-orange 1/ <i>Maclura pomifera</i>	Not Recommended	Not Recommended	15-20	20-25/15	15-20	25-30/15	15-20	30-40/20-25
3	DECIDUOUS TREES	Pawpaw <i>Asimina Adans.</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	15-25/10-20
3	DECIDUOUS TREES	Pear, Chinese (Harbin) <i>Pyrus ussuriensis</i> Recommended cultivar: McDermand	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	15-25/15	20-25	15-25/15
3	DECIDUOUS TREES	Pecan, Northern <i>Carya illinoensis</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended		60-70 (South of Platte River only)		70-80 (South of Platte River only)
3	DECIDUOUS TREES	Redbud, Eastern 1/ <i>Cercis canadensis</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-20	10-15/10	15-20	15-20/10-20
3	DECIDUOUS TREES	Sycamore, American <i>Platanus occidentalis</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	30-35	40-45/20	35-40	50-70/30-40
3	DECIDUOUS TREES	Walnut, Black <i>Juglans nigra</i>	20-25	30-40/30	20-25	30-40/30	20-25	40-50/30	25-30	40-60/30
3	DECIDUOUS TREES	Willow, Black 1/ <i>Salix nigra</i>	Not Recommended	Not Recommended	20-25	30-35/20	25-30	30-35/20	25-30	35-50/20
3	DECIDUOUS TREES	Willow, Peachleaf 1/ <i>Salix amygdaloides</i>	Not Recommended	Not Recommended	20-25	20-30/20	20-25	20-30/20	20-25	20-30/20

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
3	DECIDUOUS TREES	Willow, White or Golden 1/ <i>Salix alba</i> (Cultivars Vitellina or Tristis often called Golden Willow)	Not Recommended	Not Recommended	20-25	30-35/20	25-30	30-35/20	25-30	35-40/20
3	DECIDUOUS SHRUBS	Antelope Bitterbrush <i>Purshia tridentate</i>	2-3		5-10		Not Recommended		Not Recommended	
3	DECIDUOUS SHRUBS	Blackhaw, Nannyberry <i>Viburnum lentago</i>	Not Recommended		Not Recommended		6-8		8-12	
3	DECIDUOUS SHRUBS	Buffaloberry, Silver 1/ <i>Shepherdia argentea</i>	5-8		10-12		10-12		10-12	
3	DECIDUOUS SHRUBS	Buttonbush <i>Cephalanthus occidentalis</i>	Not Recommended		Not Recommended		Not Recommended		8-10	
3	DECIDUOUS SHRUBS	Cherry, Nanking <i>Prunus tomentosa</i>	Not Recommended		4-5		4-5		5-7	
3	DECIDUOUS SHRUBS	Chokeberry, Black <i>Aronia melanocarpa</i>	Not Recommended		4-5		4-8		6-8	
3	DECIDUOUS SHRUBS	Chokecherry, Common 1/ <i>Prunus virginiana</i>	5-8		6-12		6-12		8-14	
3	DECIDUOUS SHRUBS	Coralberry <i>Symphoricarpos orbiculatus</i>	Not Recommended		Not Recommended		2-3		2-3	
3	DECIDUOUS SHRUBS	Cotoneaster, Peking <i>Cotoneaster acutifolia</i>	4-5		5-6		5-8		5-10	
3	DECIDUOUS SHRUBS	Cranberry, Highbush <i>Viburnum trilobum</i>	Not Recommended		Not Recommended		6-12		10-12	
3	DECIDUOUS SHRUBS	Currant, Buffalo 1/ <i>Ribes odoratum</i>	3-6		3-6		3-6		3-6	
3	DECIDUOUS SHRUBS	Currant, Golden 1/ <i>Ribes aureum</i>	2-4		2-4		4-6		4-6	
3	DECIDUOUS SHRUBS	Dogwood, Gray <i>Cornus racemosa</i>	4-6		6-8		6-8		6-8	
3	DECIDUOUS SHRUBS	Dogwood, Redosier <i>Cornus sericea</i>	5-6		5-7		6-8		8-10	
3	DECIDUOUS SHRUBS	Elderberry <i>Sambucus canadensis</i>	Not Recommended		4-6		4-6		4-8	

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
3	DECIDUOUS SHRUBS	Euonymus, Winterberry <i>Euonymus bungeanus</i> Recommended cultivar: Pink Lady Winterberry	5-10		5-10		8-14		8-14	
3	DECIDUOUS SHRUBS	Hazelnut, American <i>Corylus americana</i>	Not Recommended		Not Recommended		6-8		6-8	
3	DECIDUOUS SHRUBS	Indigo, False <i>Amorpha fruticosa</i>	Not Recommended		Not Recommended		4-6		8-10	
3	DECIDUOUS SHRUBS	Juneberry (Saskatoon Serviceberry) 1/ <i>Amelanchier alnifolia</i>	5-7		5-7		6-10		6-10	
3	DECIDUOUS SHRUBS	Lilac 1/ <i>Syringa vulgaris</i>	5-6		5-6		5-8		6-10	
3	DECIDUOUS SHRUBS	Mahogany, Mountain 1/ <i>Cercocarpus montana</i>	5-10		5-10		Not Recommended		Not Recommended	
3	DECIDUOUS SHRUBS	Peashrub, Siberian 1/ <i>Caragana arborescens</i>	6-8		6-8		8-10		8-12	
3	DECIDUOUS SHRUBS	Plum, American 1/ <i>Prunus americana</i>	5-7		5-8		5-8		6-10	
3	DECIDUOUS SHRUBS	Rose, Arkansas [prairie rose] <i>Rosa arkansana</i>	1-2		1-2		1-2		1-2	
3	DECIDUOUS SHRUBS	Rose, Hansen Hedge <i>Rosa</i> Sp. <i>Rosa rugosa</i> x <i>R. woodsii</i>	4-6		4-6		4-8		6-8	
3	DECIDUOUS SHRUBS	Rose, Woods' <i>Rosa woodsii</i>	3-5		3-5		4-5		4-5	
3	DECIDUOUS SHRUBS	Sagebrush, Big <i>Artemisia tridentata</i>	3-6		Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	
3	DECIDUOUS SHRUBS	Sagebrush, Silver <i>Artemisia cana</i>	3-6		Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	
3	DECIDUOUS SHRUBS	Saltbush, Fourwing 1/ <i>Atriplex canescens</i>	2-5		Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	
3	DECIDUOUS SHRUBS	Sandcherry, Western <i>Prunus besseyi</i>	2-3		2-3		2-4		3-6	
3	DECIDUOUS SHRUBS	Snowberry, Common <i>Symphoricarpos albus</i>	Not Recommended		Not Recommended		3-4		3-4	

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
3	DECIDUOUS SHRUBS	Snowberry, Western <i>Symphoricarpos occidentalis</i>	3-4		3-4		3-4		3-4	
3	DECIDUOUS SHRUBS	Sumac, Skunkbush 1/ <i>RhusTrilobata</i> Recommended cultivars: Big Horn, Konza Fragrant	3-5		4-6		4-6		4-8	

1/ Adapted to calcareous soils

2/ Black locust can be severely impacted by insect damage; recommend limiting use to wildlife and pollinator plantings, rather than for windbreaks

3/ Green Ash - only to be used in diverse tree and shrub plantings; **not windbreaks**

4/ Conservation mulch improves growth and survival

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
4	CONIFEROUS TREES	Arborvitae, American or Northern White Cedar <i>Thuja occidentalis</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	25-30/20
4	CONIFEROUS TREES	Arborvitae, Oriental <i>Thuja orientalis</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	15-20/15
4	CONIFEROUS TREES	Baldcypress <i>Taxodium distichum</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-30	40-50/20
4	CONIFEROUS TREES	Fir, Douglas <i>Pseudotsuga menziesii</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-25	30-35/20	20-30	40-50/20
4	CONIFEROUS TREES	Fir, White <i>Abies concolor</i>	Not Recommended	Not Recommended	20-25	30-40/25	20-25	30-40/25	20-30	40-50/25
4	CONIFEROUS TREES	Juniper, Rocky Mountain <i>Juniperus scopulorum</i>	10-20	15-25/15	10-20	15-25/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4	CONIFEROUS TREES	Pine, Austrian <i>Pinus nigra</i>	5-25	30-50/20	15-30	30-50/20	20-30	35-50/20	20-35	40-60/20
4	CONIFEROUS TREES	Pine, Eastern White <i>Pinus strobus</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	30-35	40-60/20
4	CONIFEROUS TREES	Pine, Jack <i>Pinus banksiana</i>	15-20	25-30/15	15-20	30-40/15	20-30	30-40/15	20-30	35-50/15-20
4	CONIFEROUS TREES	Pine, Limber <i>Pinus flexilis</i>	10-15	25-40/15	10-15	25-40/15-20	15-20	30-40/15-20	20-25	35-50/15-20
4	CONIFEROUS TREES	Pine, Pinyon [Two needle Pinyon] <i>Pinus edulis</i>	5-10	15-20/15-20	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4	CONIFEROUS TREES	Pine, Ponderosa <i>Pinus ponderosa</i>	15-25	30-50/20	15-30	30-50/20	20-30	35-50/20	20-35	40-60/20
4	CONIFEROUS TREES	Pine, Southwestern White <i>Pinus strobiformis</i>	15-25	30-50/20	15-30	30-50/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4	CONIFEROUS TREES	Redcedar, Eastern <i>Juniperus virginiana</i>	10-20	20-25/15	10-20	20-25/15	10-25	25-30/15-20	15-25	30-40/20
4	CONIFEROUS TREES	Spruce, Colorado Blue <i>Picea pungens</i>	15-20	25-30/20	15-20	30-40/20	15-25	30-40/20-30	15-30	40-60/25-30
4	CONIFEROUS TREES	Spruce, Norway <i>Picea abies</i>	Not Recommended	Not Recommended	25-30	30-40/20	25-30	30-40/20	20-30	45-60/25

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
4	CONIFEROUS TREES	Spruce, White <i>Picea glauca</i> (variety Black Hills)	15-20	25-30/15	20-25	30-40/20	20-25	30-40/20	20-30	30-40/20
4	DECIDUOUS TREES	Apricot, Manchurian <i>Prunus armeniaca</i>	Not Recommended	Not Recommended	5-10	10-15/10	10-15	10-15/10	10-20	10-20/10
4	DECIDUOUS TREES	Ash, Green 1/ <i>Fraxinus pennsylvanica</i>	Not Recommended	Not Recommended	15-25	30-40/30	20-30 35-40/30		25-30	40-50/30-40
4	DECIDUOUS TREES	Aspen, Quaking <i>Populus tremuloides</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	20-30	15-20	20-30
4	DECIDUOUS TREES	Basswood/ Linden, American <i>Tilia americana</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-30	35-40/30	25-30	50-70/30-40
4	DECIDUOUS TREES	Boxelder <i>Acer negundo</i>	15-20	25-30/20	15-20	25-30/20	15-20	30-35/20	20-25	35-40/20
4	DECIDUOUS TREES	Catalpa, Northern <i>Catalpa speciosa</i>	Not Recommended	Not Recommended	25-30	25-30/20	25-30	30-40/20	25-30	40-50/25
4	DECIDUOUS TREES	Cherry, Black <i>Prunus serotina</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	35-40/20	20-30	30-50/20
4	DECIDUOUS TREES	Cottonwood, Eastern <i>Populus deltoides</i> Recommended cultivars: Might Mo, Noreaster, Platte	30-55	60-80/40	30-55	65-80/40	45-55	65-80/40-50	50-60	70-90/40-50
4	DECIDUOUS TREES	Crabapple <i>Malus sp.</i> Recommended cultivars: Radiant, Siberian, Midwest, Roselow Sargent	5-10	10-15/15	10-15	10-15/15	10-15	10-15/15	15-20	15-20/15
4	DECIDUOUS TREES	Crabapple, Prairie <i>Malus ionensis</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	5-15	15-20/15	5-20	15-20/15
4	DECIDUOUS TREES	Elm, Siberian <i>Ulmus pumila</i>	15-30	15-30	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4	DECIDUOUS TREES	Hackberry <i>Celtis occidentalis</i>	15-20	30-40/20	20-25	40-50/20	20-30	45-50/20	20-30	50-60/30
4	DECIDUOUS TREES	Hawthorn, Cockspur <i>Crataegus crusgalli</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	10-15/15	10-20	10-20/15
4	DECIDUOUS TREES	Hawthorn, Washington <i>Crataegus phaenopyrum</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	10-15/15	10-20	10-20/15

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
4	DECIDUOUS TREES	Hickory, Bitternut <i>Carya cordiformis</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	45-50/20
4	DECIDUOUS TREES	Hickory, Shagbark <i>Carya ovata</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	45-50/20
4	DECIDUOUS TREES	Honeylocust <i>Gleditsia triacanthos</i>	15-25	30-40/20	20-30	30-40/20	25-30	35-40/20	25-35	40-50/25-30
4	DECIDUOUS TREES	Hophornbeam, Eastern <i>Ostrya virginiana</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-20	15-20/10-20	10-20	20-25/10-20
4	DECIDUOUS TREES	Kentucky Coffeetree <i>Gymnocladus dioicus</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	25-30	35-40/20	25-30	45-70/25-30
4	DECIDUOUS TREES	Locust, Black 2/ <i>Robinia pseudoacacia</i>	20-25	25-30/15	25-30	25-30/15	25-30	35-40/20	25-30	40-50/20
4	DECIDUOUS TREES	Maple, Amur <i>Acer ginnala</i> Recommended cultivar: Flame	10-15	10-15/15	10-15	10-15/15	15-20	15-20/15	15-20	15-20/15
4	DECIDUOUS TREES	Maple, Sugar <i>Acer saccharum</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-25	35-430
4	DECIDUOUS TREES	Mulberry, Red <i>Morus rubra</i>	15-20	15-20/15	15-20	30-35/15-20	20-25	35-40/20	20-25	40-45/25-30
4	DECIDUOUS TREES	Mulberry, Russian or White <i>Morus alba var. tatarica</i>	15-20	15-20/15	15-20	30-35/15-20	15-20	35-40/20	20-25	40-40/25-30
4	DECIDUOUS TREES	Oak, Black <i>Quercus velutina</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-25	40-60/30-40
4	DECIDUOUS TREES	Oak, Bur <i>Quercus macrocarpa</i>	15-20	25-30/15-20	20-25	30-40/20	20-25	35-40/30	20-30	40-60/30-40
4	DECIDUOUS TREES	Oak, Chinkapin <i>Quercus muhlenbergii</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-25	40-50/30	20-25	40-60/30-40
4	DECIDUOUS TREES	Oak, English <i>Quercus robur</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	30-40	55-65
4	DECIDUOUS TREES	Oak, Gambel <i>Quercus gambelii</i>	5-10	15-20	10-15	25	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4	DECIDUOUS TREES	Oak, Northern Red <i>Quercus rubra</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-25	40-60/30-40

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
4	DECIDUOUS TREES	Oak, Swamp White <i>Quercus bicolor</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-30	40-50/20-30
4	DECIDUOUS TREES	Oak, White <i>Quercus alba</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-25	40-60/30-40
4	DECIDUOUS TREES	Osage-orange <i>Maclura pomifera</i>	Not Recommended	Not Recommended	15-20	20-25/15	15-20	25-30/15	15-20	30-35/20-25
4	DECIDUOUS TREES	Redbud, Eastern <i>Cercis canadensis</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	10-15/10	15-20	15-20/10-20
4	DECIDUOUS TREES	Sycamore, American <i>Platanus occidentalis</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	30-35	40-45/20	30-40	50-70/30-40
4	DECIDUOUS TREES	Walnut, Black <i>Juglans nigra</i>	20-25	30-40/30	20-25	30-40/30	20-25	40-50/30	25-30	40-60/30
4	CONIFEROUS SHRUBS	Juniper, Prostrate <i>Juiperus communis</i>	4-7	4-7/15	4-7	4-7/15	4-7	4-7/15	4-7	4-7/15
4	DECIDUOUS SHRUBS	Antelope Bitterbrush <i>Purshia tridentate</i>	2-3		5-10		Not Recommended		Not Recommended	
4	DECIDUOUS SHRUBS	Blackhaw, Nannyberry <i>Viburnum lentago</i>	Not Recommended		Not Recommended		6-8		8-12	
4	DECIDUOUS SHRUBS	Buffaloberry, Silver <i>Shepherdia argentea</i>	5-8		10-12		10-12		10-12	
4	DECIDUOUS SHRUBS	Cherry, Nanking <i>Prunus tomentosa</i>	Not Recommended		4-5		4-5		5-7	
4	DECIDUOUS SHRUBS	Chokeberry, Black <i>Aronia melanocarpa</i>	Not Recommended		5-8		4-8		6-8	
4	DECIDUOUS SHRUBS	Chokecherry, Common <i>Prunus virginiana</i>	5-8		6-12		6-12		8-14	
4	DECIDUOUS SHRUBS	Coralberry <i>Symphoricarpos orbiculatus</i>	Not Recommended		Not Recommended		2-3		2-3	
4	DECIDUOUS SHRUBS	Cotoneaster, Peking <i>Cotoneaster acutifolia</i>	4-5		5-6		5-8		5-10	
4	DECIDUOUS SHRUBS	Cranberry, Highbush <i>Viburnum trilobum</i>	Not Recommended		Not Recommended		6-12		10-12	
4	DECIDUOUS SHRUBS	Currant, Buffalo <i>Ribes odoratum</i>	3-6		3-6		3-6		3-6	

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
4	DECIDUOUS SHRUBS	Currant, Golden <i>Ribes aureum</i>	2-4		2-4		4-6		4-6	
4	DECIDUOUS SHRUBS	Dogwood, Gray <i>Cornus racemosa</i>	4-6		6-8		6-8		6-8	
4	DECIDUOUS SHRUBS	Dogwood, Redosier <i>Cornus sericea</i>	5-6		5-7		6-8		8-10	
4	DECIDUOUS SHRUBS	Euonymus, Winterberry <i>Euonymus bungeanus</i> Recommended cultivar: Pink Lady Winterberry	6-10		6-10		8-14		8-14	
4	DECIDUOUS SHRUBS	Hazelnut, American <i>Corylus americana</i>	Not Recommended		Not Recommended		6-8		6-8	
4	DECIDUOUS SHRUBS	Juneberry (Saskatoon Serviceberry) <i>Amelanchier alnifolia</i>	5-7		5-7		6-10		6-10	
4	DECIDUOUS SHRUBS	Lilac <i>Syringa vulgaris</i>	5-6		5-6		5-8		6-10	
4	DECIDUOUS SHRUBS	Mahogany, Mountain <i>Cercocarpus montana</i>	5-10		Not Recommended		Not Recommended		Not Recommended	
4	DECIDUOUS SHRUBS	Peashrub, Siberian <i>Caragana arborescens</i>	6-8		6-8		8-10		8-12	
4	DECIDUOUS SHRUBS	Plum, American <i>Prunus americana</i>	5-7		5-8		5-8		6-10	
4	DECIDUOUS SHRUBS	Rose, Arkansas [prairie rose] <i>Rosa arkansana</i>	1-2		1-2		1-2		1-2	
4	DECIDUOUS SHRUBS	Rose, Hansen Hedge <i>Rosa</i> Sp. <i>Rosa rugosa</i> x <i>R. woodsii</i>	4-6		4-6		4-8		6-8	
4	DECIDUOUS SHRUBS	Rose, Woods' <i>Rosa woodsii</i>	3-5		3-5		4-5		4-5	
4	DECIDUOUS SHRUBS	Sagebrush, Big <i>Artemisia tridentata</i>	3-6		Not Recommended		Not Recommended		Not Recommended	
4	DECIDUOUS SHRUBS	Sagebrush, Silver <i>Artemisia cana</i>	3-6		Not Recommended		Not Recommended		Not Recommended	
4	DECIDUOUS SHRUBS	Saltbush, Fourwing <i>Atriplex canescens</i>	2-5		Not Recommended		Not Recommended		Not Recommended	

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Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
4	DECIDUOUS SHRUBS	Sandcherry, Western <i>Prunus besseyi</i>	2-3		2-3		2-4		3-6	
4	DECIDUOUS SHRUBS	Snowberry, Common <i>Symphoricarpos albus</i>	Not Recommended		Not Recommended		3-4		3-4	
4	DECIDUOUS SHRUBS	Snowberry, Western <i>Symphoricarpos occidentalis</i>	3-4		3-4		3-4		3-4	
4	DECIDUOUS SHRUBS	Sumac, Skunkbush <i>Rhus trilobata</i> Recommended cultivars: Big horn, Konza fragrant	3-5		4-6		4-6		4-8	

1/ Green Ash - only to be used in diverse tree and shrub plantings; **not windbreaks**

2/ Black Locust - for wildlife and pollinators (refer to table 11)

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
4K	CONIFEROUS TREES	Juniper, Rocky Mountain <i>Juniperus scopulorum</i>	10-20	15-25/15	10-20	15-25/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4K	CONIFEROUS TREES	Pine, Bristlecone <i>Pinus aristata</i>	5-10	25-30/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4K	CONIFEROUS TREES	Pine, Limber <i>Pinus flexilis</i>	10-15	25-40/15	10-15	25-45/15-20	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4K	CONIFEROUS TREES	Pine, Ponderosa <i>Pinus ponderosa</i>	15-25	30-50/20	15-30	30-55/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4K	CONIFEROUS TREES	Pine, Southwestern White <i>Pinus strobiformis</i>	15-25	30-50/20	15-30	30-55/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4K	CONIFEROUS TREES	Redcedar, Eastern <i>Juniperus virginiana</i>	10-20	20-25/15	10-20	20-25/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4K	DECIDUOUS TREES	Apricot, Manchurian <i>Prunus armeniaca</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	10-15/10	10-20	10-20/10
4K	DECIDUOUS TREES	Ash, Green 1/ <i>Fraxinus pennsylvanica</i>	Not Recommended	Not Recommended	15-25	30-40/30	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4K	DECIDUOUS TREES	Catalpa, Northern <i>Catalpa speciosa</i>	Not Recommended	Not Recommended	25-30	25-30/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4K	DECIDUOUS TREES	Cottonwood, Eastern <i>Populus deltoides</i> Recommended cultivars: Might Mo, Noreaster, Platte	30-55	60-80/40	30-55	65-85/40	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4K	DECIDUOUS TREES	Elm, Siberian <i>Ulmus pumila</i>	15-30	15-35/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4K	DECIDUOUS TREES	Hackberry <i>Celtis occidentalis</i>	15-20	30-40/20	20-25	40-50/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4K	DECIDUOUS TREES	Honeylocust <i>Gleditsia triacanthos</i>	15-25	30-40/20	20-30	30-40/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4K	DECIDUOUS TREES	Locust, Black 2/ <i>Robinia pseudoacacia</i>	20-25	25-35/15	25-30	25-35/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4K	DECIDUOUS TREES	Mulberry, Red <i>Morus rubra</i>	15-20	15-25/15	15-20	30-35/15-20	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4K	DECIDUOUS TREES	Mulberry, Russian or White <i>Morus alba var. tatarica</i>	15-20	15-25/15	15-20	30-35/15-20	Not Recommended	Not Recommended	Not Recommended	Not Recommended

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
4K	DECIDUOUS TREES	Oak, Bur <i>Quercus macrocarpa</i>	15-20	25-35/15-20	20-25	30-40/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4K	DECIDUOUS TREES	Oak, Gambel <i>Quercus gambelii</i>	5-10	15-20	10-15	25	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4K	DECIDUOUS TREES	Osage-orange <i>Maclura pomifera</i>	Not Recommended	Not Recommended	15-20	20-215	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4K	CONIFEROUS SHRUBS	Juniper, Common (Prostrate) <i>Juiperus communis</i>	4-7	4-7/15	4-7	4-7/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4K	DECIDUOUS SHRUBS	Antelope Bitterbrush <i>Purshia tridentate</i>	2-3		5-10		Not Recommended		Not Recommended	
4K	DECIDUOUS SHRUBS	Buffaloberry, Silver <i>Shepherdia argentea</i>	5-8		10-12		Not Recommended		Not Recommended	
4K	DECIDUOUS SHRUBS	Chokecherry, Common <i>Prunus virginiana</i>	5-8		6-12		Not Recommended		Not Recommended	
4K	DECIDUOUS SHRUBS	Currant, Buffalo <i>Ribes odoratum</i>	3-6		3-6		Not Recommended		Not Recommended	
4K	DECIDUOUS SHRUBS	Currant, Golden <i>Ribes aureum</i>	2-4		2-4		Not Recommended		Not Recommended	
4K	DECIDUOUS SHRUBS	Lilac <i>Syringa vulgaris</i>	5-6		5-6		Not Recommended		Not Recommended	
4K	DECIDUOUS SHRUBS	Mahogany, Mountain <i>Cercocarpus montana</i>	5-10		Not Recommended		Not Recommended		Not Recommended	
4K	DECIDUOUS SHRUBS	Peashrub, Siberian <i>Caragana arborescens</i>	6-8		6-8		Not Recommended		Not Recommended	
4K	DECIDUOUS SHRUBS	Plum, American <i>Prunus americana</i>	5-7		5-8		Not Recommended		Not Recommended	
4K	DECIDUOUS SHRUBS	Saltbush, Fourwing <i>Atriplex canescens</i>	2-5		Not Recommended		Not Recommended		Not Recommended	
4K	DECIDUOUS SHRUBS	Sumac, Skunkbush <i>Rhus trilobata</i> Recommended cultivars: Big horn, Konza fragrant	3-5		4-6		Not Recommended		Not Recommended	

1/ Green Ash - only to be used in diverse tree and shrub plantings; **not windbreaks**

2/ Black Locust - for wildlife and pollinators (refer to table 11)

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
4C	CONIFEROUS TREES	Baldcypress <i>Taxodium distichum</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-30	40-50/20
4C	CONIFEROUS TREES	Juniper, Rocky Mountain <i>Juniperus scopulorum</i>	10-20	15-25/15	10-20	15-25/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4C	CONIFEROUS TREES	Pine, Austrian <i>Pinus nigra</i>	5-25	30-50/20	15-30	30-50/20	20-30	35-50/20	20-35	40-60/20
4C	CONIFEROUS TREES	Pine, Jack <i>Pinus banksiana</i>	15-20	25-30/15	15-20	30-40/15	20-30	30-40/15	Not Recommended	Not Recommended
4C	CONIFEROUS TREES	Pine, Limber <i>Pinus flexilis</i>	10-15	25-40/15	10-15	25-40/15-20	15-20	30-40/15-20	Not Recommended	Not Recommended
4C	CONIFEROUS TREES	Pine, Pinyon [Two needle Pinyon] <i>Pinus edulis</i>	5-10	15-20/15-20	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4C	CONIFEROUS TREES	Pine, Ponderosa <i>Pinus ponderosa</i>	15-25	30-50/20	15-30	30-55/20	20-30	35-55/20	20-35	40-60/20
4C	CONIFEROUS TREES	Pine, Southwestern White <i>Pinus strobiformis</i>	15-25	30-50/20	15-30	30-55/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4C	CONIFEROUS TREES	Redcedar, Eastern <i>Juniperus virginiana</i>	10-20	20-25/15	10-20	20-25/15	10-25	25-35/15-20	15-25	30-40/20
4C	CONIFEROUS TREES	Spruce, Colorado Blue <i>Picea pungens</i>	15-20	25-35/20	15-20	30-40/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4C	DECIDUOUS TREES	Apricot, Manchurian <i>Prunus armeniaca</i>	Not Recommended	Not Recommended	5-10	10-15/10	10-15	10-15/10	10-20	10-20/10
4C	DECIDUOUS TREES	Ash, Green 1/ <i>Fraxinus pennsylvanica</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-30 35-40/30		25-30	40-50/30-40
4C	DECIDUOUS TREES	Boxelder <i>Acer negundo</i>	15-20	25-35/20	15-20	25-35/20	15-20	25-35/20	20-25	35-40/20
4C	DECIDUOUS TREES	Catalpa, Northern <i>Catalpa speciosa</i>	Not Recommended	Not Recommended	25-30	25-30/20	25-30	30-40/20	25-30	40-50/25
4C	DECIDUOUS TREES	Cottonwood, Eastern <i>Populus deltoides</i> Recommended cultivars: Might Mo, Noreaster, Platte	30-55	60-80/40	30-55	65-85/40	45-55	65-85/40-50	Not Recommended	Not Recommended

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
4C	DECIDUOUS TREES	Crabapple <i>Malus sp.</i> Recommended cultivars: Radiant, Siberian, Midwest, Roselow Sargent	5-10	10-15/15	10-15	10-15/15	10-15	10-15/15	Not Recommended	Not Recommended
4C	DECIDUOUS TREES	Elm, Siberian <i>Ulmus pumila</i>	15-30	15-35/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4C	DECIDUOUS TREES	Hackberry <i>Celtis occidentalis</i>	15-20	30-40/20	20-25	40-50/20	20-30	45-55/20	20-30	50-60/30
4C	DECIDUOUS TREES	Hawthorn, Cockspur <i>Crataegus crusgalli</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	10-15/15	10-20	10-20/15
4C	DECIDUOUS TREES	Hawthorn, Washington <i>Crataegus phaenopyrum</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	10-15/15	10-20	10-20/15
4C	DECIDUOUS TREES	Hickory, Bitternut <i>Carya cordiformis</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	45-50/20
4C	DECIDUOUS TREES	Hickory, Shagbark <i>Carya ovata</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	45-50/20
4C	DECIDUOUS TREES	Honeylocust <i>Gleditsia triacanthos</i>	15-25	30-40/20	20-30	30-40/20	25-30	35-40/14420	25-35	40-50/25-30
4C	DECIDUOUS TREES	Hophornbeam, Eastern <i>Ostrya virginiana</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-20	15-20/10-20	10-20	20-25/10-20
4C	DECIDUOUS TREES	Kentucky Coffeetree <i>Gymnocladus dioicus</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	25-30	35-45/20	25-30	45-70/25-30
4C	DECIDUOUS TREES	Locust, Black 2/ <i>Robinia pseudoacacia</i>	20-25	25-35/15	25-30	25-35/15	25-30	35-45/20	25-30	40-50/20
4C	DECIDUOUS TREES	Mulberry, Red <i>Morus rubra</i>	15-20	15-25/15	15-20	30-35/15-20	20-25	35-40/20	20-25	40-45/25-30
4C	DECIDUOUS TREES	Mulberry, Russian or White <i>Morus alba var. tatarica</i>	15-20	15-25/15	15-20	30-35/15-20	15-20	35-40/20	20-25	40-45/25-30
4C	DECIDUOUS TREES	Oak, Black <i>Quercus velutina</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-25	40-60/30-40
4C	DECIDUOUS TREES	Oak, Bur <i>Quercus macrocarpa</i>	15-20	25-35/15-20	20-25	30-40/20	20-25	35-430	20-30	40-60/30-40

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
4C	DECIDUOUS TREES	Oak, Chinkapin <i>Quercus muhlenbergii</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-25	40-50/30	20-25	40-60/30-40
4C	DECIDUOUS TREES	Oak, Gambel <i>Quercus gambelii</i>	5-10	15-20	10-15	25	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4C	DECIDUOUS TREES	Oak, Northern Red <i>Quercus rubra</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-25	40-60/30-40
4C	DECIDUOUS TREES	Oak, Swamp White <i>Quercus bicolor</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-30	40-50/20-30
4C	DECIDUOUS TREES	Osage-orange <i>Maclura pomifera</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	25-30/15	15-20	30-320-25
4C	CONIFEROUS SHRUBS	Juniper, Common (Prostrate) <i>Juiperus communis</i>	4-7	4-7/15	4-7	4-7/15	4-7	4-7/15	4-7	4-7/15
4C	DECIDUOUS SHRUBS	Antelope Bitterbrush <i>Purshia tridentate</i>	2-3		5-10		Not Recommended		Not Recommended	
4C	DECIDUOUS SHRUBS	Blackhaw, Nannyberry <i>Vibernum lentago</i>	Not Recommended		v		6-8		8-12	
4C	DECIDUOUS SHRUBS	Buffaloberry, Silver <i>Shepherdia argentea</i>	5-8		10-12		10-12		10-12	
4C	DECIDUOUS SHRUBS	Cherry, Nanking <i>Prunus tomentosa</i>	Not Recommended		4-5		4-5		5-7	
4C	DECIDUOUS SHRUBS	Chokeberry, Black <i>Aronia melanocarpa</i>	Not Recommended		5-8		4-8		6-8	
4C	DECIDUOUS SHRUBS	Chokecherry, Common <i>Prunus virginiana</i>	5-8		6-12		6-12		8-14	
4C	DECIDUOUS SHRUBS	Coralberry <i>Symphoricarpos orbiculatus</i>	Not Recommended		Not Recommended		2-3		2-3	
4C	DECIDUOUS SHRUBS	Cotoneaster, Peking <i>Cotoneaster acutifolia</i>	4-5		5-6		5-8		5-10	
4C	DECIDUOUS SHRUBS	Cranberry, Highbush <i>Viburnum trilobum</i>	Not Recommended		Not Recommended		6-12		10-12	
4C	DECIDUOUS SHRUBS	Currant, Buffalo <i>Ribes odoratum</i>	3-6		3-6		3-6		3-6	

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
4C	DECIDUOUS SHRUBS	Currant, Golden <i>Ribes aureum</i>	2-4		2-4		4-6		4-6	
4C	DECIDUOUS SHRUBS	Dogwood, Gray <i>Cornus racemosa</i>	4-6		6-8		6-8		6-8	
4C	DECIDUOUS SHRUBS	Dogwood, Redosier <i>Cornus sericea</i>	5-6		5-7		6-8		8-10	
4C	DECIDUOUS SHRUBS	Euonymus, Winterberry <i>Euonymus alatus</i> Recommended cultivar: Pink Lady Winterberry	6-10		6-10		8-14		8-14	
4C	DECIDUOUS SHRUBS	Hazelnut, American <i>Corylus americana</i>	Not Recommended		Not Recommended		Not Recommended		6-8	
4C	DECIDUOUS SHRUBS	Juneberry (Saskatoon Serviceberry) <i>Amelanchier alnifolia</i>	5-7		5-7		6-10		6-10	
4C	DECIDUOUS SHRUBS	Lilac <i>Syringa vulgaris</i>	5-6		5-6		5-8		6-10	
4C	DECIDUOUS SHRUBS	Mahogany, Mountain <i>Cercocarpus montana</i>	5-10		5-10		Not Recommended		Not Recommended	
4C	DECIDUOUS SHRUBS	Peashrub, Siberian <i>Caragana arborescens</i>	6-8		6-8		8-10		8-10	
4C	DECIDUOUS SHRUBS	Plum, American <i>Prunus americana</i>	5-7		5-8		5-8		6-10	
4C	DECIDUOUS SHRUBS	Rose, Arkansas [prairie rose] <i>Rosa arkansana</i>	1-2		1-2		1-2		1-2	
4C	DECIDUOUS SHRUBS	Rose, Hansen Hedge <i>Rosa</i> Sp. <i>Rosa rugosa x R. woodsii</i>	4-6		4-6		4-8		6-8	
4C	DECIDUOUS SHRUBS	Rose, Woods' <i>Rosa woodsii</i>	3-5		3-5		4-5		4-5	
4C	DECIDUOUS SHRUBS	Sagebrush, Big <i>Artemisia tridentata</i>	3-6		Not Recommended		Not Recommended		Not Recommended	
4C	DECIDUOUS SHRUBS	Sagebrush, Silver <i>Artemisia cana</i>	3-6		Not Recommended		Not Recommended		Not Recommended	

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
4C	DECIDUOUS SHRUBS	Saltbush, Fourwing <i>Atriplex canescens</i>	2-5		Not Recommended		Not Recommended		Not Recommended	
4C	DECIDUOUS SHRUBS	Snowberry, Common <i>Symphoricarpos albus</i>	Not Recommended		Not Recommended		3-4		3-4	
4C	DECIDUOUS SHRUBS	Snowberry, Western <i>Symphoricarpos occidentalis</i>	3-4		3-4		3-4		3-4	
4C	DECIDUOUS SHRUBS	Sumac, Skunkbush <i>Rhus trilobata</i> Recommended cultivars: Big horn, Konza fragrant	3-5		4-6		4-6		4-8	

1/ Green Ash - only to be used in diverse tree and shrub plantings; **not windbreaks**

2/ Black Locust - for wildlife and pollinators (refer to table 11)

Soils Group	Tree/Shrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
4CK	CONIFEROUS TREES	Juniper, Rocky Mountain <i>Juniperus scopulorum</i>	10-20	15-25/15	10-20	15-25/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4CK	CONIFEROUS TREES	Pine, Bristlecone <i>Pinus aristata</i>	5-10	25-30/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4CK	CONIFEROUS TREES	Pine, Limber <i>Pinus flexilis</i>	10-15	25-40/15	10-15	25-40/15-20	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4CK	CONIFEROUS TREES	Pine, Ponderosa <i>Pinus ponderosa</i>	15-25	30-50/20	15-30	30-50/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4CK	CONIFEROUS TREES	Pine, Southwestern White <i>Pinus strobiformis</i>	15-25	30-50/20	15-30	30-50/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4CK	CONIFEROUS TREES	Redcedar, Eastern <i>Juniperus virginiana</i>	10-20	20-215	10-20	20-215	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4CK	DECIDUOUS TREES	Apricot, Manchurian <i>Prunus armeniaca</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	10-15/10	10-20	10-20/10
4CK	DECIDUOUS TREES	Ash, Green 1/ <i>Fraxinus pennsylvanica</i>	15-20	25-30/25	15-25	30-40/30	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4CK	DECIDUOUS TREES	Catalpa, Northern <i>Catalpa speciosa</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	30-35/20	15-20	30-35/20
4CK	DECIDUOUS TREES	Cottonwood, Eastern <i>Populus deltoides</i> Recommended cultivars: Might Mo, Noreaster, Platte	30-55	60-80/40	30-55	65-80/40	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4CK	DECIDUOUS TREES	Crabapple Malus sp. Recommended cultivars: Radiant, Siberian, Midwest, Roselow Sargent	5-10	10-115	10-15	10-115	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4CK	DECIDUOUS TREES	Elm, Siberian <i>Ulmus pumila</i>	15-30	15-320	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4CK	DECIDUOUS TREES	Hackberry <i>Celtis occidentalis</i>	15-20	30-40/20	20-25	40-50/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4CK	DECIDUOUS TREES	Honeylocust <i>Gleditsia triacanthos</i>	15-25	30-40/20	20-30	30-40/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4CK	DECIDUOUS TREES	Locust, Black 2/ <i>Robinia pseudoacacia</i>	20-25	25-30/15	25-30	25-30/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4CK	DECIDUOUS TREES	Mulberry, Red <i>Morus rubra</i>	15-20	15-20/15	15-20	30-35/15-20	Not Recommended	Not Recommended	Not Recommended	Not Recommended

Soils Group	Tree/Shrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
4CK	DECIDUOUS TREES	Mulberry, Russian or White <i>Morus alba var. tatarica</i>	15-20	15-20/15	15-20	30-35/15-20	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4CK	DECIDUOUS TREES	Oak, Bur <i>Quercus macrocarpa</i>	15-20	25-30/15-20	20-25	30-40/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4CK	DECIDUOUS TREES	Oak, Gambel <i>Quercus gambelii</i>	5-10	15-20	10-15	25	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4CK	DECIDUOUS TREES	Osage-orange <i>Maclura pomifera</i>	Not Recommended	Not Recommended	15-20	20-25/G4115	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4CK	CONIFEROUS SHRUBS	Juniper, Common (Prostrate) <i>Juiperus communis</i>	4-7	4-7/15	4-7	4-7/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended
4CK	DECIDUOUS SHRUBS	Antelope Bitterbrush <i>Purshia tridentate</i>	2-3		Not Recommended		Not Recommended	Not Recommended	Not Recommended	Not Recommended
4CK	DECIDUOUS SHRUBS	Buffaloberry, Silver <i>Shepherdia argentea</i>	5-8		10-12		Not Recommended	Not Recommended	Not Recommended	Not Recommended
4CK	DECIDUOUS SHRUBS	Chokecherry, Common <i>Prunus virginiana</i>	5-8		6-12		Not Recommended	Not Recommended	Not Recommended	Not Recommended
4CK	DECIDUOUS SHRUBS	Currant, Buffalo <i>Ribes odoratum</i>	3-6		3-6		Not Recommended	Not Recommended	Not Recommended	Not Recommended
4CK	DECIDUOUS SHRUBS	Currant, Golden <i>Ribes aureum</i>	2-4		2-4		Not Recommended	Not Recommended	Not Recommended	Not Recommended
4CK	DECIDUOUS SHRUBS	Lilac <i>Syringa vulgaris</i>	5-6		5-6		Not Recommended	Not Recommended	Not Recommended	Not Recommended
4CK	DECIDUOUS SHRUBS	Mahogany, Mountain <i>Cercocarpus montana</i>	5-10		Not Recommended		Not Recommended	Not Recommended	Not Recommended	Not Recommended
4CK	DECIDUOUS SHRUBS	Peashrub, Siberian <i>Caragana arborescens</i>	6-8		6-8		Not Recommended	Not Recommended	Not Recommended	Not Recommended
4CK	DECIDUOUS SHRUBS	Plum, American <i>Prunus americana</i>	5-7		5-8		Not Recommended	Not Recommended	Not Recommended	Not Recommended
4CK	DECIDUOUS SHRUBS	Saltbush, Fourwing <i>Atriplex canescens</i>	2-5		Not Recommended		Not Recommended	Not Recommended	Not Recommended	Not Recommended
4CK	DECIDUOUS SHRUBS	Sumac, Skunkbush <i>Rhus trilobata</i> Recommended cultivars: Big horn, Konza fragrant	3-5		4-6		Not Recommended	Not Recommended	Not Recommended	Not Recommended

1/ Green Ash - only to be used in diverse tree and shrub plantings; **not windbreaks**

2/ Black Locust - for wildlife and pollinators (refer to table 11)

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
5	CONIFEROUS TREES	Arborvitae, American or Northern White Cedar <i>Thuja occidentalis</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	25-30/20
5	CONIFEROUS TREES	Arborvitae, Oriental 1/ <i>Thuja orientalis</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	15-20/15
5	CONIFEROUS TREES	Juniper, Rocky Mountain 1/ <i>Juniperus scopulorum</i>	10-20	15-25/15	10-20	15-25/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended
5	CONIFEROUS TREES	Pine, Austrian <i>Pinus nigra</i>	5-25	30-50/20	15-30	30-55/20	20-30	35-50/20	20-35	40-60/20
5	CONIFEROUS TREES	Pine, Eastern White <i>Pinus strobus</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	25-30	40-50/20	30-35	40-60/20
5	CONIFEROUS TREES	Pine, Jack <i>Pinus banksiana</i>	15-20	25-35/15	15-20	30-40/15	15-30	30-40/15	20-30	40-45/15
5	CONIFEROUS TREES	Pine, Limber 1/ <i>Pinus flexilis</i>	10-15	25-40/15	10-15	25-45/15-20	15-20	30-45/15-20	20-25	35-55/15-20
5	CONIFEROUS TREES	Pine, Pinyon [Two needle Pinyon] <i>Pinus edulis</i>	5-10	15-20/15-20	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
5	CONIFEROUS TREES	Pine, Ponderosa 1/ <i>Pinus ponderosa</i>	15-25	30-50/20	15-30	30-55/20	20-30	35-55/20	20-35	40-60/20
5	CONIFEROUS TREES	Pine, Southwestern White <i>Pinus strobiformis</i>	15-25	30-50/20	15-30	30-55/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended
5	CONIFEROUS TREES	Redcedar, Eastern 1/ <i>Juniperus virginiana</i>	10-20	20-25/15	10-20	20-25/15	10-25	25-30/15-20	15-25	30-40/20
5	CONIFEROUS TREES	Spruce, Colorado Blue <i>Picea pungens</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-25	30-45/20-25	20-30	40-60/25
5	CONIFEROUS TREES	Spruce, Norway <i>Picea abies</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	25-30	30-45/20	25-30	45-60/25
5	CONIFEROUS TREES	Spruce, White <i>Picea glauca</i> (variety Black Hills)	15-20	25-35/15	20-25	30-40/20	20-25	30-45/20	25-30	30-45/20
5	DECIDUOUS TREES	Apricot, Manchurian <i>Prunus armeniaca</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	10-15/10	10-20	10-20/10
5	DECIDUOUS TREES	Ash, Green 1/, 3/ <i>Fraxinus pennsylvanica</i>	15-20	25-35/25	20-25	30-40/30	20-30	35-45/30	25-30	40-50/30-40
5	DECIDUOUS TREES	Basswood/ Linden, American <i>Tilia americana</i>	20-25	30-40/30	25-30	30-40/30	25-30	35-45/30	25-30	40-50/30-40
5	DECIDUOUS TREES	Boxelder <i>Acer negundo</i>	15-20	25-35/20	15-20	25-35/20	20-25	30-35/20	20-25	35-40/20
5	DECIDUOUS TREES	Catalpa, Northern 1/ <i>Catalpa speciosa</i>	Not Recommended	Not Recommended	25-30	25-30/20	25-30	30-40/20	25-30	40-50/25

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
5	DECIDUOUS TREES	Crabapple 1/ <i>Malus sp.</i> Recommended cultivars: Radiant, Siberian, Midwest, Roselow Sargent	10-15	10-15/15	10-15	10-15/15	10-15	10-15/15	15-20	15-20/15
5	DECIDUOUS TREES	Elm, Siberian <i>Ulmus pumila</i>	20-25	20-30/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
5	DECIDUOUS TREES	Hackberry 1/ <i>Celtis occidentalis</i>	15-20	30-40/20	20-25	40-50/20	20-30	45-50/20	20-30	50-60/30
5	DECIDUOUS TREES	Hawthorn, Cockspur 1/ <i>Crataegus crusgalli</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	15-20/15	15-20	15-20/15
5	DECIDUOUS TREES	Hawthorn, Washington 1/ <i>Crataegus phaenopyrum</i>	Not Recommended	Not Recommended	10-15	15-20/15	10-15	15-20/15	15-20	15-20/15
5	DECIDUOUS TREES	Hickory, Bitternut <i>Carya cordiformis</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	45-55/20
5	DECIDUOUS TREES	Hickory, Shagbark <i>Carya ovata</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	45-55/20
5	DECIDUOUS TREES	Honeylocust 1/ <i>Gleditsia triacanthos</i>	15-25	30-40/20	20-30	30-40/20	25-30	35-420	25-35	40-50/25-30
5	DECIDUOUS TREES	Kentucky Coffeetree <i>Gymnocladus dioicus</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	25-30	35-45/20	25-30	45-70/25-30
5	DECIDUOUS TREES	Locust, Black 1/, 2/ <i>Robinia pseudoacacia</i>	20-25	25-30/15	25-30	25-35/15	25-30	35-45/20	25-30	40-50/20
5	DECIDUOUS TREES	Maple, Amur <i>Acer ginnala</i> Recommended cultivar: Flame	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	15-20/15	15-20	15-20/15
5	DECIDUOUS TREES	Maple, Silver <i>Acer saccharinum</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	30-35	40-60/30-40	35-40	50-70/30-50
5	DECIDUOUS TREES	Maple, Sugar <i>Acer saccharum</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-25	40-50/30
5	DECIDUOUS TREES	Mulberry, Red 1/ <i>Morus rubra</i>	15-20	15-20/15	15-20	30-35/15-20	20-25	35-40/20	20-25	40-45/25-30
5	DECIDUOUS TREES	Mulberry, Russian or White 1/ <i>Morus alba var. tatarica</i>	15-20	15-20/15	15-20	30-35/15-20	15-20	35-40/20	20-25	40-45/25-30
5	DECIDUOUS TREES	Oak, Black <i>Quercus velutina</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	25-30	40-60/30-40
5	DECIDUOUS TREES	Oak, Bur 1/ <i>Quercus macrocarpa</i>	15-20	25-30/15-20	20-25	30-40/20	20-25	35-40/30	25-30	40-60/30-40
5	DECIDUOUS TREES	Oak, English <i>Quercus robur</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	30-40	55-65
5	DECIDUOUS TREES	Oak, Gambel 1/ <i>Quercus gambelii</i>	5-10	15-20	10-15	25	Not Recommended	Not Recommended	Not Recommended	Not Recommended
5	DECIDUOUS TREES	Oak, Northern Red <i>Quercus rubra</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	25-30	40-60/30-40

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
5	DECIDUOUS TREES	Oak, White <i>Quercus alba</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	25-30	40-60/30-40
5	DECIDUOUS TREES	Osage-orange 1/ <i>Maclura pomifera</i>	Not Recommended	Not Recommended	15-20	20-25/15	15-20	25-30/15	15-20	25-30/15
5	DECIDUOUS TREES	Pear, Chinese (Harbin) <i>Pyrus ussuriensis</i> Recommended cultivar: McDermand	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	15-25/15	20-25	20-25/15
5	DECIDUOUS TREES	Sycamore, American <i>Platanus occidentalis</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	35-40	50-70/30-40
5	CONIFEROUS SHRUBS	Juniper, Common (Prostrate) <i>Juiperus communis</i>	4-7	4-7/15	4-7	4-7/15	4-7	4-7/15	4-7	4-7/15
5	DECIDUOUS SHRUBS	Antelope Bitterbrush <i>Purshia tridentate</i>	2-3		Not Recommended		Not Recommended		Not Recommended	
5	DECIDUOUS SHRUBS	Blackhaw, Nannyberry 1/ <i>Vibernum lentago</i>	Not Recommended		Not Recommended		6-8		8-12	
5	DECIDUOUS SHRUBS	Buffaloberry, Silver 1/ <i>Shepherdia argentea</i>	5-8		10-12		10-12		10-12	
5	DECIDUOUS SHRUBS	Buttonbush <i>Cephalanthus occidentalis</i>	Not Recommended		Not Recommended		Not Recommended		8-10	
5	DECIDUOUS SHRUBS	Cherry, Nanking <i>Prunus tomentosa</i>	Not Recommended		Not Recommended		4-5		5-7	
5	DECIDUOUS SHRUBS	Chokeberry, Black <i>Aronia melanocarpa</i>	Not Recommended		5-8		5-8		5-8	
5	DECIDUOUS SHRUBS	Chokecherry, Common 1/ <i>Prunus virginiana</i>	5-8		6-12		6-12		8-14	
5	DECIDUOUS SHRUBS	Coralberry <i>Symphoricarpos orbiculatus</i>	Not Recommended		Not Recommended		2-3		2-3	
5	DECIDUOUS SHRUBS	Cotoneaster, Peking <i>Cotoneaster acutifolia</i>	4-5		5-6		5-8		5-10	
5	DECIDUOUS SHRUBS	Cranberry, Highbush <i>Viburnum trilobum</i>	Not Recommended		Not Recommended		6-8		6-10	
5	DECIDUOUS SHRUBS	Currant, Buffalo 1/ <i>Ribes odoratum</i>	3-6		3-6		3-6		3-6	
5	DECIDUOUS SHRUBS	Currant, Golden 1/ <i>Ribes aureum</i>	2-4		2-4		4-6		4-6	
5	DECIDUOUS SHRUBS	Dogwood, Gray <i>Cornus racemosa</i>	Not Recommended		6-8		6-8		6-8	
5	DECIDUOUS SHRUBS	Dogwood, Redosier <i>Cornus sericea</i>	5-6		5-7		6-8		8-10	
5	DECIDUOUS SHRUBS	Elderberry <i>Sambucus canadensis</i>	Not Recommended		4-6		4-6		4-8	

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
5	DECIDUOUS SHRUBS	Euonymus, Winterberry <i>Euonymus alatus</i> Recommended cultivar: Pink Lady Winterberry	5-10		5-10		8-14		8-14	
5	DECIDUOUS SHRUBS	Juneberry (Saskatoon Serviceberry) 1/ <i>Amelanchier alnifolia</i>	5-7		5-7		6-10		6-10	
5	DECIDUOUS SHRUBS	Lilac 1/ <i>Syringa vulgaris</i>	5-6		5-6		5-8		6-10	
5	DECIDUOUS SHRUBS	Mahogany, Mountain 1/ <i>Cercocarpus montana</i>	5-10		Not Recommended		Not Recommended		Not Recommended	
5	DECIDUOUS SHRUBS	Peashrub, Siberian 1/ <i>Caragana arborescens</i>	6-8		6-8		6-10		8-10	
5	DECIDUOUS SHRUBS	Plum, American 1/ <i>Prunus americana</i>	5-7		5-8		5-8		6-10	
5	DECIDUOUS SHRUBS	Rose, Arkansas (Prairie Rose) <i>Rosa arkansana</i>	1-2		1-2		1-2		1-2	
5	DECIDUOUS SHRUBS	Rose, Hansen Hedge Rosa Sp. <i>Rosa rugosa x R. woodsii</i>	4-6		4-6		4-8		6-8	
5	DECIDUOUS SHRUBS	Rose, Woods <i>Rosa woodsii</i>	3-5		3-5		4-5		4-5	
5	DECIDUOUS SHRUBS	Sagebrush, Big <i>Artemisia tridentata</i>	3-6		Not Recommended		Not Recommended		Not Recommended	
5	DECIDUOUS SHRUBS	Sagebrush, Silver <i>Artemisia cana</i>	3-6		Not Recommended		Not Recommended		Not Recommended	
5	DECIDUOUS SHRUBS	Saltbush, Fourwing <i>Atriplex canescens</i>	2-5		Not Recommended		Not Recommended		Not Recommended	
5	DECIDUOUS SHRUBS	Sandcherry, Western <i>Prunus besseyi</i>	2-3		2-3		2-4		3-6	
5	DECIDUOUS SHRUBS	Snowberry, Common <i>Symphoricarpos albus</i>	Not Recommended		Not Recommended		3-4		3-4	
5	DECIDUOUS SHRUBS	Snowberry, Western <i>Symphoricarpos occidentalis</i>	3-4		3-4		3-4		3-4	
5	DECIDUOUS SHRUBS	Sumac, Skunkbush 1/ <i>Rhus trilobata</i> Recommended cultivars: Big Horn, Konza Fragrant	3-5		4-6		4-6		4-8	

1/ Adapted to calcareous soils

2/ Black locust can be severely impacted by insect damage; recommend limiting use to wildlife and pollinator plantings, rather than for windbreaks

3/ Green Ash - only to be used in diverse tree and shrub plantings; not windbreaks

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			0-YEAR	MATURE	0-YEAR	MATURE	0-YEAR	MATURE	0-YEAR	MATURE
			HEIGHT (ft)	HGTSPREAD (ft)	HEIGHT (ft)	HGTSPREAD (ft)	HEIGHT (ft)	HGTSPREAD (ft)	HEIGHT (ft)	HGTSPREAD (ft)
5K	CONIFEROUS TREES	Juniper, Rocky Mountain 1/ <i>Juniperus scopulorum</i>	10-20	15-25/15	10-20	15-25/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended
5K	CONIFEROUS TREES	Pine, Limber 1/ <i>Pinus flexilis</i>	10-15	25-40/15	10-15	25-45/15-20	15-20	30-45/15-20	20-25	35-55/15-20
5K	CONIFEROUS TREES	Pine, Ponderosa 1/ <i>Pinus ponderosa</i>	15-25	30-50/20	15-30	30-45/20	20-30	35-520	20-35	40-60/20
5K	CONIFEROUS TREES	Pine, Southwestern White <i>Pinus strobiformis</i>	15-25	30-50/20	15-30	30-55/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended
5K	CONIFEROUS TREES	Redcedar, Eastern <i>Juniperus virginiana</i>	10-20	20-25/15	10-20	20-25/15	10-25	25-35/15-20	15-25	30-40/20
5K	DECIDUOUS TREES	Apricot, Manchurian <i>Prunus armeniaca</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	10-15/10	10-20	10-20/10
5K	DECIDUOUS TREES	Ash, Green 1/, 2/ <i>Fraxinus pennsylvanica</i>	10-15	20-25/20	10-15	20-25/20	10-15	20-25/20	10-15	
5K	DECIDUOUS TREES	Aspen, Quaking 1/ <i>Populus tremuloides</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	30-40	15-20	30-40
5K	DECIDUOUS TREES	Catalpa, Northern 1/ <i>Catalpa speciosa</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	25-30	30-40/20	25-30	
5K	DECIDUOUS TREES	Crabapple 1/ <i>Malus sp.</i> Recommended cultivars: Radiant, Siberian, Midwest, Roselow Sargent	10-15	10-15/15	10-15	10-15/15	10-15	10-15/15	15-20	15-20/15
5K	DECIDUOUS TREES	Elm, Siberian 1/ <i>Ulmus pumila</i>	15-20	30-35/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
5K	DECIDUOUS TREES	Hackberry 1/ <i>Celtis occidentalis</i>	10-15	25-30/20	20-25	40-50/20	10-15	25-30/20	10-15	30-35/30
5K	DECIDUOUS TREES	Hawthorn, Cockspur 1/ <i>Crataegus crusgalli</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	15-20/15	15-20	15-20/15
5K	DECIDUOUS TREES	Hawthorn, Washington 1/ <i>Crataegus phaenopyrum</i>	Not Recommended	Not Recommended	10-15	15-20/15	10-15	15-20/15	15-20	15-20/15
5K	DECIDUOUS TREES	Honeylocust 1/ <i>Gleditsia triacanthos</i>	Not Recommended	Not Recommended	20-30	30-40/20	20-30	30-40/20	25-35	40-50/25-30
5K	DECIDUOUS TREES	Locust, Black 1/, 3/ <i>Robinia pseudoacacia</i>	20-25	25-35/15	25-30	25-315	25-30	35-45/20	25-30	40-50/20

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			0-YEAR	MATURE	0-YEAR	MATURE	0-YEAR	MATURE	0-YEAR	MATURE
			HEIGHT (ft)	HGTSPREAD (ft)	HEIGHT (ft)	HGTSPREAD (ft)	HEIGHT (ft)	HGTSPREAD (ft)	HEIGHT (ft)	HGTSPREAD (ft)
5K	DECIDUOUS TREES	Mulberry, Red 1/ <i>Morus rubra</i>	15-20	15-215	15-20	30-35/15-20	20-25	35-40/20	20-25	40-425-30
5K	DECIDUOUS TREES	Mulberry, Russian or White 1/ <i>Morus alba var. tatarica</i>	15-20	15-215	15-20	30-35/15-20	15-20	35-40/20	20-25	40-425-30
5K	DECIDUOUS TREES	Oak, Bur 1/ <i>Quercus macrocarpa</i>	5-10	15-20	10-15	25	Not Recommended	Not Recommended	Not Recommended	Not Recommended
5K	DECIDUOUS TREES	Oak, Gambel 1/ <i>Quercus gambelii</i>	5-10	15-20	10-15	25	Not Recommended	Not Recommended	Not Recommended	Not Recommended
5K	DECIDUOUS TREES	Osage-orange 1/ <i>Maclura pomifera</i>	Not Recommended	Not Recommended	15-20	20-25/15	15-20	25-30/15	15-20	30-35/20-25
5K	CONIFEROUS SHRUBS	Juniper, Common (Prostrate) <i>Juiperus communis</i>	4-7	4-7/15	4-7	4-7/15	4-7	4-7/15	4-7	4-7/15
5K	DECIDUOUS SHRUBS	Antelope Bitterbrush 1/ <i>Purshia tridentate</i>	2-3		Not Recommended		Not Recommended		Not Recommended	
5K	DECIDUOUS SHRUBS	Blackhaw, Nannyberry 1/ <i>Vibenum lentago</i>	Not Recommended		Not Recommended		6-8		8-12	
5K	DECIDUOUS SHRUBS	Buffaloberry, Silver 1/ <i>Shepherdia argentea</i>	5-8		10-12		10-12		10-12	
5K	DECIDUOUS SHRUBS	Chokecherry, Common 1/ <i>Prunus virginiana</i>	5-8		5-8		6-12		8-14	
5K	DECIDUOUS SHRUBS	Currant, Buffalo 1/ <i>Ribes odoratum</i>	2-4		3-6		3-6		3-6	
5K	DECIDUOUS SHRUBS	Currant, Golden 1/ <i>Ribes aureum</i>	2-4		2-4		4-6		4-6	
5K	DECIDUOUS SHRUBS	Juneberry (Saskatoon Serviceberry) 1/ <i>Amelanchier alnifolia</i>	5-7		5-7		6-10		6-10	
5K	DECIDUOUS SHRUBS	Lilac 1/ <i>Syringa vulgaris</i>	5-6		5-6		5-8		6-10	
5K	DECIDUOUS SHRUBS	Peashrub, Siberian 1/ <i>Caragana arborescens</i>	6-8		6-8		8-10		8-10	
5K	DECIDUOUS SHRUBS	Plum, American 1/ <i>Prunus americana</i>	5-7		5-8		5-8		6-10	

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			0-YEAR	MATURE	0-YEAR	MATURE	0-YEAR	MATURE	0-YEAR	MATURE
			HEIGHT (ft)	HGTSPREAD (ft)	HEIGHT (ft)	HGTSPREAD (ft)	HEIGHT (ft)	HGTSPREAD (ft)	HEIGHT (ft)	HGTSPREAD (ft)
5K	DECIDUOUS SHRUBS	Saltbush, Fourwing 1/ <i>Atriplex canescens</i>	2-5		Not Recommended		Not Recommended		Not Recommended	
5K	DECIDUOUS SHRUBS	Sumac, Skunkbush 1/ <i>Rhus trilobata</i> Recommended cultivars: Big Horn, Konza Fragrant	3-5		4-6		4-6		4-8	

1/ Adapted to calcareous soils

2/ Green Ash - only to be used in diverse tree and shrub plantings; **not windbreaks**

3/ Black Locust - for wildlife and pollinators (refer to table 11)

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
6	CONIFEROUS TREES	Juniper, Rocky Mountain <i>Juniperus scopulorum</i>	10-20	15-25/15	10-20	15-25/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6	CONIFEROUS TREES	Pine, Austrian <i>Pinus nigra</i>	10-15	20-25/20	15-20	20-25/20	15-20	25-35/20	20-25	30-40/20
6	CONIFEROUS TREES	Pine, Jack <i>Pinus banksiana</i>	10-15	20-25/15	10-15	20-25/15	15-25	25-30/15	15-25	25-30/15
6	CONIFEROUS TREES	Pine, Limber <i>Pinus flexilis</i>	10-15	25-40/15	10-15	25-45/15-20	15-20	30-45/15-20	20-25	35-55/15-20
6	CONIFEROUS TREES	Pine, Pinyon [Two needle Pinyon] <i>Pinus edulis</i>	5-10	15-20/15-20	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6	CONIFEROUS TREES	Pine, Ponderosa <i>Pinus ponderosa</i>	15-25	30-50/20	15-30	30-55/20	20-30	35-55/20	20-35	40-60/20
6	CONIFEROUS TREES	Pine, Southwestern White <i>Pinus strobiformis</i>	15-25	30-50/20	15-30	30-55/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6	CONIFEROUS TREES	Redcedar, Eastern <i>Juniperus virginiana</i>	10-20	20-25/15	10-20	20-25/15	10-25	25-35/15-20	15-25	30-40/20
6	DECIDUOUS TREES	Catalpa, Northern <i>Catalpa speciosa</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	30-35/20	15-20	30-35/20
6	DECIDUOUS TREES	Elm, Siberian <i>Ulmus pumila</i>	15-30	15-35/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6	DECIDUOUS TREES	Hackberry <i>Celtis occidentalis</i>	15-20	30-40/20	20-25	40-50/20	20-30	45-55/20	20-30	50-60/30
6	DECIDUOUS TREES	Honeylocust <i>Gleditsia triacanthos</i>	15-25	30-40/20	20-30	30-40/20	25-30	35-45/20	25-35	40-50/25-30
6	DECIDUOUS TREES	Locust, Black 2/ <i>Robinia pseudoacacia</i>	20-25	25-35/15	25-30	25-35/15	25-30	35-45/20	25-30	40-50/20
6	DECIDUOUS TREES	Mulberry, Red <i>Morus rubra</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	20-25/15	10-15	20-25/15
6	DECIDUOUS TREES	Mulberry, Russian or White <i>Morus alba var. tatarica</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	20-25/15	10-15	20-25/15
6	DECIDUOUS TREES	Oak, Bur <i>Quercus macrocarpa</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	20-25/15	10-15	20-25/15
6	DECIDUOUS TREES	Oak, Gambel <i>Quercus gambelii</i>	5-10	15-20	10-15	25	Not Recommended	Not Recommended	Not Recommended	Not Recommended

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
6	DECIDUOUS TREES	Osage-orange <i>Maclura pomifera</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	20-30/15	15-20	30-35/20-25
6	CONIFEROUS SHRUBS	Juniper, Common (Prostrate) <i>Juiperus communis</i>	4-7	4-7/15	4-7	4-7/15	4-7	4-7/15	4-7	4-7/15
6	DECIDUOUS SHRUBS	Antelope Bitterbrush <i>Purshia tridentate</i>	2-3		2-3		Not Recommended		Not Recommended	
6	DECIDUOUS SHRUBS	Buffaloberry, Silver <i>Shepherdia argentea</i>	5-8		10-12		10-12		10-12	
6	DECIDUOUS SHRUBS	Chokecherry, Common <i>Prunus virginiana</i>	5-8		6-12		6-12		8-14	
6	DECIDUOUS SHRUBS	Coralberry <i>Symphoricarpos orbiculatus</i>	Not Recommended		Not Recommended		2-3		2-3	
6	DECIDUOUS SHRUBS	Cotoneaster, Peking <i>Cotoneaster acutifolia</i>	4-5		5-6		5-8		5-10	
6	DECIDUOUS SHRUBS	Currant, Buffalo <i>Ribes odoratum</i>	3-6		3-6		3-6		3-6	
6	DECIDUOUS SHRUBS	Currant, Golden <i>Ribes aureum</i>	2-4		2-4		4-6		4-6	
6	DECIDUOUS SHRUBS	Peashrub, Siberian <i>Caragana arborescens</i>	6-8		6-8		6-10		8-10	
6	DECIDUOUS SHRUBS	Rose, Arkansas [prairie rose] <i>Rosa arkansana</i>	1-2		1-2		1-2		1-2	
6	DECIDUOUS SHRUBS	Rose, Hansen Hedge <i>Rosa</i> Sp. <i>Rosa rugosa</i> x <i>R. woodsii</i>	4-6		4-6		4-8		6-8	
6	DECIDUOUS SHRUBS	Rose, Woods' <i>Rosa woodsii</i>	3-5		3-5		4-5		4-5	
6	DECIDUOUS SHRUBS	Sagebrush, Silver <i>Artemisia cana</i>	3-6		Not Recommended		Not Recommended		Not Recommended	
6	DECIDUOUS SHRUBS	Saltbush, Fourwing <i>Atriplex canescens</i>	2-5		Not Recommended		Not Recommended		Not Recommended	
6	DECIDUOUS SHRUBS	Sandcherry, Western <i>Prunus besseyi</i>	2-3		2-3		2-4		3-6	

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
6	DECIDUOUS SHRUBS	Snowberry, Common <i>Symphoricarpos albus</i>	Not Recommended		Not Recommended		2-3		2-3	
6	DECIDUOUS SHRUBS	Snowberry, Western <i>Symphoricarpos occidentalis</i>	2-3		2-3		2-3		2-3	
6	DECIDUOUS SHRUBS	Sumac, Skunkbush <i>Rhus trilobata</i> Recommended cultivars: Big horn, Konza fragrant	3-5		4-6		4-6		4-8	

1/ Green Ash - only to be used in diverse tree and shrub plantings; **not windbreaks**

2/ Black Locust - for wildlife and pollinators (refer to table 11)

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
6K	CONIFEROUS TREES	Juniper, Rocky Mountain <i>Juniperus scopulorum</i>	10-20	15-25/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6K	CONIFEROUS TREES	Pine, Jack <i>Pinus banksiana</i>	10-15	20-25/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-25	25-30/15
6K	CONIFEROUS TREES	Pine, Limber <i>Pinus flexilis</i>	10-15	25-40/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-25	35-55/15-20
6K	CONIFEROUS TREES	Pine, Ponderosa <i>Pinus ponderosa</i>	15-25	30-50/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-35	40-60/20
6K	CONIFEROUS TREES	Pine, Southwestern White <i>Pinus strobiformis</i>	15-25	30-50/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6K	CONIFEROUS TREES	Redcedar, Eastern <i>Juniperus virginiana</i>	10-20	20-25/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-25	30-40/20
6K	DECIDUOUS TREES	Catalpa, Northern <i>Catalpa speciosa</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	30-35/20
6K	DECIDUOUS TREES	Elm, Siberian <i>Ulmus pumila</i>	15-30	15-35/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6K	DECIDUOUS TREES	Hackberry <i>Celtis occidentalis</i>	15-20	30-40/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-30	50-60/30
6K	DECIDUOUS TREES	Honeylocust <i>Gleditsia triacanthos</i>	15-25	30-40/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended	25-35	40-50/25-30
6K	DECIDUOUS TREES	Locust, Black 1/ <i>Robinia pseudoacacia</i>	20-25	25-35/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6K	DECIDUOUS TREES	Mulberry, Red <i>Morus rubra</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	20-25/15
6K	DECIDUOUS TREES	Mulberry, Russian or White <i>Morus alba var. tatarica</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	20-25/15
6K	DECIDUOUS TREES	Oak, Bur <i>Quercus macrocarpa</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	20-25/15
6K	DECIDUOUS TREES	Oak, Gambel <i>Quercus gambelii</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6K	DECIDUOUS TREES	Osage-orange <i>Maclura pomifera</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	30-35/20-25
6K	CONIFEROUS SHRUBS	Juniper, Common (Prostrate) <i>Juiperus communis</i>	4-7	4-7/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended	4-7	4-7/15

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Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
6K	DECIDUOUS SHRUBS	Antelope Bitterbrush <i>Purshia tridentate</i>	2-3		Not Recommended		Not Recommended		Not Recommended	
6K	DECIDUOUS SHRUBS	Buffaloberry, Silver <i>Shepherdia argentea</i>	5-8		Not Recommended		Not Recommended		10-12	
6K	DECIDUOUS SHRUBS	Chokecherry, Common <i>Prunus virginiana</i>	5-8		Not Recommended		Not Recommended		8-14	
6K	DECIDUOUS SHRUBS	Cotoneaster, Peking <i>Cotoneaster acutifolia</i>	4-5		Not Recommended		Not Recommended		5-10	
6K	DECIDUOUS SHRUBS	Currant, Buffalo <i>Ribes odoratum</i>	3-6		Not Recommended		Not Recommended		3-6	
6K	DECIDUOUS SHRUBS	Currant, Golden <i>Ribes aureum</i>	2-4		Not Recommended		Not Recommended		4-6	
6K	DECIDUOUS SHRUBS	Peashrub, Siberian <i>Caragana arborescens</i>	6-8		Not Recommended		Not Recommended		8-10	
6K	DECIDUOUS SHRUBS	Saltbush, Fourwing <i>Atriplex canescens</i>	2-5		Not Recommended		Not Recommended		Not Recommended	
6K	DECIDUOUS SHRUBS	Sumac, Skunkbush <i>Rhus trilobata</i> Recommended cultivars: Big horn, Konza fragrant	3-5		Not Recommended		Not Recommended		4-8	

1/ Black Locust - for wildlife and pollinators (refer to table 11)

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
6D	CONIFEROUS TREES	Juniper, Rocky Mountain <i>Juniperus scopulorum</i>	10-20	15-25/15	10-20	15-25/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6D	CONIFEROUS TREES	Pine, Austrian <i>Pinus nigra</i>	Not Recommended	Not Recommended	15-20	20-25/20	15-20	25-35/20	20-25	30-40/20
6D	CONIFEROUS TREES	Pine, Jack <i>Pinus banksiana</i>	10-15	20-25/15	10-15	20-25/15	15-25	25-30/15	15-25	25-30/15
6D	CONIFEROUS TREES	Pine, Limber <i>Pinus flexilis</i>	10-15	25-40/15	10-15	25-45/15-20	15-20	30-45/15-20	20-25	35-55/15-20
6D	CONIFEROUS TREES	Pine, Pinyon [Two needle Pinyon] <i>Pinus edulis</i>	5-10	15-20/15-20	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6D	CONIFEROUS TREES	Pine, Ponderosa <i>Pinus ponderosa</i>	15-25	30-50/20	15-30	30-55/20	20-30	35-55/20	20-35	40-60/20
6D	CONIFEROUS TREES	Pine, Southwestern White <i>Pinus strobiformis</i>	15-25	30-50/20	15-30	30-55/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6D	CONIFEROUS TREES	Redcedar, Eastern <i>Juniperus virginiana</i>	10-20	20-25/15	10-20	20-25/15	10-25	25-35/15-20	15-25	30-40/20
6D	DECIDUOUS TREES	Aspen, Quaking <i>Populus tremuloides</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	20-30	15-20	20-30
6D	DECIDUOUS TREES	Catalpa, Northern <i>Catalpa speciosa</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	30-35/20	15-20	30-35/20
6D	DECIDUOUS TREES	Elm, Siberian <i>Ulmus pumila</i>	15-30	15-35/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6D	DECIDUOUS TREES	Hackberry <i>Celtis occidentalis</i>	15-20	30-40/20	20-25	40-50/20	20-30	45-55/20	20-30	50-60/30
6D	DECIDUOUS TREES	Honeylocust <i>Gleditsia triacanthos</i>	15-25	30-40/20	20-30	30-40/20	25-30	35-45/20	25-35	40-50/25-30
6D	DECIDUOUS TREES	Locust, Black 1/ <i>Robinia pseudoacacia</i>	20-25	25-35/15	25-30	25-35/15	25-30	35-45/20	25-30	40-50/20
6D	DECIDUOUS TREES	Mulberry, Red <i>Morus rubra</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	20-25/15	10-15	20-25/15
6D	DECIDUOUS TREES	Mulberry, Russian or White <i>Morus alba var. tatarica</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	20-25/15	10-15	20-25/15
6D	DECIDUOUS TREES	Oak, Bur <i>Quercus macrocarpa</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	20-25/15	10-15	20-25/15

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
6D	DECIDUOUS TREES	Oak, Gambel <i>Quercus gambelii</i>	5-10	15-20	10-15	25	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6D	DECIDUOUS TREES	Osage-orange <i>Maclura pomifera</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	20-30/15	15-20	30-35/20-25
6D	DECIDUOUS TREES	Pear, Harbin <i>Pyrus ussuriensis</i> Recommended cultivar: McDermand	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	15-20/15	20-25	20-25/15
6D	CONIFEROUS SHRUBS	Juniper, Common (Prostrate) <i>Juiperus communis</i>	4-7	4-7/15	4-7	4-7/15	4-7	4-7/15	4-7	4-7/15
6D	DECIDUOUS SHRUBS	Antelope Bitterbrush <i>Purshia tridentate</i>	2-3		2-3		Not Recommended		Not Recommended	
6D	DECIDUOUS SHRUBS	Buffaloberry, Silver <i>Shepherdia argentea</i>	5-8		10-12		10-12		10-12	
6D	DECIDUOUS SHRUBS	Chokecherry, Common <i>Prunus virginiana</i>	5-8		6-12		6-12		8-14	
6D	DECIDUOUS SHRUBS	Coralberry <i>Symphoricarpos orbiculatus</i>	Not Recommended		Not Recommended		2-3		2-3	
6D	DECIDUOUS SHRUBS	Cotoneaster, Peking <i>Cotoneaster acutifolia</i>	4-5		5-6		5-8		5-10	
6D	DECIDUOUS SHRUBS	Currant, Buffalo <i>Ribes odoratum</i>	3-6		3-6		3-6		3-6	
6D	DECIDUOUS SHRUBS	Currant, Golden <i>Ribes aureum</i>	2-4		2-4		4-6		4-6	
6D	DECIDUOUS SHRUBS	Peashrub, Siberian <i>Caragana arborescens</i>	6-8		6-8		6-10		8-10	
6D	DECIDUOUS SHRUBS	Rose, Arkansas [prairie rose] <i>Rosa arkansana</i>	1-2		1-2		1-2		4-7	
6D	DECIDUOUS SHRUBS	Rose, Hansen Hedge <i>Rosa</i> Sp. <i>Rosa rugosa</i> x <i>R. woodsii</i>	4-6		4-6		4-8		4-8	
6D	DECIDUOUS SHRUBS	Rose, Woods' <i>Rosa woodsii</i>	3-5		3-5		4-5		4-9	
6D	DECIDUOUS SHRUBS	Sagebrush, Silver <i>Artemisia cana</i>	3-6		Not Recommended		Not Recommended		Not Recommended	

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Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
6D	DECIDUOUS SHRUBS	Saltbush, Fourwing <i>Atriplex canescens</i>	2-5		Not Recommended		Not Recommended		Not Recommended	
6D	DECIDUOUS SHRUBS	Sandcherry, Western <i>Prunus besseyi</i>	2-3		2-3		2-4		3-6	
6D	DECIDUOUS SHRUBS	Snowberry, Common <i>Symphoricarpos albus</i>	Not Recommended		Not Recommended		2-3		2-3	
6D	DECIDUOUS SHRUBS	Snowberry, Western <i>Symphoricarpos occidentalis</i>	2-3		2-3		2-3		2-3	
6D	DECIDUOUS SHRUBS	Sumac, Skunkbush <i>Rhus trilobata</i> Recommended cultivars: Big horn, Konza fragrant	3-5		4-6		4-6		4-8	

1/ Black Locust - for wildlife and pollinators (refer to table 11)

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
6DK	CONIFEROUS TREES	Juniper, Rocky Mountain <i>Juniperus scopulorum</i>	10-20	15-25/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6DK	CONIFEROUS TREES	Pine, Jack <i>Pinus banksiana</i>	10-15	20-25/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6DK	CONIFEROUS TREES	Pine, Limber <i>Pinus flexilis</i>	10-15	25-40/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6DK	CONIFEROUS TREES	Pine, Ponderosa <i>Pinus ponderosa</i>	15-25	30-50/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6DK	CONIFEROUS TREES	Redcedar, Eastern <i>Juniperus virginiana</i>	10-20	20-25/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6DK	DECIDUOUS TREES	Elm, Siberian <i>Ulmus pumila</i>	15-30	15-35/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6DK	DECIDUOUS TREES	Oak, Gambel <i>Quercus gambelii</i>	5-10	15-20	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6DK	CONIFEROUS SHRUBS	Juniper, Common (Prostrate) <i>Juniperus communis</i>	4-7	4-7/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6DK	DECIDUOUS SHRUBS	Antelope Bitterbrush <i>Purshia tridentate</i>	2-3		Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6DK	DECIDUOUS SHRUBS	Buffaloberry, Silver <i>Shepherdia argentea</i>	5-8		Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6DK	DECIDUOUS SHRUBS	Chokecherry, Common <i>Prunus virginiana</i>	5-8		Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6DK	DECIDUOUS SHRUBS	Cotoneaster, Peking <i>Cotoneaster acutifolia</i>	4-5		Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6DK	DECIDUOUS SHRUBS	Currant, Buffalo <i>Ribes odoratum</i>	3-6		Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6DK	DECIDUOUS SHRUBS	Currant, Golden <i>Ribes aureum</i>	2-4		Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6DK	DECIDUOUS SHRUBS	Peashrub, Siberian <i>Caragana arborescens</i>	6-8		Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6DK	DECIDUOUS SHRUBS	Saltbush, Fourwing <i>Atriplex canescens</i>	2-5		Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
6DK	DECIDUOUS SHRUBS	Sandcherry, Western <i>Prunus besseyi</i>	2-3		Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended

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Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
6DK	DECIDUOUS SHRUBS	Sumac, Skunkbush <i>Rhus trilobata</i> Recommended cultivars: Big horn, Konza fragrant	3-5		Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
7	CONIFEROUS TREES	Juniper, Rocky Mountain <i>Juniperus scopulorum</i>	10-20	15-25/15	10-20	15-25/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended
7	CONIFEROUS TREES	Pine, Austrian <i>Pinus nigra</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-20	25-35/20	20-25	30-40/20
7	CONIFEROUS TREES	Pine, Bristlecone <i>Pinus aristata</i>	5-10	20-25/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
7	CONIFEROUS TREES	Pine, Jack <i>Pinus banksiana</i>	10-15	20-25/15	10-15	20-25/15	15-25	25-30/15	15-25	25-30/15
7	CONIFEROUS TREES	Pine, Limber <i>Pinus flexilis</i>	5-10	15-20/10	5-10	15-20/10	10-15	20-30/20	15-20	25-35/20
7	CONIFEROUS TREES	Pine, Pinyon [Two needle Pinyon] <i>Pinus edulis</i>	5-10	15-20/15-20	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
7	CONIFEROUS TREES	Pine, Ponderosa <i>Pinus ponderosa</i>	10-20	30-40/20	10-20	30-45/20	20-30	35-45/20	20-35	35-45/20
7	CONIFEROUS TREES	Pine, Southwestern White <i>Pinus strobiformis</i>	10-20	30-40/20	10-20	30-45/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended
7	CONIFEROUS TREES	Redcedar, Eastern <i>Juniperus virginiana</i>	10-20	20-25/15	10-25	20-25/15	10-25	25-35/15-20	15-25	25-35/20
7	DECIDUOUS TREES	Apricot, Manchurian <i>Prunus armeniaca</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-20	10-20/10
7	DECIDUOUS TREES	Elm, Siberian <i>Ulmus pumila</i>	15-20	30-35	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
7	DECIDUOUS TREES	Hackberry <i>Celtis occidentalis</i>	10-15	25-30	10-15	25-30	10-15	25-30	10-15	30-35
7	DECIDUOUS TREES	Honeylocust <i>Gleditsia triacanthos</i>	Not Recommended	Not Recommended	10-15	20-25	10-15	20-25	25-35	40-50/25-30
7	DECIDUOUS TREES	Locust, Black 1/ <i>Robinia pseudoacacia</i>	20-25	25-35/15	25-30	25-35/15	25-30	35-45/20	25-30	40-50/20
7	DECIDUOUS TREES	Mulberry, Red <i>Morus rubra</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-25	20-25/15
7	DECIDUOUS TREES	Mulberry, Russian or White <i>Morus alba var. tatarica</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	20-25	20-25/15
7	DECIDUOUS TREES	Oak, Bur <i>Quercus macrocarpa</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	25-35/20-30	15-20	30-40
7	DECIDUOUS TREES	Oak, Gambel <i>Quercus gambelii</i>	5-10	15-20	10-15	25	Not Recommended	Not Recommended	Not Recommended	Not Recommended
7	DECIDUOUS TREES	Osage-orange <i>Maclura pomifera</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	30-35/20-25
7	CONIFEROUS SHRUBS	Juniper, Common (Prostrate) <i>Juiperus communis</i>	4-7	4-7/15	4-7	4-7/15	4-7	4-7/15	4-7	4-7/15
7	DECIDUOUS SHRUBS	Buffaloberry, Silver <i>Shepherdia argentea</i>	5-8		10-12		10-12		10-12	
7	DECIDUOUS SHRUBS	Chokecherry, Common <i>Prunus virginiana</i>	5-8		6-12		6-12		8-14	

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
7	DECIDUOUS SHRUBS	Currant, Buffalo <i>Ribes odoratum</i>	2-4		2-4		2-4		2-4	
7	DECIDUOUS SHRUBS	Currant, Golden <i>Ribes aureum</i>	2-4		2-4		4-6		4-6	
7	DECIDUOUS SHRUBS	Peashrub, Siberian <i>Caragana arborescens</i>	6-8		6-8		8-10		8-10	
7	DECIDUOUS SHRUBS	Plum, American <i>Prunus americana</i>	5-7		5-8		5-8		6-10	
7	DECIDUOUS SHRUBS	Rose, Arkansas [prairie rose] <i>Rosa arkansana</i>	1-2		1-2		1-2		1-2	
7	DECIDUOUS SHRUBS	Rose, Hansen Hedge <i>Rosa</i> Sp. <i>Rosa rugosa</i> x <i>R. woodsii</i>	4-6		4-6		4-8		6-8	
7	DECIDUOUS SHRUBS	Rose, Woods' <i>Rosa woodsii</i>	3-5		3-5		4-5		4-5	
7	DECIDUOUS SHRUBS	Sandcherry, Western <i>Prunus besseyi</i>	2-3		2-3		2-4		3-6	
7	DECIDUOUS SHRUBS	Snowberry, Western <i>Symphoricarpos occidentalis</i>	2-3		2-3		2-3		2-3	
7	DECIDUOUS SHRUBS	Sumac, Skunkbush <i>Rhus trilobata</i> Recommended cultivars: Big horn, Konza fragrant	3-5		4-6		4-6		4-8	

1/ Black Locust - for wildlife and pollinators (refer to table 11)

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
8	CONIFEROUS TREES	Juniper, Rocky Mountain 1/ <i>Juniperus scopulorum</i>	10-20	15-25/15	10-20	15-25/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended
8	CONIFEROUS TREES	Pine, Bristlecone <i>Pinus aristata</i>	5-10	25-30/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
8	CONIFEROUS TREES	Pine, Limber 1/ <i>Pinus flexilis</i>	10-15	25-40/15	10-15	25-45/15-20	15-20	30-45/15-20	20-25	35-55/15-20
8	CONIFEROUS TREES	Pine, Ponderosa 1/ <i>Pinus ponderosa</i>	15-25	30-50/20	15-30	30-55/20	20-30	35-55/20	20-35	40-60/20
8	CONIFEROUS TREES	Pine, Southwestern White <i>Pinus strobiformis</i>	15-25	30-50/20	15-30	30-55/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended
8	CONIFEROUS TREES	Redcedar, Eastern 1/ <i>Juniperus virginiana</i>	10-20	20-25/15	10-20	20-25/15	10-25	25-35/15-20	15-25	30-40/20
8	DECIDUOUS TREES	Apricot, Manchurian <i>Prunus armeniaca</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	10-15/10	10-20	10-20/10
8	DECIDUOUS TREES	Ash, Green 1/, 2/ <i>Fraxinus pennsylvanica</i>	10-15	20-25/20	10-15	20-25/20	10-15	20-25/20	10-15	25-30/20-25
8	DECIDUOUS TREES	Aspen, Quaking 1/ <i>Populus tremuloides</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	20-30	15-20	20-30
8	DECIDUOUS TREES	Catalpa, Northern 1/ <i>Catalpa speciosa</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	15-20	30-35/20	15-20	30-35/20
8	DECIDUOUS TREES	Elm, Siberian 1/ <i>Ulmus pumila</i>	15-20	30-35/20	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended	Not Recommended
8	DECIDUOUS TREES	Hackberry 1/ <i>Celtis occidentalis</i>	10-15	25-30/20	10-15	25-30/20	10-15	25-30/20	10-15	30-35/30
8	DECIDUOUS TREES	Honeylocust 1/ <i>Gleditsia triacanthos</i>	Not Recommended	Not Recommended	10-15	20-25/15-20	10-15	20-25/20	25-35	40-50/25-30
8	DECIDUOUS TREES	Oak, Bur 1/ <i>Quercus macrocarpa</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	25-35/30	15-20	40-60/30-40
8	DECIDUOUS TREES	Oak, Gambel 1/ <i>Quercus gambelii</i>	5-10	15-20	10-15	25	Not Recommended	Not Recommended	Not Recommended	Not Recommended
8	DECIDUOUS TREES	Osage-orange 1/ <i>Maclura pomifera</i>	Not Recommended	Not Recommended	Not Recommended	Not Recommended	10-15	20-25/15-20	10-15	30-35/20-25
8	CONIFEROUS SHRUBS	Juniper, Common (Prostrate) <i>Juniperus communis</i>	4-7	4-7/15	4-7	4-7/15	4-7	4-7/15	4-7	4-7/15

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Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
8	DECIDUOUS SHRUBS	Antelope Bitterbrush 1/ <i>Purshia tridentate</i>	2-3		Not Recommended		Not Recommended		Not Recommended	
8	DECIDUOUS SHRUBS	Buffaloberry, Silver 1/ <i>Shepherdia argentea</i>	5-8		10-12		10-12		10-12	
8	DECIDUOUS SHRUBS	Chokecherry, Common 1/ <i>Prunus virginiana</i>	5-8		6-12		6-12		8-14	
8	DECIDUOUS SHRUBS	Currant, Buffalo 1/ <i>Ribes odoratum</i>	2-4		2-4		3-6		3-6	
8	DECIDUOUS SHRUBS	Currant, Golden 1/ <i>Ribes aureum</i>	2-4		2-4		4-6		4-6	
8	DECIDUOUS SHRUBS	Lilac 1/ <i>Syringa vulgaris</i>	5-6		5-6		5-8		6-10	
8	DECIDUOUS SHRUBS	Mahogany, Mountain 1/ <i>Cercocarpus montana</i>	5-10		5-10		Not Recommended		Not Recommended	
8	DECIDUOUS SHRUBS	Peashrub, Siberian 1/ <i>Caragana arborescens</i>	6-8		6-8		8-10		8-10	
8	DECIDUOUS SHRUBS	Plum, American 1/ <i>Prunus americana</i>	5-7		5-8		5-8		6-10	
8	DECIDUOUS SHRUBS	Sumac, Skunkbush 1/ <i>Rhus trilobata</i> Recommended cultivars: Big Horn, Konza Fragrant	3-5		4-6		4-6		4-8	

1/ Adapted to calcareous soils

2/ Green Ash - only to be used in diverse tree and shrub plantings; **not windbreaks**

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
9L	CONIFEROUS TREES	Juniper, Rocky Mountain <i>Juniperus scopulorum</i>	10-20	15-25/15	10-20	15-25/15	Not Recommended	Not Recommended	Not Recommended	Not Recommended
9L	CONIFEROUS TREES	Redcedar, Eastern <i>Juniperus virginiana</i>	10-20	20-25/15	10-20	20-25/15	10-25	25-35/15-20	15-25	30-40/20
9L	DECIDUOUS TREES	Boxelder <i>Acer negundo</i>	15-20	25-35/20	15-20	25-35/20	15-20	30-35/20	20-25	35-40/20
9L	DECIDUOUS SHRUBS	Buffaloberry, Silver <i>Shepherdia argentea</i>	5-8		10-12		10-12		10-12	
9L	DECIDUOUS SHRUBS	Peashrub, Siberian <i>Caragana arborescens</i>	6-8		6-8		8-10		8-10	
9L	DECIDUOUS SHRUBS	Sagebrush, Big <i>Artemisia tridentata</i>	3-6		Not Recommended		Not Recommended		Not Recommended	
9L	DECIDUOUS SHRUBS	Sagebrush, Silver <i>Artemisia cana</i>	3-6		Not Recommended		Not Recommended		Not Recommended	
9L	DECIDUOUS SHRUBS	Saltbush, Fourwing <i>Atriplex canescens</i>	2-5		Not Recommended		Not Recommended		Not Recommended	
9L	DECIDUOUS SHRUBS	Sumac, Skunkbush <i>Rhus trilobata</i> Recommended cultivars: Big horn, Konza fragrant	3-5		4-6		4-6		4-8	

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
9W	Trees/shrubs not recommended on this site									

Group 9W = Wet - Saline/Alkaline soils

Soils Group	TreeShrub Type	Species	ZONE I		ZONE II		ZONE III		ZONE IV	
			20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE	20-YEAR	MATURE
			HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)	HEIGHT (ft)	HGT/SPREAD (ft)
10	Site Visit Required									

Note: Site visit required before any species can be recommended due to soil limitations, such as soil depth, texture, drainage, channeled phases, available water capacity, slope or salts which severely limit planting, species selection, survival or growth of trees and shrubs. Recommend checking with local forester for technical assistance.

Summary - List of Attributes by Species for Conservation Tree/Shrub Plantings in Nebraska

Coniferous Trees	PLANTS Database Symbol	Native by Vegetative Zones I, II, III, or IV N = Not Native	Shade Tolerance (1)	Flood Tolerance (2)	Wildlife Value (3)				Windbreak Density (4)		Products (5)	Root Suckering (6) N = No, Y = Yes	Comments (7)
					Use Groups	Function	Rating	Season	Summer	Winter			
Arborvitae, American or Northern White Cedar (<i>Thuja occidentalis</i>)	THOC2	N	L	M	SB	C	L	N/A	H	H	F	N	Native to Great Lakes region and Northeastern US. Prefers moist, fertile soils. Subject to winter burn. Plantings limited to eastern Nebraska. Height 20-30 ft.
Arborvitae, Oriental (<i>Platycladus orientalis</i>)	PLOR80	N	M	M	SB	C	L	N/A	H	H	F, B	N	Winter hardiness questionable in Vegetative Zone III (seed source important). Prefers moist, well-drained soils. Possible substitute for eastern redcedar in windbreaks. Plantings limited to eastern Nebraska. Height to 20 ft.
Baldcypress (<i>Taxodium distichum</i>)	TADI2	N	M	H	SB	C	L	N/A	M	L	L	N	Deciduous conifer - rust fall color and loses needles in fall. Prefers acid soils; tolerates slightly alkaline soils. Drought tolerant. Winter hardiness questionable in Vegetative Zone III. Height to 60 ft.
Fir, Douglas (<i>Pseudotsuga menziesii</i>)	PSME	N	M	L	SB	B	M	F	H	H	C, L	N	Delicate; protect from strong winds. Uses include wildlife habitat - seed source is important for songbirds. Height to 60 ft.
Fir, White (<i>Abies concolor</i>)	ABCO	N	H	L	SB	B	M	F	H	H	C	N	Delicate. Uses include wildlife habitat - seed source important for songbirds. Height to 60 ft.
Juniper, Rocky Mountain (<i>Juniperus scopulorum</i>)	JUSC2	I, II	M	L	SB GB	B	H	F/W	H	H	C, S	N	Cercospora a problem in eastern Nebraska. Only female plants produce seeds. Adapted to wide range of soil types. Drought tolerant. Use in windbreaks and wildlife habitat. Height to 40 ft.
Pine, Austrian (<i>Pinus nigra</i>)	PINI	N	L	L	SB GB	B	M	F/W	M	M	C	N	Affected by dothistroma and tip blight; moderately susceptible to pine wilt disease. Adapted to range of pH and soils. Drought tolerant. Use for windbreaks and wildlife habitat. Height to 50 ft.
Pine, Bristlecone (<i>Pinus aristata</i>)	PIAR	N	L	L	SB	C	L	N/A	M	M		N	Does not thrive in humid eastern prairies; susceptible to dothistroma and tip blight. Lives longer in dry climates; hardy and long-lived on sunny, dry, infertile sites. Height to 20 ft.
Pine, Eastern White (<i>Pinus strobus</i>)	PIST	N	M	L	SB	C	L	N/A	M	M	C, L, B	N	Needs protection from winds; avoid use in outside rows. Fine needles in clusters of five. Height to 60 ft.
Pine, Jack (<i>Pinus banksiana</i>)	PIBA2	N	L	L	SB	C	L	N/A	M	M		N	Moderately susceptible to pine wilt disease. Possible substitute for eastern redcedar in windbreaks. Adapted to range of pH and soils - including very sandy soils. Drought tolerant. Native to Great Lakes region and Canada. Height to 60 ft.
Pine, Limber (<i>Pinus flexilis</i>)	PIFL2	I	L	L	SB	C	L	N/A	M	M	F	N	Susceptible to dothistroma needle blight and blister rust. Slow growing. Windbreak species in Zone I. Native population in Kimball Co. Excellent for wildlife plantings. Use in multirow windbreaks only. Height to 50 ft.
Pine, Pinyon (Two Needle) (<i>Pinus edulis</i>)	PIED	N	L	L	SB GB	B	H	F	H	H	C, P, F, E1	N	Slow growing. Excellent winter hardiness, drought resistant and tolerant of alkaline soils. Excellent species for wildlife. Pine 'nut' edible by wildlife and humans. Height to 30 ft.
Pine, Ponderosa (<i>Pinus ponderosa</i>)	PIPO	I, II, III	L	L	SB GB	B	H	F/W	M	M	C, L, P, F, B	N	Susceptible to tip blight/Zimmerman moth. Use for windbreaks and wildlife habitat. Wild turkey utilize seed source. Prefers acid soils; tolerates low fertility and drought. Height to 50 ft.

Summary - List of Attributes by Species for Conservation Tree/Shrub Plantings in Nebraska

Coniferous Trees	PLANTS Database Symbol	Native by Vegetative Zones I, II, III, or IV N = Not Native	Shade Tolerance (1)	Flood Tolerance (2)	Wildlife Value (3)				Windbreak Density (4)		Products (5)	Root Suckering (6) N = No, Y = Yes	Comments (7)
					Use Groups	Function	Rating	Season	Summer	Winter			
Pine, Southwestern White (<i>Pinus strobiformis</i>)	PIST3	N	L	L	SB	C	L	N/A	M	M	C, F	N	Native to Arizona, New Mexico, and Mexico. Susceptible to dothistroma needle blight and blister rust. Faster growing than limber pine. Use as windbreak species in southwestern NE only. Seed source should be from elevations above 7600 ft. Height to 110 ft.
Redcedar, Eastern (<i>Juniperus virginiana</i>)	JUVI	I, II, III, IV	M	M	SB GB	B	H	F/W	H	H	P, S, L	N	Invasive in grasslands in eastern and central Nebraska; only female plants produce seeds. Reliable windbreak species. Cercospora can be a problem. Height to 50 ft.
Spruce, Colorado Blue (<i>Picea pungens</i>)	PIPU	N	M	L	SB	B	M	F/W	H	H	C	N	Color range from green to blue. Uses include windbreaks and wildlife habitat. Height to 60ft.
Spruce, Norway (<i>Picea abies</i>)	PIAB	N	M	L	SB	B	M	F/W	H	H		N	Long, banana shaped cones. Uses include windbreaks and wildlife habitat. Height to 60 ft.
Spruce, White (<i>Picea glauca</i>) (recommended Black Hills variety (<i>Picea glauca densata</i>))	PIGL PIGLD	N	M	L	SB	C	L	N/A	H	H		N	Small cones. Most tolerant spruce tree for wind, cold, heat, and drought. Height to 40 ft.

(1) **Shade Tolerance** - adaptation for underplantings (H = high, M = medium, L = low)

(2) **Flood Tolerance** - relative value in riparian locations (H = high tolerance of frequent Flood with poor drainage, M - medium tolerance to Flood and needs good drainage, L = low tolerance of Flood)

(3) **Wildlife Value - Use Groups:** SM = small mammals, LM = large mammals, SB = song birds, GB = game birds, MB = moths/butterflies; Function: F = food, C = cover, B = both; Rating: H = high value on a long-term use, M = high value on a seasonal basis, L = value on a limited, short-term basis; Season when food is available: Sp = Spring, Su = Summer, F = Fall, W = Winter, N/A = Not Applicable

(4) **Windbreak Density** - Summer = comparable protection from wind; Winter = comparable protection from wind and snow drifting; H = high, M = medium, L = low

(5) **Products** - C = Christmas trees, P = posts, S = shavings, L = lumber, F = firewood, B = biomass, E1 = edible directly off the plant, E2 = edible if processed

(6) **Root Suckering** - comparable aggressiveness to root sprout, N = No, Y = Yes

(7) **Comments** - check with your local forester or natural resource professional for other possible considerations

Summary - List of Attributes by Species for Conservation Tree/Shrub Plantings in Nebraska

Deciduous Trees	PLANTS Database Symbol	Native by Vegetative Zones I, II, III, or IV N = Not Native	Shade Tolerance (1)	Flood Tolerance (2)	Wildlife Value (3)				Windbreak Density (4)		Products (5)	Root Suckering (6) N = No, Y = Yes	Comments (7)
					Use Groups	Function	Rating	Season	Summer	Winter			
Apricot, Manchurian (<i>Prunus armeniaca</i>)	PRAR3	N	L	L	SM SB	F	M	Su	M	L	E2	N	Native of China. Cultivated for fruit. Varieties <i>mandshurica</i> Maxim. and <i>sibirica</i> L. are hardy with potential ornamental value in the northern Great Plains. Prefers sun; pH and soil adaptable. Autumn foliage golden. Use native fruit-bearing species in unaltered habitats. Songbirds attracted to fruit. Height to 30 ft.
Ash, Green (<i>Fraxinus pennsylvanica</i>)	FRPE	I, II, III, IV	M	H	SM SB	B	H	Sp-F	M	L	F, L	N	Highly susceptible to Emerald Ash Borer that will kill infected trees. Susceptible to native ash borers when young. Historically was widely used in shelterbelt plantings. Currently recommended for use in diverse tree plantings and wildlife plantings only; not for windbreaks . Height to 70 ft.
Aspen, Quaking (<i>Populus tremuloides</i>)	POTR5	I, II	L	L	GB LM	B	H	All	M	L		Y	Suckers when mature to form aspen grove. Buds and catkins eaten by birds; leaves and twigs provide big game browse. Height to 60 ft.
Basswood/Linden, American (<i>Tilia americana</i>)	TIAM	III, IV	H	M	SB MB	B	M	Su/F	M	L	L	N	Native to eastern NE, west to Cherry County along the Niobrara River, and west to Morse Bluff on the Platte River. Also native from the eastern portions of the Dakotas, KS, and OK to the Atlantic Coast from NC to ME. Prefers sun to partial shade, deep, moist fertile soils; pH adaptable. Drought tolerant. Grows best on well watered, partially shaded sites protected from desiccating winds. Flowers used extensively by bees. Used as carving wood. Height to 70 ft.
Birch, Paper (<i>Betula papyrifera</i>)	BEPA	II	M	L	SB LM	B	M	F/W	M	L		N	Native along Niobrara Valley. Bark is white and peeling. Buds and twigs used to a limited degree by songbirds and deer, respectively. Short life span. Bronze birch borer a problem. Height to 50 ft.
Birch, River (<i>Betula nigra</i>)	BENI	N	M	M	SB LM	F	L	F/W	M	L		Y	Suitable for Vegetative Zone IV on moist soils. Bark has salmon pink shades. Height to 40 ft.
Boxelder (<i>Acer negundo</i>)	ACNE2	I, II, III, IV	L	H	SM SB	B	H	Sp-F	M	L		N	Short-lived tree with multiple trunk form. Provides good cavities for wildlife shelter. Hardy on poor sites; common in riparian areas. Songbirds attracted to seeds. Height to 50 ft.
Catalpa, Northern (<i>Catalpa speciosa</i>)	CASP8	IV	L	M	MB SB	C	L	N/A	M	L	F	N	Large leaves; white flowers; long seed pods. Susceptible to ash borers. Height to 60 ft.
Cherry, Black (<i>Prunus serotina</i>)	PRSE2	III, IV	L	L	SB SM	B	H	Su	M	L	L, E2	N	Native to eastern Nebraska; prefers moist fertile soils on bottomlands. Valuable timber species. Height to 60 ft.
Cottonwood, Eastern or Plain (<i>Populus deltoides</i>) Recommended cultivars: Might Mo, Noreaster, Platte	PODE3	I, II, III, IV	L	H	SM SB	B	H	F/W	M	L	B, L, S	N	Nebraska state tree. Susceptible to Cytospora canker on uplands. Prefers moist soils, especially along rivers and streams. Wildlife use twigs as browse when young and is a good den tree when mature. Height to 80 ft.

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Crabapple (<i>Malus sp.</i>) (Siberian crab is <i>M. baccata</i> ; Sargent crab is <i>M. sargentii</i>)	MABA	N	L	L	SB SM	B	M	Su/F	M	L		N	Countless crabapple hybrids and varieties exist with varying characteristics. Radiant is a 25-30 ft. pink-flowered cultivar of Siberian that is susceptible to scab. Midwest is a 15-25 ft. white-flowered cultivar of Siberian. Roselow is a white-flowered, 6-8 ft., shrub-like cultivar of Sargent.
Crabapple, Prairie (<i>Malus ionensis</i>)	MAIO	IV	L	L	SB SM	B	H	Su/F	M	L		Y	Species is native to extreme eastern Nebraska. Susceptible to cedar-apple rust. Fruit is small, hard, and green. Suckering roots form thickets. Height to 20 ft.
Elm, American (<i>Ulmus americana</i>)	ULAM	I, II, III, IV	M	M	SB SM	B	M	Sp	M	L	F, L	N	Not recommended because of susceptibility to Dutch Elm Disease. Red or slippery elm (<i>Ulmus rubra</i>) may be a suitable native substitute. Height to 70ft.
Elm, Siberian (<i>Ulmus pumila</i>)	ULPU	N	M	L	SB	B	L	Sp	M	L	F, L	N	Invasive into grasslands and disturbed areas by seedling establishment. Recommended for Veg. Zone I only. Strongly suggest seeking alternate species for Veg. Zones II, III, and IV. Often mistakenly called Chinese elm. Seeds eaten by songbirds. Height to 80 ft.
Hackberry (<i>Celtis occidentalis</i>)	CEOC	I, II, III, IV	H	M	SB SM	B	H	Su	M	L	F, L	N	Common windbreak species; adapted to wide range of soils. Susceptible to herbicide drift. Nipple gall common on leaves. Songbirds eat seeds. Height to 70 ft.
Hawthorn, Cockspur (<i>Crataegus crusgalli</i>)	CRCR2	N	L	L	SB SM	B	H	F/W	M	L		N	Native to eastern US. Sharp thorns on some varieties. Red fruits persist into winter. Height to 20 ft.
Hawthorn, Washington (<i>Crataegus phaenopyrum</i>)	CRPH	N	L	M	SB SM	B	H	F/W	M	L		N	Common conservation species. Often thorny. Red berries persist into winter. Possible rust problems. Height to 30 ft.
Hickory, Bitternut (<i>Carya cordiformis</i>)	CACO15	III, IV	M	M	SM SB	B	H	F	M	L	F	N	Native to eastern Nebraska in association with oaks. Slow growing. Bark is smooth. Nut is bitter. Height to 80 ft.
Hickory, Shagbark (<i>Carya ovata</i>)	CAOV2	IV	M	L	SM SB	B	H	F	M	L	L, F, E2	N	Native to Missouri River bluff woodlands. Extremely slow growing. Bark forms large plates when mature. Nut is edible but extraction is difficult. Height to 80 ft.
Honeylocust (<i>Gleditsia triacanthos</i>)	GLTR	III, IV	L	M	LM SM	F	M	Su-F	M	L	F, L	Y	Nitrogen fixing legume. Common windbreak tree. Seeds eaten by small mammals; pods eaten by cattle. Possible thorns. Potentially invasive in grasslands in eastern Nebraska. Height to 60 ft.
Hophornbeam, Eastern or Ironwood (<i>Ostrya virginiana</i>)	OSVI	III, IV	H	L	SM SB	B	M	Su	M	L	F	N	Difficult to obtain as nursery stock. Small tree with very dense wood. Understory species that does well in shady conditions. Height to 40 ft.
Kentucky Coffeetree (<i>Gymnocladus dioicus</i>)	GYDI	III, IV	L	L	SB	C	L	N/A	M	L		Y	Nitrogen fixing legume. Prefers moist fertile soils but adapted a wide range. Drought resistant. Possible toxicity of seeds to humans. Nonaggressive root suckering. Height to 60 ft.
Locust, Black (<i>Robinia pseudoacacia</i>)	ROPS	N	L	L	SB	C	L	N/A	M	L	P, F	Y	Nitrogen fixing legume. Problems with locust borer. Bark and seeds may be toxic. Aggressive root suckering; potentially invasive due to spontaneous root suckers causing clonal spread. Height to 60 ft.

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Maple, Amur (<i>Acer ginnala</i>) (recommended cultivar: Flame)	ACGI	N	M	M	SB	B	H	Su-W	M	L		N	Small tree or large shrub form. Beautiful autumn color. Seeds eaten by songbirds and twigs browsed by deer. Height to 15 ft.
Maple, Silver (<i>Acer saccharinum</i>)	ACSA2	III, IV	M	H	SM SB	B	M	Sp/S u	M	L	B, F	Y	Narrow crotch angles may produce multiple stems; susceptible to wind breakage. Nonaggressive root suckering. Fastest growing maple. Common in riparian areas. Height to 60 ft.
Maple, Sugar (<i>Acer saccharum</i>)	ACSA3	N	M	M	SM SB	B	M	Sp/S u	M	L	F, L, E2	Y	Orange/red fall color. Winter hardiness questionable in northern Nebraska. Sap is source of maple syrup. Nonaggressive root suckering. Height to 60 ft.
Mulberry, Red (<i>Morus rubra</i>)	MORU2	IV	H	L	SB SM	B	H	Sp	M	L	F, P, E1, E2	N	Native to southeast Nebraska. Leaves often not lobed compared to white mulberry and all fruits mature purple to black. Only female plants produce seeds. Height to 50 ft.
Mulberry, Russian or White (<i>Morus alba var. tatarica</i>)	MOAL	N	H	L	SB SM	B	M	Sp	M	L	E1, E2	N	Hybridizes with red mulberry in the wild. Leaves often lobed compared to red mulberry and some fruits mature as white. Only female plants produce seeds. Height to 40 ft.
Oak, Black (<i>Quercus velutina</i>)	QUVE	IV	M	L	SM GB	B	H	F	M	L	F	N	Natural site is typically rocky, sandy to clay soil on a dry upland. Approaches northern red oak stature on fertile, bottomland soil. Autumn foliage red, leaves persist through winter. Grows best on sunny site in fertile, moist soil, neutral to acidic. Height to 50 ft.
Oak, Bur (<i>Quercus macrocarpa</i>)	QUMA2	I, II, III, IV	M	L	SM GB	B	H	F	M	L	F, L	N	Drought tolerant. Prefers sunny site; pH and soil adaptable. Tolerates occasional poor drainage and inundation. Round, wide spreading crown. Name from bur-like fringe located around rim of acorn cup. Ranges from south central Canada throughout the Great Plains states. Lacks bright fall color. Drops leaves after first sharp freeze. Height to 75 ft.
Oak, Chinkapin (<i>Quercus muhlenbergii</i>)	QUMU	IV	L	L	SM GB	B	H	F	M	L	F	N	Drought tolerant. Prefers sunny site; pH and soil adaptable. Generally grown on well-drained sites, from streambanks to dry ridges, with a preference for soils of limestone origin. Seldom found on acidic soils. Sweet acorns were consumed by Native Americans and are excellent wildlife food. Rounded crown. Ranges from central TX and OK to eastern KS and the northeastern U.S. Does not display bright fall colors. Height to 60 ft.
Oak, English (<i>Quercus robur</i>)	QURO2	N	M	L	SM GB	B	H	F	M	L	F, L	N	Native to Europe, East Asia, and North Africa, resulting in extensive genetic variability. Recognized by long-stalked acorns. Drought tolerant. Prefers sunny site; pH and soil adaptable. Height to 65 ft.

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					Use Groups	Function	Rating	Season	Summer	Winter			
Oak, Gambel (<i>Quercus gambelii</i>)	QUGA	I	L	L	SM GB	B	H	F	M	L		N	Suitable for small spaces and dry sites. Ranges from dry foothills, canyons, and lower slopes of mountains of NV, UT, CO, AZ, NM, and fringes of adjoining states and Mexico. Locally known as scrub oak due to slow growth and tendency to form thickets. Acorns are excellent wildlife food. Crown is narrow and sparse. Wood is hard, heavy and close grained. Prefers sunny sites; pH and soil adaptable; drought tolerant. Height to 20 ft.
Oak, Northern Red (<i>Quercus rubra</i>)	QURU	IV	M	L	SM GB	B	H	F	M	L	F, L	N	Native to states east of the Great Plains; grows on eastern fringes of the Plains. Acorns valuable wildlife food. Is a substitute for pin oak in many situations with less chance of becoming chlorotic on calcareous soils. Produces strong, hard wood used in flooring, furniture, veneer, and interior finishing. Rounded spreading crown. Reddish autumn color. Grows best in sun. Prefers fertile, moist soils, neutral to acidic. Drought tolerant. Height to 70 ft.
Oak, Pin (<i>Quercus palustris</i>)	QUPA2	N	L	H	SM GB	B	H	F	M	L	F	N	Native to the U.S. from eastern KS to the Atlantic coast and from TN to southern MI. Acorns valuable wildlife food. Grows naturally on poorly drained, claypan soils and withstands short periods of flooding. Iron chlorosis and growth stunting are problems if planted in calcareous soils. Prefers sun to partial shade, fertile, moist, neutral to acidic soils. Pyramidal crown. Variable autumn foliage from green to shades of yellow and red. Does not produce high quality lumber due to many small persistent branches. Height to 60 ft.
Oak, Swamp White (<i>Quercus bicolor</i>)	QUBI	N	M	H	SM GB	B	H	F	M	L	F	N	Occurs naturally in lowlands and swamp edges from IA to MO eastward to the Atlantic coast. Easily mistaken for bur oak or white oak due to leaf similarities. It has long and slender-stalked acorns similar to English oak. Prefers sun and moist, fertile, neutral to acidic soils. Tolerates compact soils high in clay. Rounded crown. Autumn foliage from subdued brownish yellows and reds, often persistent through winter. Acorns valuable wildlife food. Wood is heavy, strong, hard, moderately durable. Height to 60 ft.
Oak, White (<i>Quercus alba</i>)	QUAL	IV	M	L	SM GB	B	H	F	M	L	F, L	N	Native to southern MN, IA, south into eastern TX and all states to the east. Desirable windbreak tree in Zone IV because leaves tend to persist throughout winter. Round crown. Durable wine red autumn foliage. Acorns provide wildlife food. Prefers sun, fertile, moist, neutral to acidic soils. Can be found on upland sites within its native range. Drought tolerant. Height to 70 ft.
Osage-orange (<i>Maclura pomifera</i>)	MAPO	N	L	M	SB GB	B	M	Su/F	M	L	P, F	N	Extremely hard, durable wood for posts. Large 'hedge apple' fruit; seeds eaten by quail/squirrels. Not very winter hardy. Invasive into grasslands in southeast NE. Height to 40 ft.
Pawpaw (<i>Asimina Adans</i>)	ASIMI	IV	H	L	SM SB	F	L	Su	M	L	E2	N	Recommended only in southeast Nebraska. Potential medicinal use. Fruit can be consumed by humans. Height to 25 ft.

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Pear, Chinese (Harbin) <i>(Pyrus ussuriensis)</i> (recommended cultivar: McDermard)	PYUS2	N	L	L	SM SB	B	L	Su/F	M	L		N	Slow growth but well adapted to northern prairie climate. White flowers; reddish fall leaf color; round greenish-yellow to light brown fruit. Height to 30 ft.
Pecan, Northern <i>(Carya illinoensis)</i>	CAIL2	N	L	L	SM SB	B	H	F	M	L	L, E1, E2	N	Use northern seed source or hardy cultivars. Excellent nut species and valuable timber species. Suitable to southeast Nebraska (southern half of Veg. Zone 4 only). Height to 80 ft.
Redbud, Eastern <i>(Cercis canadensis)</i>	CECA4	IV	H	L	SB MB	F	M	F	L	L		N	Winter hardiness is questionable (seed source important). Susceptible to 2,4-D herbicide. Beautiful early spring flowers. Height to 30 ft.
Sycamore, American <i>(Platanus occidentalis)</i>	PLOC	IV	L	H	SB SM	C	L	N/A	M	L	B, L	N	Anthraxnose disease is a potential problem. Prefers deep, moist rich soils found in bottomlands. Height to 80 ft.
Walnut, Black <i>(Juglans nigra)</i>	JUNI	III, IV	L	L	SM	F	H	F	M	L	L, F, E2	N	Sensitive to broadleaf herbicides. Green husk on nut turning dark brown at maturity. Needs well-drained soils. Most valuable of timber trees. Height to 70 ft.
Willow, Black <i>(Salix nigra)</i>	SANI	III, IV	L	H	SB GB LM	B	H	F/W	M	L	B	N	Native only to extreme eastern Nebraska. Often confused with peachleaf willow. Short-lived species. Buds and twigs consumed by various wildlife species. Cytospora canker on upland sites. Height to 60 ft.
Willow, Peach Leaf <i>(Salix amygdaloides)</i>	SAAM2	I, II, III, IV	L	H	SB GB LM	B	H	F/W	M	L		N	Native across Nebraska - especially central and west. Similar to black willow but leaves are slightly wider and whitish on underside. Buds and twigs consumed by various wildlife species. Used by cavity nesting birds. Height up to 60 ft.
Willow, White (or Golden) <i>(Salix alba)</i> (Cultivars Vitellina or Tristis often called Golden Willow)	SAAL2	N	L	H	SB SM	C	L	N/A	M	L		N	Grows well in wet sites and may colonize naturally along streams and in wetlands. Tristis is the most hardy cultivar. Cytospora canker on upland sites. Height to 60 ft.

(1) **Shade Tolerance** - adaptation for underplantings (H = high, M = medium, L = low)

(2) **Flood Tolerance** - relative value in riparian locations (H = high tolerance of frequent Flood with poor drainage, M - medium tolerance to Flood and needs good drainage, L = low tolerance of Flood)

(3) **Wildlife Value - Use Groups:** SM = small mammals, LM = large mammals, SB = song birds, GB = game birds, MB = moths/butterflies; Function: F = food, C = cover, B = both; Rating: H = high value on a long-term use, M = high value on a seasonal basis, L = value on a limited, short-term basis; Season when food is available: Sp = Spring, Su = Summer, F = Fall, W = Winter

(4) **Windbreak Density** - Summer = comparable protection from wind; Winter = comparable protection from wind and snow drifting; H = high, M = medium, L = low

(5) **Products** - C = Christmas trees, P = posts, S = shavings, L = lumber, F = firewood, B = biomass, E1 = edible directly off the plant, E2 = edible if processed

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					Use Groups	Function	Rating	Season	Summer	Winter			
Antelope Bitterbrush (<i>Purshia tridentate</i>)	PUTR2	I	L	L	LM SM	B	H	F/W	M	L		N	Excellent big game browse species and small mammals eat seeds. Height to 3 ft.
Blackhaw, Rusty (<i>Viburnum rufidulum</i>)	VIRU	N	L	L	SB GB	B	H	F	H	M	E1	Y	Habit: shrub, tree, open, irregular, May blossoms, augumn fruits reddish, becoming black, sweet and edible. Drought tolerant in zone 5, pH 5.5-7.0. Use: wildlife habitat, windbreak. Height to 30 ft.
Buffaloberry, Silver (<i>Shepherdia argentea</i>)	SHAR	I, II, III	L	M	SB GB	B	H	F/W	H	M	E1, E2	Y	Thorny shrub with red-orange fruit. Cold and drought hardy. Minimum spacing 5x5; can be planted in coarse and medium soils. Height 10-12 ft.
Buttonbush (<i>Cephalanthus occidentalis</i>)	CEOC2	IV	L	H	GB	B	L	F	M	L		Y	Recommended only in southeast Nebraska. Seeds eaten by waterfowl. Prefers moist sites. Minimum spacing is 4x4; can be planted in coarse, medium and fine soils. Height 8-12 ft.
Cherry, Nanking (<i>Prunus tomentosa</i>)	PRTO80	N	L	L	SB SM	B	M	Su	M	L	E1, E2	N	Short-lived <10 years. Early fruit producer of sweet cherries. Minimum spacing 6x6; can be planted in coarse and medium soils. Height 5-7 ft.
Chokeberry, Black (<i>Aronia melanocarpa</i>)	PHME13	N	L	L	SB LM	B	H	F/W	M	L		Y	Blackish purple fruits persist into winter. Minimum spacing 4x4; can be planted in coarse, medium and fine soils. Height 3-8 ft
Chokecherry, Common (<i>Prunus virginiana</i>)	PRVI	I, II, III, IV	M	M	SB GB	B	H	Su	H	M	E1, E2	Y	Red fall leaf color. Small dark fruit is bitter without processing. Minimum spacing 4x4; can be planted in coarse, medium and fine soils. Height 8-14 ft.
Coralberry (<i>Symphoricarpos orbiculatus</i>)	SYOR	III, IV	M	M	SB SM	B	H	F/W	M	L		Y	Reddish-pink berries persist into winter. Height 3 ft.
Cotoneaster, Peking (<i>Cotoneaster acutifolia</i>)	COAC2	N	L	M	MB SB	B	M	F/W	H	M		N	Fire blight possible problem. Minimum spacing 5x5; can be planted in coarse, medium and fine soils. Height 5-10 ft.
Cranberry, American or Highbush (<i>Viburnum trilobum</i>)	VITR8	N	M	M	SB	B	M	F/W	H	M	E2	N	Bright red berries persist into winter. Makes ruby red jelly/jam. Minimum spacing 6x6; can be planted in coarse, medium and fine soils. Height 10-12 ft.
Currant, Buffalo (<i>Ribes odoratum</i>)	RIAUV	I, II, III, IV	M	L	SB SM	B	M	Su	H	M	E1, E2	Y	Adapted to a variety of sites. Minimum spacing 5x5; can be planted in medium soils. Height 4-6 ft.
Currant, Golden (<i>Ribes aureum</i>)	RIAU	I, II, III, IV	M	L	SB SM	B	M	Su	H	M	E1, E2	Y	Adapted to a variety of sites. Minimum spacing 5x5; can be planted in medium soils. Buffalo currant (<i>Ribes odoratum</i>) is a closely related species. Height 4-6 ft.
Dogwood, Gray (<i>Cornus racemosa</i>)	CORA6	III, IV	H	H	SB	B	H	Su/F	H	M		Y	Understory shrub that grows in full shade to sun. Suckers to form thickets. Minimum spacing 3x3; can be planted in coarse, medium and fine soils. understory shrub. Height 6-10 ft.
Dogwood, Redosier (<i>Cornus sericea</i>)	COSE16	I, II, III, IV	M	H	SB LM	B	H	F/W	M	L		Y	Red stems in winter. Good riparian buffer species. Provides browse for big game. Minimum spacing 4x4; can be planted in coarse, medium and fine soils. Height 8-10 ft.
Elderberry (<i>Sambucus canadensis</i>)	SANIC4	III, IV	L	H	MB SB	F	M	Su	H	M	E1, E2	Y	Prefers moist sites. Root sprouts readily; leaves and stems may be toxic. Minimum spacing 5x5; can be planted in medium soils. Height 4-8 ft.

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					Use Groups	Function	Rating	Season	Summer	Winter			
Euonymus, Winterberry (<i>Euonymus bungeanus</i>)	EUBU5	N	M	M	SB	B	L	F/W	M	L	E1	N	Large shrub-small tree form. Bright orange-red seeds in the fall. Cultivar released by Manhattan PMC. Height to 20 ft.
Hazelnut, American (<i>Corylus americana</i>)	COAM3	IV	M	M	SB SM	B	H	F	M	L	E1	Y	Susceptible to canker. Nuts enclosed in downy bracts. Minimum spacing 5x5; can be planted in medium and fine soils. Height 6-10 ft.
Indigo, Desert False (<i>Amorpha fruticosa</i>)	AMFR	II, III, IV	L	H	SB	C	L	N/A	M	L		Y	Legume with seed pod. Native along riparian areas and prefers moist soils. Minimum spacing 4x4; can be planted in coarse, medium and fine soils. Height 5-10 ft.
Juniper, Common (<i>Juniperus communis</i>)	JUCO6	I, II	M	L	SM SB	B	M	F/W	M	M		N	Evergreen shrub to small tree. Numerous varieties in several forms (prostrate to upright). Certain varieties subject to bagworms, cercospora. Available from Lawyer Nursery, MT (unknown variety or seed source). Height 3 to 15 ft.
Lilac (<i>Syringa vulgaris</i>)	SYVU	N	L	L	SB MB	B	M	Su	H	M		Y	Hardy shrub. Purple flowers result in persistent seed capsule. Powdery mildew a potential problem. Minimum spacing 6x6; can be planted in coarse, medium and fine soils. Height 6-10 ft.
Mahogany, Mountain (<i>Cercocarpus montanus</i>)	CEMOM4	I	L	L	LM	F	H	F/W	M	L		N	Excellent big game browse species. Plumose fruits persist into winter. Drought tolerant. Height 5-10 ft.
Nannyberry (<i>Viburnum lentago</i>)	VILE	III, IV	M	M	SB	B	H	Su	M	L		Y	Small tree or large shrub form. Good for wildlife habitat or windbreaks; drought tolerant; may be confused with Black Haw (<i>Viburnum rufidulum</i>). Height to 25 ft.
Peashrub, Siberian (<i>Caragana aborescens</i>)	CAAR18	N	L	L	SB	F	L	F	H	M	B	Y	Legume. Cold and drought hardy. Effective windbreak species. Readily defoliated by grasshoppers. Minimum spacing 5x5; can be planted in medium and fine soils. Height 8-12 ft.
Plum, American (<i>Prunus americana</i>)	PRAM	I, II, III, IV	M	M	GB SB	B	H	Su	H	M	E1, E2	Y	Medium pink-red fruits. Widely adapted. Suckers to make dense thickets. Minimum spacing for wildlife 2x2; can be planted in coarse and medium soils. Height 8-12 ft.
Rose, Arkansas (<i>Rosa arkansana</i>)	ROAR3	I, II, III, IV	L	L	GB SB	B	H	F/W	L	L	E2	Y	Also called prairie rose. Height to 2 ft.
Rose, Hansen Hedge (<i>Rosa sp.</i>); (<i>Rosa rugosa</i> x <i>R. woodsii</i>)	ROWOHH	N	L	L	SB MB	B	H	F/W	M	L		Y	Woods or Arkansas Rose preferred on unaltered habitats. Origin might be SDSU selection of <i>Rosa rugosa</i> x <i>Rosa woodsii</i> . Height to 6 ft.
Rose, Woods (<i>Rosa woodsii</i>)	ROWO	I, II, III	L	L	GB SB	B	H	F/W	M	L	E2	Y	Preferred winter food for prairie grouse. Available through some NRDs. Height to 5 ft.
Sagebrush, Big (<i>Artemisia tridentata</i>)	ARTR2	I	L	L	LM SM	B	H	F/W	M	L		N	Excellent big game browse species - maintains leaves in winter for high protein diet. Provides big game fawning habitat. Rodents eat seeds. Height 3-6 ft.
Sagebrush, Silver (<i>Artemisia cana</i>)	ARCA13	I	L	L	LM	B	H	F/W	M	L		N	Excellent big game browse species. Provides cover for big game fawning habitat. Height 2-5 ft.

Summary - List of Attributes by Species for Conservation Tree/Shrub Plantings in Nebraska

Shrubs	PLANTS Database Symbol	Native by Vegetative Zones I, II, III, or IV N = Not Native	Shade Tolerance (1)	Flood Tolerance (2)	Wildlife Value (3)				Windbreak Density (4)		Products (5)	Root Suckering (6) N = No, Y = Yes	Comments (7)
					Use Groups	Function	Rating	Season	Summer	Winter			
Saltbush, Fourwing (<i>Atriplex canescens</i>)	ATCA2	I	L	L	LM SM	B	M	F/W	M	L		N	Maintains leaves in winter. Seeds are persistent. Limit use to high pH and alkaline soils. Height to 2-5 ft.
Sandcherry, Western (<i>Prunus besseyi</i>)	PRPUB	I, II, III	L	L	GB SB SM	F	M	Su	M	L	E1, E2	Y	Early fruit producer of dark sweet cherries. Minimum spacing for wildlife 2x2; can be planted in coarse and medium soils. Height 4-6 ft.
Serviceberry, Saskatoon (<i>Amelanchier alnifolia</i>)	AMAL2	I, II, III	H	M	SB LM	B	H	Su	H	M	E1, E2	Y	Native to northern Nebraska. Produces near black, edible fruit. Minimum spacing 5x5; can be planted in coarse, medium, and fine soils. Height 6-12 ft.
Snowberry, Common (<i>Symphoricarpos albus</i>)	SYAL	III, IV	M	M	SB SM	B	H	F/W	M	L		Y	Whitish berries persist into winter. Western snowberry (<i>Symphoricarpos occidentalis</i>) is a very similar species native to Vegetative Zones I, II, III and IV. Used for windbreaks and wildlife habitat. Height 2-3 ft.
Snowberry, Western (<i>Symphoricarpos occidentalis</i>)	SYOC	I, II, III, IV	M	M	SB SM	B	H	F/W	M	L		Y	Potential to spread in rangeland. Whitish berries persist into winter. Common snowberry (<i>Symphoricarpos albus</i>) is a very similar species native to Vegetative Zones III and IV. Used for windbreaks and wildlife habitat. Height 2-3 ft.
Sumac, Skunkbush (<i>Rhus trilobata</i>) Recommended cultivars: Big horn, Konza fragrant	RHTR	I, II, III, IV	L	L	SM SB	B	M	F/W	M	L		N	Good red fall foliage. Leaves have pungent odor. Red fuzzy seed is persistent and not consumed widely by wildlife. Minimum spacing 4x4; can be planted in coarse and medium soils. Height 4-8 ft.
Willow, Sandbar (<i>Salix exigua</i>) Interior Rowlee	SAIN3	I, II, III, IV	M	H	LM SB	C	M	N/A	H	M	B	Y	Excellent riparian buffer species. Controls streambank erosion and provides wildlife cover. Height to 15 ft.

(1) **Shade Tolerance** - adaptation for underplantings (H = high, M = medium, L = low)

(2) **Flood Tolerance** - relative value in riparian locations (H = high tolerance of frequent Flood with poor drainage, M - medium tolerance to Flood and needs good drainage, L = low tolerance of Flood)

(3) **Wildlife Value - Use Groups:** SM = small mammals, LM = large mammals, SB = song birds, GB = game birds, MB = moths/butterflies; Function: F = food, C = cover, B = both; Rating: H = high value on a long-term use, M = high value on a seasonal basis, L = value on a limited, short-term basis; Season when food is available: Sp = Spring, Su = Summer, F = Fall, W = Winter, N/A = Not Applicable

(4) **Windbreak Density** - Summer = comparable protection from wind; Winter = comparable protection from wind and snow drifting; H = high, M = medium, L = low

(5) **Products** - C = Christmas trees, P = posts, S = shavings, L = lumber, F = firewood, B = biomass, E1 = edible directly off the plant, E2 = edible if processed

(6) **Root Suckering** - comparable aggressiveness to root sprout, N = No, Y = Yes

(7) **Comments** - check with your local forester or natural resource professional for other possible considerations

Primary References

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Exhibit 6-9: Colorado Windbreak Suitability Groups

COLORADO WINDBREAK SUITABILITY GROUPS

INTRODUCTION

Windbreak suitability groups are being developed to assist in selecting species best suited for the various soils and for predicting height growth and effectiveness. In this first stage, we have covered Land Resource Areas 67, 69, and 72.

All species of trees and shrubs have climatic and physiographic boundaries. On the eastern plains, this is very apparent, as we are introducing species that are not native to the environment.

The groups were developed by considering individual species performance under the following conditions: soil, climate, physiography, and management which includes species, spacing, and arrangement. They may be used to select species for a variety of purposes including: windbreaks, recreation, wildlife, ornamental, critical area, or reforestation plantings.

All soil series mapped have been placed in 10 groups of similar soils. Groups 1, 2, 4, 5, 6, and 9 have been divided into subgroups. Group 10 contains the soils with restrictive conditions that will require an on-site inspection to determine if a planting is feasible.

The tree or shrub heights listed in the tables show the expected height at 20 years after planting. This information should be used to determine placement of the windbreak, area of protection, and species arrangement.

WINDBREAK SUITABILITY GROUP - INDEX

Soil	Group or Subgroup
Absted	9N
Adena	3
Albinas	3
Alda	1
Alda (saline)	9G
Altvan	6G
Anselmo variant	9N
Apishapa	9G
Arvada	9N
Ascalon	3
Avar	9N

Baca (CL, SICL, VAR)	4C
Baca (L, SIL)	4L
Bainville	10
Bankard	IK
Bayard	5
Beckton	9N
Bernal	10
Bethune	4L
Bijou	5
Bijou (wet)	1
Blakeland	7
Bloom	9G
Boel	1
Bonaccord	4C
Bresser	3
Bridgeport	3
Briggsdale	6R
Buick	3
Bushman	5K

Cadoma	9N
Calkins	1
Campo	4C
Campus	8
Canyon	10
Caruso	1
Cascajo	10
Cass	1
Chappell	6G
Cheyenne	6G
Christianburg	4C
Colby	8
Colombo	8
Concordia	9N

Curabith	6G
Cushman	6R

Dacono	6G
Dailey	7
Dalhart	3
Dawes	4L
Deertrail	9N
Dioxice	8
Dix	10
Dunday	7
Dwyer	7
Dwyer variant	9G

Eastonville	5
Eckley	6G
Edgewater	1
Els	1
Elsmere	1
Epping	10
Escabosa	6R

Firstview	9N
Fondis	4C
Fort Collins	3

Gaynor	4C
Gaynor (gravelly)	4L
Gilcrest	5
Glenburg	IK
Glendive	IK
Goshen	1

Harbord	3
Harvey	5K
Harvey (dry)	8
Haverson	1
Haverson (saline)	9N
Haverson Family	1
Havre	IK
Haxtun	3
Hayford	9G
Heldt	4C
Heldt (SL)	4L
Heldt (alkaline plains, salt flats)	9N
Heldt (salt meadow)	9G
Hoehne	1

Ildefonso	5K
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Iliff	4L
Inavale	7
Ipage	1

Julesburg	5
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Keith	3
Keota	6R
Keyner	9N
Kim	8
Kimst	8
Kitcarson	1K
Koen	9N
Kornman	IK
Kuma	3
Kutch	4C

Laird	9N
Larimer	6G
Las	IK
Las Animas	9G
Las Animas (non-saline)	IK
Las Variant	2K
Lebsack	9N
Limon	9N
Limon (clayey plains)	4C
Limon (salt meadow)	10
Lincoln	1K
Lismas	10
Little	9N
Little (stoney)	10
Lohmiller	4C
Longmont	9G
Loup	2K
Loveland	IK

Manter	5
Manvel	8
Manzanola (CL)	4C
Manzanola (L, SICL)	4L
Manzanst	4C
McCook	1
McCook Variant	3
Midway	10
Minnequa	8
Mitchell	8
Mosher	9N

Neesapah	5K
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Nelson	6R
Nepesta	8
Neville	8
Nihill	10
Norka	3
Nucla	8
Numa	8
Nunn (L, LS, SL)	4L
Nunn (stoney)	10
Nunn (wet)	9N
Nunn variant	9N

Olnest	3
Olney	3
Ordway	9N
Orsa	6G
Osgood	7
Otero	5K

Paoli	5
Peetz	6G
Penrose	10
Platner	4L
Platte	1
Playas	10
Pleasant	10
Pleasant (L)	4C
Potter	10
Pultney	9N

Rago	4L
Rago (flooded)	4L
Razor	4C
Renohill	4L
Renohill (CL, STCL)	4C
Renohill (L, FSL, SL)	6R
Richfield	3
Rizozo	10
Rocky Ford	8
Rosebud	6R
Ryegate	6R

Sampson	3
Samsil	10
Satanta	3
Schamber	10
Shingle	10
Singerton	9N
Slickens	10

Stapleton	6R
Stoneham	3
Stoneham Variant	6R
Sundance	3

Table Mountain	3
Tassel	10
Terry	6R
Theodalund	6R
Tivoli	7
Travessilla	10
Treon	10
Tripp	3
Truckton	5
Tulloch	7
Tyrone	9N

UIm (CL, VAR)	4C
Uim (L, SL)	4L
Ulmet	4L
Ulysses	3

Valent	7
Valent (>9%)	10
Valentine	7
Valentine (>15%)	10
Valmont	4C
Valmont (>5%)	10
Vebar	7
Villegreen	6R
Vona	5

Wages	3
Wann	2K
Weld	4L
Westplain	9G
Wiley	8

Yoder	6G
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WINDBREAK SUITABILITY GROUPS

SOIL DESCRIPTION

GROUP

- 1** Loamy soils (<35% clay content) that are subject to frequent flooding or seasonal high water tables; in the upper 12 inches they lack free carbonates, have a pH less than 7.8 and are non-saline.
- 1K** Loamy soils (<35% clay content) that are subject to frequent flooding or seasonal high water table; in the upper 12 inches they have free carbonates, have a pH of 7.8 to 9.0, or have an electrical conductivity (EC) of less than 4 mmhos/cm
- 2K** Artificially drained phases of very poorly and poorly drained soils; in the upper 12 inches they have free carbonates, have a pH of 7.8 to 9.0 or have an EC of less than 4 mmhos/cm.
- 3** Moderately well and well drained loamy soils (<35% clay content) and clayey soils with a loamy surface mantle greater than 20 inches with high available water capacities (AWC 7.5"); in the upper 12 inches they lack free carbonates, have a pH less than 7.8 and are non-saline.
- 4C** Somewhat poorly, moderately well, and well drained soils with greater than 35% clay content throughout when mixed to 8 inches.
- 4L** Somewhat poorly, moderately well, and well drained clayey soils with a 4-to-6 inch loamy surface mantel.
- 5** Moderately well and well drained loamy and loamy-skeletal soils with moderate and moderately high available water capacities (AWC 3.75 to 7.5"); in the upper 12 inches they lack free-carbonates, have a pH less than 7.8, and are non-saline.
- 5K** Moderately well and well drained loamy and loamy-skeletal soils with moderate available water capacities (AWC 5.0 to 7.5"); in the upper 12 inches they have free carbonates, have a pH of 7.8 to 9.0, or have an EC of less than 4 mmhos/cm.
- 6** Deep, moderately well to excessively drained loamy-skeletal and sandy-skeletal soils with low available water capacities (AWC 2 to 3.75").
- 6G** Deep, moderately well to excessively drained loamy-skeletal and sandy-skeletal soils with low available water capacities (AWC 2 to 3.75"). Moderately deep soils over sand and/or gravel.
- 6R** Deep, moderately well to excessively drained loamy-skeletal and sandy-skeletal soils with low available water capacities (AWC 2 to 3.75"). Moderately deep soils with loamy surface over bedrock or a duripan.
- 7** Deep soils that are sandy throughout.
- 8** Moderately well and well drained loamy soils (<35% clay content) with high available water capacities (AWC >7.5"); in the upper 12 inches they have free carbonates, have a pH of 7.8 to 9.0 or have an EC of less than 4 mmhos/cm.
- 9G** Deep soils with a water table within 5 feet of the surface; some are subject to flooding or ponding; in the upper 12 inches they have a pH of greater than 7.8 and an EC of 4-16 mmhos/cm.
- 9N** Deep soils without a water table within 5 feet of the surface and are not subject to flooding or ponding; in the upper 12 inches they have a pH of greater than 7.8 and an EC of 4-16 mmhos/cm.

- 10** Very shallow and shallow soils; soils with a very low available water capacity (AWC <2"); very poorly and poorly drained soils that are saturated or ponded throughout the growing season; and toxic soils.

Windbreak Suitability Group 1

Description:

Loamy soils (<35% clay content) that are subject to frequent flooding or seasonal high water tables; in the upper 12 inches they lack free carbonates, have a pH less than 7.8 and are non-saline.

Limitations:

Spring planting may be delayed for a short period because of soil wetness.

Soils:

Alda	Goshen
Bijou (wet)	Haverson
Boel	Haverson Family
Calkins	Hoehne
Caruso	lpage
Edgewater	McCook
Els	Platte
Elsmere	

ADAPTED SPECIES FOR WINDBREAK GROUP 1

MEASURED OR ESTIMATED HEIGHT IN FEET AT AGE 20
BY MOISTURE (ANNUAL PRECIPITATION) SUBGROUP

COMMON NAME	12-15"	15-18"	18"+	PERM. IRRIGATED
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Evergreen Coniferous Trees:

Austrian pine	10	18	22	30
Blue spruce	14	18	20	29
Douglas-fir	10	12	16	27
Eastern redcedar	15	17	19	23
Pinyon pine				
Ponderosa pine	12	18	22	30
Rocky Mtn. Juniper	10	16	18	24
Scotch pine	10	16	20	30
White fir	10	12	16	27

Deciduous Trees:

Black Locust	10	15	24	32
Bur oak		12	16	30
Eastern cottonwood	25	30	36	55

Golden willow		15	22	34
Green ash	15	20	22	32
Hackberry	14	18	22	30
Honeylocust	8	15	23	36
Narrowleaf cottonwood				
Osage-orange		10	16	22
Plains cottonwood	25	30	36	55
Russian mulberry	10	12	15	30
Siberian elm	20	27	28	40

Shrubs:

American plum	7	8	9	12
Amur honeysuckle	3	5	8	11
Antelope bitterbrush				
Autumn olive	6	7	8	14
Basin big sagebrush				
Common chokecherry	7	8	8	14
Fourwing saltbush	4	5	5	8
Hansen rose	3	4	5	8
Lilac	5	7	7	10
Nanking cherry	4	6	7	11
Peking cotoneaster	4	5	7	10
Redosier dogwood	4	5	7	8
Rubber rabbitbrush				
Saskatoon serviceberry		5	6	9
Siberian peabush	7	8	11	15
Silver buffaloberry	7	8	10	12
Skunkbush sumac	5	6	8	10
Tatarian honeysuckle	5	7	8	11
Western sandcherry	3	4	4	4
Woods rose				

Windbreak Suitability Group IK

Description:

Loamy soils (<35% clay content) that are subject to frequent flooding or seasonal high water table; in the upper 12 inches they have free carbonates, have a pH of 7.8 to 9.0 or have an electrical conductivity (EC) of less than 4 mmhos/cm.

Limitations:

Spring planting may be delayed for a short period because of soil wetness. Free carbonates, high pH, and a slight EC affect the selection and growth of species.

Soils:

Bankard	Kornman
Glenburg	Las
Glendive	Las Animas (non-saline)
Havre	Lincoln
Kitcarson	Loveland

ADAPTED SPECIES FOR WINDBREAK GROUP 1K

MEASURED OR ESTIMATED HEIGHT IN FEET AT AGE 20
BY MOISTURE (ANNUAL PRECIPITATION) SUBGROUP

COMMON NAME	12-15"	15-18"	18"+	PERM. IRRIGATED
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Evergreen Coniferous Trees:

Austrian pine				
Blue spruce	13	17	19	27
Douglas-fir				
Eastern redcedar	15	17	19	23
Pinyon pine				
Ponderosa pine	15	18	20	28
Rocky Mtn. Juniper	10	16	18	22
Scotch pine				
White fir				

Deciduous Trees:

Black Locust	10	15	24	32
Bur oak		10	15	28
Eastern cottonwood				
Golden willow	15	20	26	34
Green ash	15	20	22	32
Hackberry	14	18	22	30
Honeylocust	14	17	21	30
Narrowleaf cottonwood				
Osage-orange	8	10	12	18
Plains cottonwood	26	30	32	48
Russian mulberry	10	13	18	30
Siberian elm	20	27	28	38

Shrubs:

American plum	6	7	7	12
Amur honeysuckle				
Antelope bitterbrush				
Autumn olive				
Basin big sagebrush				
Common chokecherry	7	8	8	12
Fourwing saltbush	4	5		
Hansen rose	3	4	5	6
Lilac	5	7	7	10
Nanking cherry	4	6	7	11
Peking cotoneaster	5	6	8	10
Redosier dogwood	4	5	6	7
Rubber rabbitbrush				
Saskatoon serviceberry	4	5	7	9

Siberian peabush	7	9	11	14
Silver buffaloberry	7	8	10	12
Skunkbush sumac	4	6	7	10
Tatarian honeysuckle	5	7	8	11
Western sandcherry	3	4	4	4
Woods rose				

Windbreak Suitability Group 2K

Description:

Artificially drained phases of very poorly and poorly drained soils; in the upper 12 inches they have free carbonates, have a pH of 7.8 to 9.0 or have an EC of less than 4 mmhos/cm.

Limitations:

Spring planting may be delayed because of wet conditions. The degree of wetness and drainage, the calcic horizon, and high pH affect selection of species.

Soils:

Las variant	Wann
Loup	

ADAPTED SPECIES FOR WINDBREAK GROUP 2K

MEASURED OR ESTIMATED HEIGHT IN FEET AT AGE 20
BY MOISTURE (ANNUAL PRECIPITATION) SUBGROUP

COMMON NAME	12-15"	15-18"	18"+	PERM. IRRIGATED
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Evergreen Coniferous Trees:

Austrian pine				
Blue spruce				
Douglas-fir				
Eastern redcedar	16	17	19	24
Pinyon pine				
Ponderosa pine	13	18	20	24
Rocky Mtn. Juniper	10	15	18	22
Scotch pine				
White fir				

Deciduous Trees:

Black Locust				
Bur oak		10	15	28
Eastern cottonwood		10	20	52
Golden willow	18	24	28	32
Green ash	14	18	22	30
Hackberry	14	18	22	28

Honeylocust	12	16	20	32
Narrowleaf cottonwood				
Osage-orange	8	10	14	22
Plains cottonwood				42
Russian mulberry	12	15	18	30
Siberian elm	20	27	28	40

Shrubs:

American plum	6	7	7	12
Amur honeysuckle				
Antelope bitterbrush				
Autumn olive				
Basin big sagebrush				
Common chokecherry	7	8	8	12
Fourwing saltbush	5			
Hansen rose				
Lilac	5	7	7	10
Nanking cherry	4	6	7	11
Peking cotoneaster	3	4	5	10
Redosier dogwood				8
Rubber rabbitbrush				
Saskatoon serviceberry				
Siberian peabush	5	7	7	10
Silver buffaloberry		8	10	11
Skunkbush sumac	4	6	7	10
Tatarian honeysuckle	5	7	8	11
Western sandcherry				
Woods rose				

Windbreak Suitability Group 3

Description:

Moderately well and well drained loamy soils (<35% clay content) and clayey soils with a loamy surface mantle greater than 20 inches with high available water capacities (AWC 7.5"); in the upper 12 inches they lack free carbonates, have a pH less than 7.8, and are non-saline.

Limitations:

Water erosion is a hazard on sloping areas.

Soils:

Adena	Norka
Albinas	Olnest
Ascalon	Olney
Bresser	Richfield
Bridgeport	Sampson
Buick	Satanta
Delhart	Stoneham
Fort Collins	Sundance

Harbord	Table Mountain
Haxtun	Tripp
Keith	Ulysses
Kuma	Wages
McCook variant	

ADAPTED SPECIES FOR WINDBREAK GROUP 3

MEASURED OR ESTIMATED HEIGHT IN FEET AT AGE 20
BY MOISTURE (ANNUAL PRECIPITATION) SUBGROUP

COMMON NAME	12-15"	15-18"	18"+	PERM. IRRIGATED
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Evergreen Coniferous Trees:

Austrian pine	12	15	19	32
Blue spruce	15	16	18	26
Douglas-fir	10	12	15	31
Eastern redcedar	10	14	16	24
Pinyon pine	9	10	12	16
Ponderosa pine	12	16	19	32
Rocky Mtn. juniper	9	10	13	22
Scotch pine	14	16	17	34
White fir	10	12	15	26

Deciduous Trees:

Black Locust	10	15	22	23
Bur oak	10	15	18	35
Eastern cottonwood				40
Golden willow		15	22	32
Green ash	12	16	18	30
Hackberry	12	15	18	32
Honeylocust	10	15	22	30
Narrowleaf cottonwood				40
Osage-orange	10	15	18	25
Plains cottonwood				40
Russian mulberry	10	12	15	30
Siberian elm	20	26	29	42

Shrubs:

American plum		7	8	12
Amur honeysuckle	6	6	7	12
Antelope bitterbrush				
Autumn olive		7	9	16
Basin big sagebrush				
Common chokecherry	7	8	8	11
Fourwing saltbush	5			
Hansen rose	4	5	6	8

Lilac	5	7	7	10
Nanking cherry	4	5	6	9
Peking cotoneaster	4	5	7	10
Redosier dogwood			7	9
Rubber rabbitbrush				
Saskatoon serv,iceberry		4	5	6
Siberian peabush	8	8	9	12
Silver buffaloberry		7	8	11
Skunkbush sumac	4	5	7	9
Tatarian honeysuckle	5	7	8	11
Western sandcherry	3	4	4	4
Woods rose				

Windbreak suitability Group 4C

Description:

Somewhat poorly, moderately well, and well drained soils with greater than 35% clay content throughout when mixed to 8 inches.

Limitations:

High clay content affects selection and growth of species. Extra care is required to insure the soil is firmly packed around the roots during planting. Drought tolerant species should be used.

Soils:

Baca (CL, SICL, VAR)	Lohmiller
Bonaccord	Manzanola (CL)
Campo	Manzanst
Christianburg	Nunn (CL)
Fondis	Pleasant (L)
Gaynor	Razor
Heldt	Renohill (CL, SICL)
Kutch	Ulm (CL, VAR)
Limon (clayey plains)	Valmont

ADAPTED SPECIES FOR WINDBREAK GROUP 4C

MEASURED OR ESTIMATED HEIGHT IN FEET AT AGE 20
BY MOISTURE (ANNUAL PRECIPITATION) SUBGROUP

COMMON NAME	12-15"	15-18"	18"+	PERM. IRRIGATED
Evergreen Coniferous Trees:				
Austrian pine		10	16	22
Blue spruce				20

Douglas-fir				
Eastern redcedar	8	11	13	20
Pinyon pine				
Ponderosa pine	10	12	14	23
Rocky Mtn. Juniper	9	10	12	20
Scotch pine				21
white fir	10	12	15	26

Deciduous Trees:

Black Locust	11	13	15	25
Bur oak				
Eastern cottonwood				
Golden willow				32
Green ash	10	12	14	27
Hackberry	10	12	14	26
Honeylocust	13	14	15	25
Narrowleaf cottonwood				
Osage-orange		10	15	20
Plains cottonwood				45
Russian mulberry		10	14	22
Siberian elm	19	21	24	35

Shrubs:

American plum	5	6	7	10
Amur honeysuckle		4	6	9
Antelope bitterbrush				
Autumn olive		6	7	12
Basin big sagebrush				
Common chokecherry	7	8	8	10
Fourwing saltbush	4			
Hansen rose		3	4	7
Lilac	5	5	6	9
Nanking cherry	4	5	6	9
Peking cotoneaster	3	4	5	8
Redosier dogwood				9
Rubber rabbitbrush				
Saskatoon serviceberry			4	6
Siberian peabush	4	5	6	10
Silver buffaloberry		5	6	10
Skunkbush sumac	4	5	7	10
Tatarian honeysuckle	5	6	7	10
Western sandcherry		2	3	5
Woods rose				

Windbreak suitability Group 4L

Description:

Somewhat poorly, moderately well, and well drained clayey soils with a 4-6 inch loamy surface mantle.

Limitations:

High clay content below the surface mantle affects the selection and growth of species, due to slow water intake and the potential for frost heaving.

Soils:

Baca (L, SL)	Nunn (L, LS, SL)
Bethune	Platner
Daws	Rago
Gaynor (gravelly)	Renohill
Heldt (SL)	Ulm (L, SL)
Iliff	Ulmet
Manzanola (L, SICL)	

ADAPTED SPECIES FOR WINDBREAK GROUP 4L

MEASURED OR ESTIMATED HEIGHT IN FEET AT AGE 20
BY MOISTURE (ANNUAL PRECIPITATION) SUBGROUP

COMMON NAME	12-15"	15-18"	18"+	PERM. IRRIGATED
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Evergreen Coniferous Trees:

Austrian pine		15	18	26
Blue spruce			16	24
Douglas-fir		12	16	23
Eastern redcedar	10	12	14	21
Pinyon pine		8	10	14
Ponderosa pine	12	15	17	26
Rocky Mtn. Juniper	9	11	13	21
Scotch pine			15	24
White fir		12	16	21

Deciduous Trees:

Black Locust		16	20	28
Bur oak		12	15	20
Eastern cottonwood				
Golden willow				32
Green ash	13	15	17	30
Hackberry	12	14	16	28
Honeylocust	12	15	18	28
Narrowleaf cottonwood				
Osage-orange	10	14	17	22
Plains cottonwood				43
Russian mulberry	10	12	15	23
Siberian elm	19	24	26	36

Shrubs:

American plum		7	7	12
Amur honeysuckle	5	6	7	11

Antelope bitterbrush				
Autumn olive	6	8	10	14
Basin big sagebrush				
Common chokecherry	7	8	8	12
Fourwing saltbush	3	3	3	4
Hansen rose	4	5	7	9
Lilac	5	7	7	10
Nanking cherry	3	4	5	8
Peking cotoneaster	3	4	5	8
Redosier dogwood			6	9
Rubber rabbitbrush				
Saskatoon serviceberry			4	6
Siberian peabush	5	7	7	10
Silver buffaloberry		8	10	11
Skunkbush sumac	4	6	7	10
Tatarian honeysuckle	5	7	8	11
Western sandcherry	2	3	4	4
Woods rose				

Windbreak suitability Group 5

Description:

Moderately well and well drained loamy and loamy-skeletal soils with moderate and moderately high available water capacities (AWC 3.75 to 7.5"); in the upper 12 inches they lack free carbonates, have a pH less than 7.8, and are non-saline.

Limitations:

Moderate to moderately high AWC can affect selection and growth of planted material.

Soils:

Bayard	Manter
Bijou	Paoli
Eastonville	Truckton
Gilcrest	Vona
Julesburg	

ADAPTED SPECIES FOR WINDBREAK GROUP 5

MEASURED OR ESTIMATED HEIGHT IN FEET AT AGE 20
BY MOISTURE (ANNUAL PRECIPITATION) SUBGROUP

COMMON NAME	12-15"	15-18"	18"+	PERM. IRRIGATED
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Evergreen Coniferous Trees:

Austrian pine	12	15	20	31
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Blue spruce		12	18	24
Douglas-fir	10	12	18	23
Eastern redcedar	10	12	16	24
Pinyon pine	8	10	12	16
Ponderosa pine	12	17	20	32
Rocky Mtn. juniper	9	11	15	21
Scotch pine		14	19	31
white fir		12	17	26

Deciduous Trees:

Black Locust	13	18	22	33
Bur oak	10	15	17	35
Eastern cottonwood				42
Golden willow			19	34
Green ash	12	16	18	32
Hackberry	11	16	18	30
Honeylocust	13	16	20	34
Narrowleaf cottonwood				42
Osage-orange	10	15	20	25
Plains cottonwood				47
Russian mulberry		12	15	24
Siberian elm	20	24	26	44

Shrubs:

American plum	6	7	7	10
Amur honeysuckle	6	8	9	12
Antelope bitterbrush				
Autumn olive				14
Basin big sagebrush				
Common chokecherry	7	8	8	11
Fourwing saltbush				
Hansen rose	5	6	7	11
Lilac	5	6	7	12
Nanking cherry		5	6	11
Peking cotoneaster	3	4	6	9
Redosier dogwood			6	9
Rubber rabbitbrush				
Saskatoon serviceberry			4	6
Siberian peabtrsh	5	7	7	12
Silver buffaloberry		7	8	11
Skunkbush sumac	4	5	6	10
Tatarian honeysuckle	5	7	8	11
Western sandcherry	3	3	4	7
Woods rose				

Windbreak suitability Group 5K

Description:

Moderately well and well drained loamy and loamy-skeletal soils with moderate available water capacities (AWC 5.0 to 7.5"); in the upper 12 inches they have free carbonates, have a pH of 7.8 to 9.0, or have an EC of less than 4 mmhos/cm.

Limitations:

The calcic horizon and high pH in the upper 18 inches and the skeletal soils affect selection of species.

Soils:

Bushman	Neespah
Harvey	Otero
Ildefonso	

ADAPTED SPECIES FOR WINDBREAK GROUP 5K

MEASURED OR ESTIMATED HEIGHT IN FEET AT AGE 20
BY MOISTURE (ANNUAL PRECIPITATION) SUBGROUP

COMMON NAME	12-15"	15-18"	18"+	PERM. IRRIGATED
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Evergreen Coniferous Trees:

Austrian pine				
Blue spruce				26
Douglas-fir				26
Eastern redcedar	8	10	12	23
Pinyon pine	8	10	11	17
Ponderosa pine	10	12	14	35
Rocky Mtn. Juniper	8	10	12	23
Scotch pine				
White fir				

Deciduous Trees:

Black Locust				
Bur oak				
Eastern cottonwood				
Golden willow				
Green ash	10	12	14	30
Hackberry			12	25
Honeylocust	12	14	17	29
Narrowleaf cottonwood				42
Osage-orange	14	17	20	35
Plains cottonwood				44
Russian mulberry				
Siberian elm	16	20	23	40

Shrubs:

American plum	6	7	8	11
Amur honeysuckle	7	7	8	13
Antelope bitterbrush				
Autumn olive	5	6	7	11
Basin big sagebrush	4			
Common chokecherry	5	6	7	9
Fourwing saltbush	4	3		
Hansen rose	5	6	8	11
Lilac	5	6	7	13
Nanking cherry		5	6	8
Peking cotoneaster				
Redosier dogwood	6	6	6	12
Rubber rabbitbrush	4			
Saskatoon serviceberry			4	6
Siberian peabush	6	7	9	15
Silver buffaloberry	5	7	8	12
Skunkbush sumac	5	6	7	10
Tatarian honeysuckle	5	7	9	12
Western sandcherry				
Woods rose				

Windbreak Suitability Group 6G

Description:

Deep, moderately well to excessively drained loamy-skeletal and sandy-skeletal soils with low available water capacities (AWC 2 to 3.75"). Moderately deep soils over and and/or gravel.

Limitations:

Field windbreaks are generally not recommended. Drought tolerance will need to be considered in species selection.

Soils:

Altvan	Eckley
Cass	Larimer
Chappell	Orsa
Curabith	Peetz
Dacono	Yoder

ADAPTED SPECIES FOR WINDBREAK GROUP 6G

MEASURED OR ESTIMATED HEIGHT IN FEET AT AGE 20
BY MOISTURE (ANNUAL PRECIPITATION) SUBGROUP

COMMON NAME	12-15"	15-18"	18"+	PERM. IRRIGATED
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Evergreen Coniferous Trees:

Austrian pine		12	14	26
Blue spruce				20
Douglas-fir				
Eastern redcedar	8	10	12	18
Pinyon pine				
Ponderosa pine	12	14	16	26
Rocky Mtn. Juniper	8	10	12	18
Scotch pine	12	14	16	24
White fir				

Deciduous Trees:

Black Locust		11	15	25
Bur oak				22
Eastern cottonwood				
Golden willow				
Green ash		12	14	26
Hackberry		12	13	24
Honeylocust		13	16	26
Narrowleaf cottonwood				42
Osage-orange				
Plains cottonwood				35
Russian mulberry		11	14	20
Siberian elm	16	20	24	30

Shrubs:

American plum			6	11
Amur honeysuckle		5	7	9
Antelope bitterbrush	4			
Autumn olive				
Basin big sagebrush	5			
Common chokecherry		6	8	12
Fourwing saltbush	4			
Hansen rose	3	4	5	11
Lilac		4	6	8
Nanking cherry			4	7
Peking cotoneaster		4	5	8
Redosier dogwood				8
Rubber rabbitbrush	4			
Saskatoon serviceberry			4	6
Siberian peabush	5	6	7	8
Silver buffaloberry		5	7	9
Skunkbush sumac		4	6	6
Tatarian honeysuckle	5	6	7	10
Western sandcherry		3	4	6
Woods rose				

Windbreak Suitability Group 6R

Description:

Deep, moderately well to excessively drained loamy-skeletal and sandy-skeletal soils with low available water capacities (AWC 2 to 3.75"). Moderately deep soils with loamy surface over bedrock or a duripan.

Field windbreaks are generally not recommended. Drought tolerance will need to be considered in species selection. When the soil is saturated, a perched water table can occur.

Soils:

Briggsdale	Ryegate
Cushman	Stapleton
Escabosa	Stoneham Variant
Keota	Terry
Nelson	Thedalund
Renohill (L, FSL, SL)	Villegreen
Rosebud	

ADAPTED SPECIES FOR WINDBREAK GROUP 6R

MEASURED OR ESTIMATED HEIGHT IN FEET AT AGE 20
BY MOISTURE (ANNUAL PRECIPITATION) SUBGROUP

COMMON NAME	12-15"	15-18"	18"+	PERM. IRRIGATED
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Evergreen Coniferous Trees:

Austrian pine	10	14	16	26
Blue spruce				24
Douglas-fir				
Eastern redcedar	8	11	13	20
Pinyon pine	8	9	10	12
Ponderosa pine	12	17	19	26
Rocky Mtn. Juniper	9	11	13	19
Scotch pine		12	15	22
White fir				

Deciduous Trees:

Black Locust		11	15	25
Bur oak				22
Eastern cottonwood				
Golden willow				30
Green ash	11	13	15	26
Hackberry		12	14	24
Honeylocust		16	18	26
Narrowleaf cottonwood				
Osage-orange		12	16	20

Plains cottonwood				35
Russian mulberry		11	15	22
Siberian elm	19	22	25	31

Shrubs:

American plum			6	11
Amur honeysuckle		5	7	10
Antelope bitterbrush	3	4		
Autumn olive				
Basin big sagebrush	4	5		
Common chokecherry		6	8	12
Fourwing saltbush				
Hansen rose	3	4	5	7
Lilac		5	6	8
Nanking cherry		4	6	9
Peking cotoneaster		5	6	8
Redosier dogwood			5	8
Rubber rabbitbrush	4			
Saskatoon serviceberry				6
Siberian peabush	5	7	7	10
Silver buffaloberry		7	8	10
Skunkbush sumac	4	5	6	7
Tatarian honeysuckle	5	7	8	10
Western sandcherry	2	3		
Woods rose				

Windbreak Suitability Group 7

Description:

Deep soils that are sandy throughout.

Limitations:

Drought conditions and soil blowing are the principal concerns in the selection and growth of plants. The sandy soil requires specialized site preparation and planting methods to insure establishment. Optimum growth and survival are not expected unless the plantings are irrigated.

Soils:

Blakeland	Tivoli
Dailey	Tulloch
Dunday	Valent
Dwyer	Valentine
Inavale	Vebar
Osgood	

ADAPTED SPECIES FOR WINDBREAK GROUP 7

MEASURED OR ESTIMATED HEIGHT IN FEET AT AGE 20
BY MOISTURE (ANNUAL PRECIPITATION) SUBGROUP

COMMON NAME	12-15"	15-18"	18"+	PERM. IRRIGATED
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Evergreen Coniferous Trees:

Austrian pine	10	12	14	24
Blue spruce				22
Douglas-fir				
Eastern redcedar	8	9	11	20
Pinyon pine	6	8	9	12
Ponderosa pine	10	12	14	23
Rocky Mtn. Juniper	7	9	11	17
Scotch pine		12	13	22
White fir				

Deciduous Trees:

Black Locust		6	8	19
Bur oak				
Eastern cottonwood				
Golden willow				
Green ash		12	14	30
Hackberry			13	29
Honeylocust		12	15	33
Narrowleaf cottonwood				
Osage-orange		8	10	17
Plains cottonwood				37
Russian mulberry				
Siberian elm		16	19	35

Shrubs:

American plum			6	13
Amur honeysuckle			7	12
Antelope bitterbrush				
Autumn olive				
Basin big sagebrush				
Common chokecherry			8	10
Fourwing saltbush		5		
Hansen rose	3	4	5	8
Lilac		4	6	11
Nanking cherry		5	6	10
Peking cotoneaster			5	11
Redosier dogwood				8
Rubber rabbitbrush	3	4		
Saskatoon serviceberry				5
Siberian peabush	5	6	8	15
Silver buffaloberry				10
Skunkbush sumac				
Tatarian honeysuckle		5	6	12
Western sandcherry		3	4	4

Woods rose	3	4		
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Windbreak suitability Group 8

Description:

Moderately well and well drained loamy soils (<35% clay content) with high available water capacities (AWC > 7.5"); in the upper 12 inches they have free carbonates, have a pH of 7.8 to 9.0, or have an EC of less than 4 mmhos/cm.

Limitations:

Free carbonates and a high pH affect the selection and growth of trees and shrubs.

Soils:

Campus	Minnequa
Colby	Mitchell
Colombo	Nepesta
Dioxice	Neville
Harvey (dry)	Nula
Kim	Numa
Kimst	Rocky Ford
Manvel	Wiley

ADAPTED SPECIES FOR WINDBREAK GROUP 8

MEASURED OR ESTIMATED HEIGHT IN FEET AT AGE 20
BY MOISTURE (ANNUAL PRECIPITATION) SUBGROUP

COMMON NAME	12-15"	15-18"	18"+	PERM. IRRIGATED
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Evergreen Coniferous Trees:

Austrian pine				24
Blue spruce				
Douglas-fir				
Eastern redcedar	9	10	12	20
Pinyon pine	8	9	11	15
Ponderosa pine	12	14	16	28
Rocky Mtn. Juniper	8	10	12	20
Scotch pine			13	22
White fir				

Deciduous Trees:

Black Locust		13	16	25
Bur oak	15	17	19	24
Eastern cottonwood				
Golden willow				
Green ash	11	13	14	28

Hackberry		12	15	26
Honeylocust		13	15	28
Narrowleaf cottonwood				
Osage-orange		10	16	22
Plains cottonwood				42
Russian mulberry				
Siberian elm	16	20	23	32

Shrubs:

American plum			8	11
Amur honeysuckle		3	5	8
Antelope bitterbrush				
Autumn olive				
Basin big sagebrush	4			
Common chokecherry		6	9	12
Fourwing saltbush				
Hansen rose		4	5	8
Lilac	5	6	7	9
Nanking cherry				
Peking cotoneaster				
Redosier dogwood				
Rubber rabbitbrush				
Saskatoon serviceberry				
Siberian peabush	5	6	7	10
Silver buffaloberry	4	5	7	11
Skunkbush sumac	5	6	7	10
Tatarian honeysuckle	5	6	8	11
Western sandcherry				
Woods rose				

Windbreak suitability Group 9G

Description:

Deep soils with a water table within 5 feet of the surface; some are subject to flooding or ponding; in the upper 12 inches they have a pH of greater than 7.8 and an EC of 4-16 mmhos/cm.

Limitations:

High pH and concentrations of salt are the primary hazards and will affect the selection and growth of trees and shrubs. Spring planting may be delayed because of soil wetness.

Soils:

Alda (saline)	Heldt (salt meadow)
Apishapa	Las Animas
Bloom	Longmont
Dwyer variant	Westplain
Hayford	

ADAPTED SPECIES FOR WINDBREAK GROUP 9G

MEASURED OR ESTIMATED HEIGHT IN FEET AT AGE 20
BY MOISTURE (ANNUAL PRECIPITATION) SUBGROUP

COMMON NAME	12-15"	15-18"	18"+	PERM. IRRIGATED
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Evergreen Coniferous Trees:

Austrian pine				
Blue spruce				
Douglas-fir				
Eastern redcedar		10	12	23
Pinyon pine				
Ponderosa pine				
Rocky Mtn. Juniper	8	10	12	22
Scotch pine				
White fir				

Deciduous Trees:

Black Locust				
Bur oak				
Eastern cottonwood				
Golden willow	15	19	12	30
Green ash	12	16	18	26
Hackberry				
Honeylocust	15	17	19	26
Narrowleaf cottonwood	10	15	22	35
Osage-orange				
Plains cottonwood	15	22	30	40
Russian mulberry				
Siberian elm	18	22	25	31

Shrubs:

American plum				
Amur honeysuckle				
Antelope bitterbrush				
Autumn olive				
Basin big sagebrush				
Common chokecherry				
Fourwing saltbush	5	6		
Hansen rose				
Lilac	5	6	7	9
Nanking cherry				
Peking cotoneaster				
Redosier dogwood				
Rubber rabbitbrush	4			
Saskatoon serviceberry				

Siberian peabush	6	7	9	12
Silver buffaloberry		8	9	10
Skunkbush sumac	4	6	7	10
Tatarian honeysuckle	5	7	8	10
Western sandcherry				
Woods rose				

Windbreak Suitability Group 9N

Description:

Deep soils without a water table within 5 feet of the surface and are not subject to flooding or ponding; in the upper 12 inches they have a pH of greater than 7.8 and an EC of 4-16 mmhos/cm.

Limitations:

High pH and concentrations of salt are the primary hazards and will affect the selection and growth of trees and shrubs.

Soils:

Absted	Koen
Anselmo variant	Laird
Arvada	Lebsack
Avar	Limon
Beckton	Litte
Cadoma	Mosher
Concordia	Nunn (wet)
Deertrail	Nunn variant
Firstview	Ordway
Haverson (saline)	Pultney
Heldt (alkaline plains, salt flats)	Singerton
Keynor	Tyrone

ADAPTED SPECIES FOR WINDBREAK GROUP 9N

MEASURED OR ESTIMATED HEIGHT IN FEET AT AGE 20
BY MOISTURE (ANNUAL PRECIPITATION) SUBGROUP

COMMON NAME	12-15"	15-18"	18"+	PERM. IRRIGATED
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Evergreen Coniferous Trees:

Austrian pine				
Blue spruce				
Douglas-fir				
Eastern redcedar	7	8	9	18
Pinyon pine				
Ponderosa pine	10	11	13	22

Rocky Mtn. Juniper	6	7	8	15
Scotch pine				
White fir				

Deciduous Trees:

Black Locust				
Bur oak				
Eastern cottonwood				
Golden willow				
Green ash	11	13	14	28
Hackberry				
Honeylocust				
Narrowleaf cottonwood				
Osage-orange				
Plains cottonwood				
Russian mulberry				
Siberian elm	11	13	17	30

Shrubs:

American plum				
Amur honeysuckle				
Antelope bitterbrush				
Autumn olive				
Basin big sagebrush				
Common chokecherry				
Fourwing saltbush	4			
Hansen rose				
Lilac		5	6	9
Nanking cherry				
Peking cotoneaster				
Redosier dogwood				
Rubber rabbitbrush				
Saskatoon serviceberry				
Siberian peabush	5	6	7	11
Silver buffaloberry		5	7	10
Skunkbush sumac	4	5	6	10
Tatarian honeysuckle	4	5	7	10
Western sandcherry				
Woods rose				

Windbreak suitability Group 10

Description:

Very shallow and shallow soils; soils with a very low available water capacity (AWC <2"); very poorly and poorly drained soils that are saturated or ponded throughout the growing season; and toxic soils.

Limitations:

Soils in this group are generally unsuited for windbreaks. On-site investigations should be carried out to determine if special treatments tailored to the existing soil conditions would allow plantings to survive. The selection of species must be tailored to the soil conditions existing at each site.

Soils:

Bainville	Pleasant
Bernal	Potter
Canyon	Rizozo
Casajo	Samsil
Dix	Schamber
Epping	Shingle
Limon (salt meadow)	Slickens
Lismas	Tassel
Little (stoney)	Travessilla
Midway	Treon
Nihill	Valent (>9%)
Nunn (stoney)	Valentine (>15%)
Penrose	Valmont (>5%)
Playas	

Exhibit 6-10: North Dakota NRCS Specification for Renovation of Windbreaks

CONSERVATION PRACTICE SPECIFICATION

Windbreak/Shelterbelt Renovation – 650

When properly applied, windbreak renovation can:

- Restore the function of an existing windbreak
- Modify the function of an existing windbreak
- Increase the health and vigor of selected windbreak plants
- Increase the longevity of a windbreak

Depending upon the renovation method chosen, some or all of the following practice standards or technical documents may be required when developing a windbreak/shelterbelt renovation plan.

- County-specific windbreak suitability groups for each soil type are found in county specific Interpretive Tables in FOTG – Section II – Soil Information.
- "Tree Care and Management" is found in FOTG – Section I – Reference Subjects – Windbreaks and Woodland.
- "Expected 20-Tree Heights" by Windbreak Suitability Groups is found in FOTG – Section II – Windbreaks and Forest.
- "Tree and Shrub Characteristics" is found in FOTG – Section I – Reference Subjects – Windbreaks and Woodland.
- "Tree/Shrub Pruning – 660." All conservation practices are located in FOTG – Section IV – Conservation Practices.
- "Windbreak/Shelterbelt Establishment – 380."

Caution: Several windbreak renovation methods involve substantial soil disturbance at depths below typical agricultural tillage. If the depth of disturbance will exceed 18 inches, notification of various utility companies via the North Dakota One Call System at 1-800-795-0555 is required.

Several of the windbreak renovation methods are considered undertakings per Section 106 of the Federal Historic Preservation Act and will need to be investigated and assessed accordingly.

Detailed purposes, descriptions and techniques for each renovation method are described below. Following the windbreak renovation descriptions and techniques is a symptom key that can be used to determine which renovation method may be most applicable for a particular windbreak.

Windbreak Renovation Purposes

Coppicing can be used to:

Increase windbreak density or hasten within-row closure on newly established shrub rows.
Rejuvenate broken-down shrubs that have become "leggy" but retain a healthy root system.
Rejuvenate many species of deciduous trees that are experiencing top dieback but still have a healthy root system.

Gap Planting can be used to:

Restore windbreak function or effectiveness.

Natural regeneration can be used to:

- Maintain age and species diversity.
- Maintain or improve windbreak densities.
- Maintain or improve windbreaks for wildlife.

Pruning can be used to:

- Reduce the density of a windbreak.
- Correct improper branching on newly planted stock.
- Correct storm, animal, or agricultural damage to trees or shrubs.
- Provide agroforestry products.

Root pruning can be used to:

- Reduce windbreak competition to crops immediately adjacent to the windbreak.
- Provide a temporary zone of reduced competition for replacement trees within or adjacent to an existing windbreak.

Row removal and replacement can be used to:

- Remove dead and dying tree and shrub rows.
- Provide a site for replacement plantings within an existing windbreak.
- Remove part of an even-aged planting to allow for a diversity of age classes.
- Provide agroforestry products.
- Alter windbreak composition or density.

Shearing can be used to:

- Increase windbreak density.
- Reduce spread or extent of the windbreak.
- Shape the windbreak to meet a specific objective.
- Shape conifers for Christmas trees (agroforestry products).

Sod release and management can be used to:

- Release trees and shrubs from herbaceous competition.
- Extend the life of the windbreak.
- Prepare the site for other renovation methods.

Supplemental planting (intra-planting) can be used to:

- Improve windbreak density.
- Improve species and age class diversity.
- Improve wildlife habitat.
- Expand a windbreak.

Thinning can be used to:

- Alter windbreak density.
- Reduce competition to adjacent trees.
- Provide agroforestry products.
- Manage snow moisture more effectively.

Underplanting (interplanting) can be used to:

- Increase species diversity.
- Increase windbreak density, especially lower densities.
- Improve windbreak characteristics without expanding windbreak acreage.

Windbreak Renovation Descriptions and Techniques

Renovation recommendations will be site-specific to match landowner objectives, site potential, and the composition and condition of the existing windbreak. Some renovation methods may

only need to be applied on an infrequent basis, while others will need regular repetition in order to maximize the benefits.

Coppicing

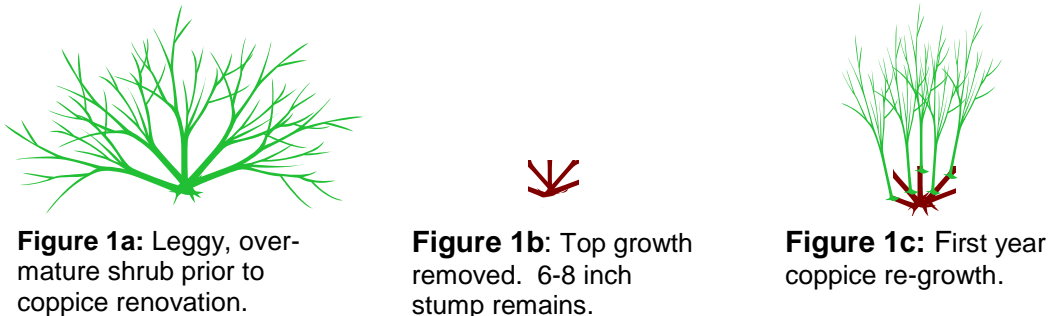
Coppicing is the removal of the top growth on deciduous trees and shrubs in order that the root systems can initiate healthy vigorous sprouting to improve or restore the function of the windbreak. This technique is applicable to most deciduous shrubs and many of the deciduous trees. Care must be taken to prevent injury to stem, root collars and roots. Cuts should be clean with no ragged ends. Bark of the residual stumps should not be damaged or stripped. Do not use rotary mowers, as they do not produce a clean, non-torn cut. The clipping operation should be done in mid to late winter before any leaf emergence.

For newly planted shrubs, 1-2 years old, existing above-ground stems may be cut off at a 6-8 inch height. This will encourage faster row closure and increased density within the planting. A wide variety of tools can be used to cut off above-ground stems including; sickle bar mowers, hedge clippers, etc.

For older shrub rows, coppicing is an effective way to remove the old, "leggy" material that has lost its windbreak effectiveness. The most commonly used tools to remove older stems are chain saws and power pole pruners. When working on larger shrubs try to leave 6-8 inch stumps above the root collar.

For most shrubs with healthy root systems, re-growth the first year will often reach 30-50% of the pre-cut height.

Figure 1 illustrates 3 different phases of a coppiced shrub renovation.



Successful coppicing of older shrubs is dependent upon the shrubs having a reasonably healthy root system. Shrub rows with many gaps, evidence of diseases, and exhibiting minimal annual growth for the past several years may not be suitable candidates for coppice renovation. In these situations coppicing, if used, will need to be supplemented with new plantings.

When using pole pruners or chainsaws, be sure to understand the safe operation requirements of these tools. Wear proper safety equipment. When uncertain of personal skills and abilities, rely on trained professionals to perform the task.

Because of the nature of old shrub rows, chainsaws and pruners will often "bind" in the cut. Using wide loader buckets or other means to take the tension off the stems and "lean" them all one direction will reduce the amount of binding that will occur. Cutting can then proceed on the "up" side of the leaning material. Exercise caution when using saws and pole pruners around tractors and loaders.

Certain deciduous trees exhibit strong tendencies towards coppicing after the main stem has been removed. To determine which species have the greatest chance of being successfully renovated via coppicing, see "Tree and Shrub Characteristics". Deciduous trees shall be cut off to a height of 1-4 inches to encourage a strongly attached sprout arising from the root collar rather than as an advantageous sprout arising from higher locations on the stump.

As with shrub coppicing, care must be taken to prevent injury to the tree stem, root collars and roots. Cuts should be clean with no ragged ends. Bark of the residual stumps should not be damaged or stripped.

Removing the top growth from trees is usually accomplished with chainsaws or specialized tools mounted on skid loaders or tractors. When using chainsaws to fell larger trees, ensure that proper techniques and safety equipment are used. If in doubt, hire someone with the necessary skill, experience, and equipment.

One main difference between coppice regeneration on shrubs versus coppice regeneration on trees is the required maintenance during the first few years after re-growth. In most cases, regenerated trees will require pruning multiple stems to leave only one or two stems per stump prior to the second to fourth growing season.

Select the stem(s) with the best form for the particular species that will meet landowner objectives. Remove remaining sprouts using proper pruning methods. Properly attached sprouts are usually those closest to the ground or arising from the root collar or immediately adjacent roots. Avoid keeping sprouts that are attached high on the stump as they tend to break easily with wind or snow. Waiting a year or two before pruning will allow weather and other site conditions to naturally prune out some of the weaker stems and make it easier to determine which sprouts are the best to leave.

Proper pruning techniques are illustrated and described in "Pruning Trees and Shrubs" <http://www.ag.ndsu.edu/pubs/plantsci/trees/h1036.pdf> and in Tree/Shrub Pruning - 660.

See figure 2 for illustrations of coppicing deciduous trees.

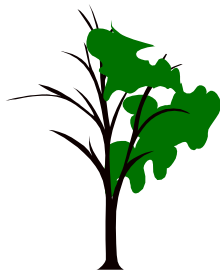


Figure 2a: Tree in a state of decline needing renovation.



Figure 2b: Top removed, leaving 4-6" stump with healthy roots.

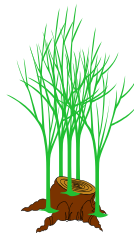


Figure 2c: Stump with multiple sprouts first or second year after main tree removal.

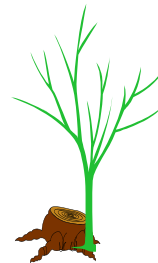


Figure 2d: Best sprout selected. Other sprouts pruned in year 3 or 4 after main tree removal.

Gap Planting

Gap planting is the planting of trees or shrubs to fill openings in otherwise healthy windbreaks. Successful gap planting is dependent upon effective weed control, species selection, and water management.

- For all windbreaks needing gap planting:
 - Select species appropriate for the soils at the location of the opening in the windbreak. It may have been a soil-related problem that caused the original plants to die.
 - Control herbaceous vegetation for one growing season before planting. Be especially diligent in killing perennial sod.
 - Establish replacement stock at a spacing appropriate for the species being replanted. See Table 1 of "Windbreak Shelterbelt Establishment" for within-row spacings.

Control weeds after planting with fabric, herbicides, mulch, or tillage. Weed control on plantings to fill gaps is critical since nearby trees and shrubs are competing with the new plant for moisture and nutrients. The newly planted tree or shrub often will not withstand losing additional moisture to weeds. Refer to pages 11-15 of Tree Care and Management for weed control details. Control of aggressive sods and weeds may be needed for many years until replants reach a size to effectively compete with the larger windbreak trees or shrubs.

- For windbreaks less than 5 years old needing gap planting:

Plant the desired species, either conservation grade stock or larger, at spacings appropriate for the species and the windbreak purpose.

Refer to pages 3-11 of "Tree Care and Management" for stock handling and planting guidelines.

Add 10-20 gallons of water every 2 weeks for the first year, when soil around the new plant is dry. Apply in such a way as to thoroughly saturate the root zone of the new tree or shrub.

- For windbreaks over 5 years old

If site conditions allow, consider root pruning to reduce competition from existing trees or shrubs.

Pruning or coppicing existing trees may be necessary to reduce shade on new plants.

Plant new trees or shrubs at a spacing appropriate for each species and windbreak purpose.

Supplemental water is essential to the successful establishment of replacement trees or shrubs in older windbreaks. Check soil moisture weekly and, provide 20-50 gallons water to each tree or shrub if the soil is dry. Apply in such a way as to thoroughly saturate the root zone of the new tree or shrub.

Natural Regeneration

Natural regeneration is managing the naturally occurring seedlings that develop within the understory of some windbreaks to improve windbreak function. Species such as green ash, basswood, eastern redcedar, honeysuckle, chokecherry, Russian-olive, and buffaloberry will often regenerate naturally within windbreaks.

Presence of naturally regenerated trees and shrubs is largely dependent upon the site. Natural regeneration rarely occurs in single-row windbreaks. Full shade, thick sods of grass, or long-term aggressive tillage will often limit the extent of natural regeneration. In North Dakota there is a marked decline in natural regeneration as normal precipitation is reduced from 22 inches to 14 inches from east to west across the state.

Managing natural regeneration usually means thinning competing woody vegetation re-growth in the understory to the desired spacings and controlling herbaceous weeds. Occasionally it involves removing some of the overstory to open the canopy and allow more sunlight to reach the younger plants.

Herbaceous vegetation shall be controlled whenever it begins to adversely affect tree and shrub growth and vigor. Thinning of woody plants can begin once they attain a 3-4 foot height. Plant-to-plant spacings after the thinning operations are dependent upon the purpose of the windbreak.

Generally a residual plant-to-plant spacing of 12-18 feet for large trees, 8-14 feet for medium height trees, and 4-6 feet for the shrub species is appropriate. Mature plant size can be found in "Tree and Shrub Characteristics." These suggested spacings are a bit wider than those for a new windbreak planting, but since thinning operations are so labor intensive, the wider spacings will allow the effects of the thinning to last longer.

Management of natural regeneration can result in a windbreak that appears to have rows, or it can be managed to look totally natural (no noticeable rows.) See figure 2.

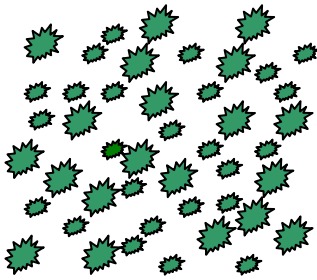


Figure 2a: Naturally regenerated stand prior to thinning.

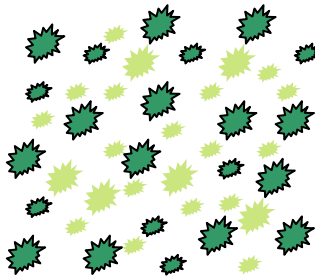


Figure 2b: Naturally regenerated stand, thinned to look natural.

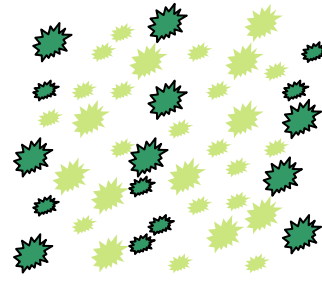


Figure 2c: Naturally regenerated stand, thinned to rows.

Generally the easiest way to perform a thinning operation in a naturally regenerated windbreak is to walk through the windbreak and mark (with paint or flagging) the plants to be left. Select those plants with the best form for the species that are located approximately where needed to give the desired plant-to-plant spacings. Try to retain a diversity of species when marking for thinning. Remove the remaining plants and saplings.

Removal of unwanted saplings can be done with loppers, axes, chainsaws, powered brush trimmers or pole pruners, etc. In most cases the freshly killed stumps of deciduous species will resprout. To prevent re-sprouting, apply the appropriate herbicide at the correct time. Some herbicides may translocate through root grafts to nearby plants of the same species. Be sure to follow all label directions and precautions. Without chemical stump treatment, thinning operations may have to be performed 2-3 times on the same plant until the residual saplings have attained sufficient height to outgrow the competition.

Where appropriate, consider leaving a few of the larger snags for den trees and roost sites. If compatible with landowner objectives and local ordinances, pruned material could be stacked and left in brush piles for additional wildlife habitat.

Pruning

Pruning is the precise removal of selected branches from trees. For most tree species new tree limbs will not grow from the area pruned, unless pruning was performed incorrectly or the trees were under severe stress. Pruning techniques shall follow the guidance of Tree/Shrub Pruning – 660 or "Pruning Trees and Shrubs."

Pruning to alter windbreak densities will often need to be repeated at a later date to maintain the desired benefits. Remaining tree limbs will often grow (spread) to fill the space left by the pruning.

- Pruning to reduce windbreak density can be done in two ways.

The first method involves removing all limbs from all trees to a certain height, usually 3-5 feet above the ground. This type of pruning is usually done on field windbreaks to address snow distribution. The result is a windbreak with the same density above the pruned area and essentially no density for the height of the pruning. After a field windbreak has been pruned in this manner, the downwind snowdrift will usually be wider, shallower, and farther away from the tree row. The down side to this method is that the protection to the crop during the growing season will be reduced, especially near the tree row. Wind velocities may be increased somewhat over open field velocities immediately adjacent to the pruned tree row, which may increase wind erosion risks. See figure 3 for the effects of this style of pruning on snow deposition.

The second method involves removing selected limbs throughout the canopy to reduce

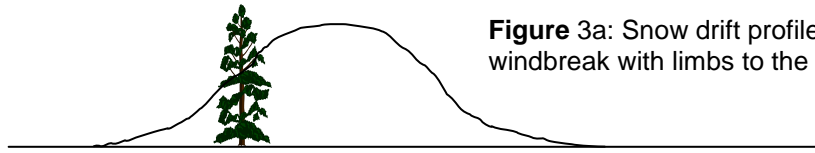


Figure 3a: Snow drift profile behind dense windbreak with limbs to the ground.

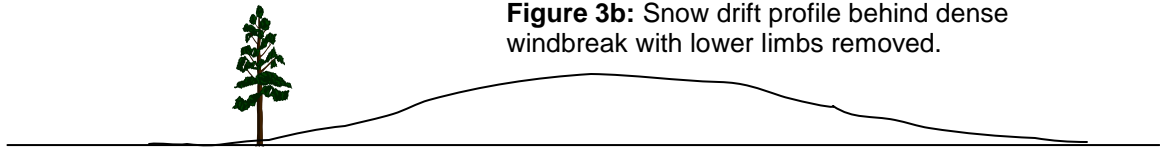


Figure 3b: Snow drift profile behind dense windbreak with lower limbs removed.

overall density of the windbreak to a desired level. This method will look more natural and would be very appropriate where windbreaks are protecting specialty crops that need the proper mix of airflow and protection. It is considerably more labor intensive and would have to be performed more often than the first method.

The zone of protection downwind from a windbreak pruned in this manner would be more uniform than for a windbreak pruned from the bottom up, though snow distribution patterns will be similar.

Best time for either type of pruning is when trees are dormant. (October to February)

Pruning to correct damage or to encourage proper tree form is probably best done whenever the need is noticed. Even though there may be a "best" time to prune, it is usually best to correct problems immediately. If problem-correcting pruning is delayed, the stress to the tree is greater, tree longevity is shortened, and the potential for the operation to be successful is decreased.

Early spring after snow melt is a good time to inspect windbreaks looking for damaged limbs, double leaders and other deformities caused by weather or animals. Using the proper pruning techniques listed at the web sites given above, prune off the damaged parts in a way that encourages rapid callus formation and proper growth forms. Some species, such as green ash, have a strong tendency to form double leaders. Double leaders decrease the longevity and function of the windbreak over time. Pruning to a single leader at the correct time (when limbs are less than one inch in diameter) will result in taller trees that are more wind hardy and will result in fewer limbs falling into adjacent fields. Windbreaks should be examined every year or after every major storm to determine pruning needs.

When scheduling pruning of pine and/or spruce windbreaks, contact local florists, crafters, and others to determine if there is a market for the pruned material. If a market exists for "greens" schedule pruning activities to coincide with market demands.

Root Pruning

Root pruning is a renovation method that severs competing tree roots within the top 18-30" of the soil. Reducing the spread of tree roots reduces the competition to nearby crops or newly planted trees. Root pruning should only be done to one side of a tree or shrub in any given year, to limit the stress to the existing plant.

- Root pruning to reduce crop stress -

Will usually need to be repeated every 3-4 years to maintain the benefits.

When performed to reduce crop stress, the root prune line shall be outside the crown drip line of the tree (usually 8-16 feet) to reduce the number and size of tree roots cut and to reduce damage to the tree foliage from the pruning machinery. See figure 3.

For some species of trees, it is best that the root prune line fall within the crop field so that normal cropland tillage or herbicide applications can control the potential re-sprouts from the root pruning.

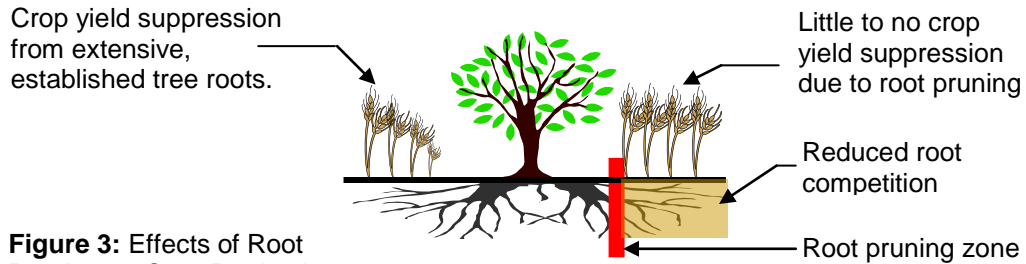


Figure 3: Effects of Root Pruning on Crop Production

- Root pruning to reduce stress to newly planted tree rows. See figure 4.

Will only provide benefits for 2-3 years.

The root prune line shall be outside the crown drip line of the tree (8 feet minimum) to reduce the number and size of tree roots cut and to reduce damage to the tree foliage from the pruning machinery.

Will provide a minimum competition-free zone at least 8 feet wide at planting time.

Will provide benefits only if adequate weed control is also performed.

Can increase establishment success when underplanting trees.

Depending upon species root pruned, root sprouts will need to be controlled.

Is not as critical if the new tree row is at least 30 feet from the nearest established tree row.

May be stressful to the remaining windbreak trees.

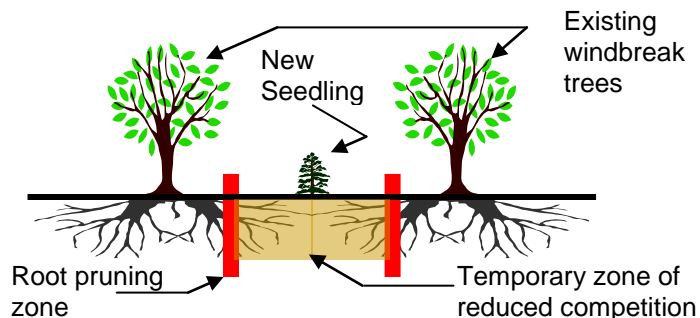


Figure 4: Root pruning to reduce stress on new trees

Row Removal and Replacement

At a minimum this renovation method removes the top growth of dead and dying trees. Traditionally it has often included the removal of stumps and roots and the leveling of the renovation site. Tops may be removed by an assortment of tools and machines such as chainsaws, hydraulic shears, hydraulic saws, PTO-driven saws, dozers, endloaders, etc. Root and stump removal and site leveling are often done with construction equipment or larger agricultural equipment.

In multirow windbreaks where removal and replacement will occur within the windbreak, one additional row will be removed beyond the number of rows to be replaced. Ex: remove 3, plant 2. This requirement is necessary to provide enough growing space for the replacement plantings. This requirement is not necessary in situations, without existing cottonwoods, where existing between-row spacings exceeded 25 feet.

Replacement plants may be planted in, or near the location of the old tree row, or they may be planted in a more distant location as long as the new windbreak(s) protect the same area or acreage.

If new trees or shrubs are to be established in the area of the old windbreak, re-sprouts will be controlled and the site will be fallowed at least one growing season before attempting to plant the new windbreak.

Perennial sod-forming grasses will be controlled for at least one growing season prior to planting the new trees or shrubs.

Tops of American elm and Siberian elm will be disposed of by burning, burying, chipping or debarking to reduce the risk of spreading Dutch elm disease. Elm wood disposal shall occur immediately if removal is during the growing season or before the next growing season if removed during the fall or winter. When this is not possible, disposal should occur within one year after removal.

Other species of woody material may be burned, buried, hauled away or left in piles as long as applicable local and state laws are followed and the disposal method meets landowner objectives. Consider burning, or burying other species if infected with diseases or infested with insects that may spread to nearby trees. Some, but not all of the laws that may apply to row removal and replacement include:

Open burning permit requirements, restrictions and liabilities.

Local ordinances regarding disposal of elm wood.

Potential impacts on cultural resources. NRCS policy lists the procedures to be followed.

Location of buried utilities. NRCS policy lists the procedures to be followed.

In multirow windbreaks where a stand of larger trees will remain after the row removal, consider leaving hollow trees as den sites and a few of the larger dead trees as raptor roost sites.

- Row removal including stumps and roots

Site will be leveled after removals to allow for planting and maintenance with normally available equipment.

Planting may be by any method that results in a healthy, vigorously growing tree or shrub. Refer to pages 8-11 of "Tree Care and Management."

Use extreme caution when replanting sites that have been leveled after stump and root removal. Buried woody debris can be hooked by moving machinery and thrust at people on the tree planter. Ensure protective shields are in place or take other precautions to minimize risks to operators.

- Row removal taking only the tops and leaving the stumps and roots

Stumps will be left short enough to not impede subsequent management operations.

Live stumps will be treated with an approved herbicide immediately after cutting to prohibit resprouting. (If resprouting is desired, follow guidance under Coppicing.)

Planting may be by any method that results in a healthy, vigorously growing tree or shrub. Due to the presence of stumps and roots, planting methods may be limited or must be modified. Often traditional tree planters will function well within a few feet of the stump row, especially when equipped with a coulter. When planting within the old stump rows, hydraulic augers work well to dig the hole, which allows for easy and proper hand planting. See figure 5. Refer to pages 8-11 of "Tree Care and Management." Though the risk of hooking roots that are buried in the soil may be less than on a leveled site, exercise caution and ensure protective shields are in place.

Maintenance operations may have to be modified on sites where new trees have been planted within the old tree row or immediately adjacent to the old tree row. Machine-applied fabric and in-row tillage are often not possible due to the remaining roots and stumps. Hand-placed and pinned fabric, mulching, warm-season grass seedings, herbicides, and careful tillage are alternative weed control methods that are appropriate- depending upon the site.

Continued control of resprouting may be needed for 1-2 years after the initial treatment. Effectiveness of initial treatment is dependent upon species, chemical, time of year, and growth stage of plant.



Figure 5a: Replacement trees hand-planted between dead stumps



Figure 5b: Replacement trees machine-planted close to dead stumps

Shearing

For reduced stress to the plant, reduced debris needing removal, and to reduce machine and labor requirements, shearing should be done as frequently as needed to refrain from cutting twigs and branches older than two years. If the condition of the windbreak has deteriorated to the point that larger limbs need to be removed, refer to Coppicing or Pruning.

Shearing is most often done on conifers managed for Christmas trees but can be effective on deciduous plants. Deciduous plants will often grow faster and require more frequent shearing. Shearing usually will increase windbreak density, no matter the owner's objective.

Shearing shall be done with tools that leave a clean, smooth cut. Damage to main stems and root systems will be negligible. Shearing will not be done with side boom rotary mowers, brush cutters, or flails.

When performed on young succulent branches, shearing can be performed with a wide assortment of tools, such as hedge trimmers, sickle-bar mowers, etc. These types of tools provide desirable, clean cuts, but may be damaged if forced to cut older limbs.

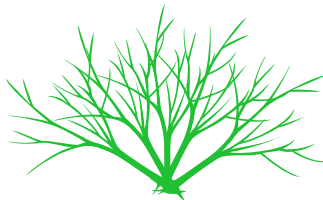


Figure 6a: Shrub with wide spread and tall height

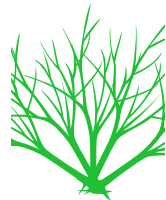


Figure 6b: Shrub sheared to reduce spread

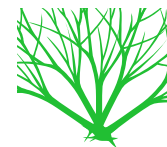


Figure 6c: Shrub sheared to reduce height and spread

- To increase windbreak density

This application is useful to increase the effectiveness of a windbreak as a visual screen or noise barrier. Final shape and appearance are dependent upon landowner desires and specific plant characteristics.

- To reduce spread or extent of windbreak

This application can constrain the plants and minimize the amount of land taken out of production. It may also control the tops of windbreaks to allow for effective operations of center-pivot irrigation systems or other uses. See figure 6.

- To shape conifers for Christmas trees or resale.

Follow the recommendations found in "Christmas Trees, a Management Guide" - Nebraska Cooperative Extension EC 76-1741

<http://www.ianr.unl.edu/pubs/Forestry/ec1741.htm#shape> or

"Shearing Recommendations for Christmas Tree Producers"

<http://web1.msue.msu.edu/aoe/xmas/ncr310.PDF>

When managing a windbreak for Christmas tree production, ensure that the minimum number of trees, and/or tree rows are left to maintain the function of the windbreak. Refer to "Windbreak Shelterbelt Establishment" for the minimum number or rows and trees per row to fulfill a particular function.

Sod Release and Management is the control and management of herbaceous weeds, particularly sod-forming grasses, in order to reduce the stress on windbreak plants and prepare the site for other renovation methods.

- Releasing trees or shrubs from herbaceous competition

For maximum effectiveness, sod-forming grasses will be controlled as early as possible in their growth stage, consistent with the control method chosen. Generally, the sods will be tilled or mowed or sprayed before the grasses get much taller than 3 inches.

When using herbicides to control sods and weeds, follow the label directions as they relate to the stage of weed growth for proper application timing. All herbicides will be applied according to label regulations with particular care to minimize damage to trees and shrubs. Several applications may be needed for adequate control. Operations may have to be repeated yearly. Generally, herbicides are most effective in controlling sods when applied to green succulent leaves in late summer or early fall. Many of the effective herbicides work on contact or via translocation. Avoid contact of these products on young bark or green leaves of trees or shrubs. Be alert to potential long-term herbicide buildup.

If tillage is used, it will not be deeper than 3 inches to minimize root damage. Tillage will not be performed within 1 foot of the trunk of the tree or shrub. Numerous applications (3-6 depending upon yearly moisture and weed species) will be needed each year. Each application runs the risk of mechanically damaging the trees and shrubs.

If mowing is used it will be applied in such a way as to maximize the stress to the sod while minimizing stress- such as bark injury or soil compaction- to the woody plants. Mow before herbaceous vegetation reaches a 4-inch height and mow as short as possible without damaging the mower. Weather conditions often dictate frequency of mowing.

- Preparing the site for replanting

The primary purpose of this renovation method is to reduce herbaceous competition on trees and shrubs.

Guidelines for herbicides and tillage release of sod-bound trees will be followed with the following additional stipulation; Tillage and/or herbicides will be applied in such a way that the sod is completely killed for one growing season before new trees or shrubs are planted. Refer to pages 4-8 of "Tree Care and Management" for site preparation details.

Mowing **is not** appropriate for this purpose.

Supplemental planting (intra-planting) is nothing more than establishing a new windbreak adjacent to an existing windbreak. Refer to the following tools for specific requirements of designing a supplemental planting.

County-specific windbreak suitability groups for each soil type are found in county specific Interpretive tables in FOTG – Section II – Soil Information.

Estimated 20-year tree heights and determining which tree species are appropriate for planting on which soils can be found in "Expected 20-Year Tree Heights" by Windbreak Suitability Groups, located in FOTG – Section I – Reference Subjects – Windbreaks and Woodland.

Planting stock, stock handling, site preparation, planting techniques, and maintenance details are found in "Tree Care and Management"

Design Requirements to meet a specific purpose are found in "Windbreak Shelterbelt Establishment"

"Tree and Shrub Characteristics"

Newly planted windbreak rows shall be no closer than 40 feet if the nearest adjacent row in the existing planting is a deciduous tree, spruce or suckering shrub.

Newly planted windbreak rows shall be no closer than 20 feet if the nearest adjacent row in the existing planting is a conifer (not spruce) or non-suckering shrub.

Thinning is a method that removes selected plants from a windbreak. Exercise caution when selecting trees to be thinned so that the function of the windbreak is not radically impaired.

Removal can be accomplished with chainsaws, tree spades, handsaws, brush cutters, tree shears, hydraulic saws or some other tool or machine. Rarely will the roots be removed, except in situations where tree spades are used to remove live trees for transplanting. Serious damage to the root systems of remaining trees or shrubs will likely occur if attempts are made to remove the roots of the thinned trees with tools other than a tree spade. (Root damage is still a possibility with a tree spade but the risk is smaller as long as the windbreak is 20 years old or less.)

Tree and shrub tops shall be removed in such a manner that residual stumps and the debris from the thinning operation do not impede subsequent management operations. Tops may be removed from the site, stacked or cut "low and short" and left where they fall. Manage the debris from the thinning in a way that is compatible with landowner objectives.

Debris from Siberian elm or American elm must be chipped, burned or buried to reduce risk of spreading Dutch elm disease. Elm wood disposal shall occur immediately if removal is during the growing season or before the next growing season if removed during the fall or winter. When this is not possible, disposal should occur within one year after removal.

Depending upon the species thinned, stump resprouting may have to be addressed. Repeat thinning operations or treatment with herbicides may be appropriate. Method chosen will depend upon the reason for the thinning. There may be a risk of selected herbicides being translocated from the treated stump to the adjacent tree or shrub via root grafts. Not all species readily develop root grafts. Root grafting does not occur between plants of different species.

- To alter windbreak density

Ensure that the windbreak maintains enough density to meet the objectives of the landowner after any thinning operation. Depending upon thinning intensity, windbreak function may be reduced for several years after thinning. To reduce this effect do not thin all rows of a multirow windbreak at the same time, or establish new tree or shrub rows several years before thinning.

Single-row windbreaks

Thinning consists of removing every other plant within the row to reduce density to the desired level. This type of thinning is most often utilized to reduce windbreak density and alter snow distribution patterns. See figure 7. Drift



Figure 7a: Dense windbreak before thinning, causing deep snowdrifts.



Figure 7b: Dense windbreak after thinning, spreading snow farther across the field.

configurations after thinning will be somewhat similar to figure 3b.

Stump re-sprouts are usually not desirable and shall be controlled. Extensive stump sprouting will often make snow distribution problems worse. If re-sprouts are desirable, refer to coppicing for details on management.

Multi-row windbreaks

Thinning consists of removing every other or every third plant within the selected row(s). It may also be done in such a manner that plant removals from several rows will result in the desired plant-to-plant spacings.

Stump re-sprouts may or may not be a problem. Control re-sprouts, if needed, by herbicides or repeated removals in a way that does not damage the remaining windbreak. If re-sprouts are desirable, refer to coppicing for details on management.

- To reduce competition to adjacent trees

Thinning consists of removing selected trees or shrubs in a manner that leaves more growing space for each of the remaining trees or shrubs. Thinning may remove every other or every third plant within the selected row. It may also be done in such a manner that plant removals from several rows will result in the desired plant-to-plant spacings. Thinning is a key function in managing natural regeneration. A residual plant-to-plant spacing of 4-6 feet is appropriate for shrubs and 12-18 feet is appropriate for large trees.

Thinning of conifers shall occur before adjacent tree canopies overlap by more than 2-3 feet throughout $\frac{1}{4}$ to $\frac{1}{2}$ their height. Extended periods of overlapping limbs throughout much of the canopy will result in dieback of the limbs on conifers and a loss of windbreak function. Timely thinning will prevent such windbreaks from "pruning themselves up" and reduce the likelihood and/or severity of some fungal diseases, especially on spruce.

- To provide agroforestry products

Depending upon the species and local markets, thinning efforts can be funded in part by the harvest and sale of agroforestry products such as Christmas trees and greens, vines, decorative twigs, or pine straw. Potential for agroforestry markets is dependent upon landowner objectives, presence of markets, and the products to be harvested.

Underplanting

Underplanting is the addition of trees or shrubs under the canopy of an existing windbreak. See figure 8. Often this type of renovation is appropriate for restoring function to a windbreak that has lost density in the lower portion of the canopy. In the absence of row removal and/or extensive pruning, species selected for underplanting shall be selected for a level of shade tolerance appropriate to the level of canopy in the existing windbreak. Refer to "Tree and Shrub Characteristics" to determine shade tolerances of individual species.



Figure 8a: Windbreak with reduced density in lower crown allowing wind and snow to blow through into areas needing protection.



Figure 8b: Windbreak renovated by establishing shade-tolerant trees or shrubs in understory.

Site preparation methods to control herbaceous weeds and sod shall be appropriate for the weed pressure. Sites with sods, deep-rooted legumes, or noxious weeds shall be fallowed for at least one season prior to planting in order to control vegetation and store moisture for the newer plants.

Where room permits, and based on the competitiveness of adjacent tree species, root pruning to provide a zone of reduced competition for several years will benefit the new planting. See root pruning for details.

Species selected for underplanting shall be shade-tolerant and suitable for planting on the soils at the planting site.

KEY TO DETERMINE APPROPRIATE RENOVATION METHOD *

Field Windbreak Key

1. The windbreak forms a complete barrier with no gaps; trees appear healthy and vigorous with few dead branches and no insect or disease problems. No noxious weeds or sod-forming grasses are present. The windbreak is meeting all of landowner objectives. No renovation is needed, continue annual maintenance program.
1. The windbreak appears unhealthy; trees may be overcrowded or protection is not adequate; individual trees are in poor condition with many dead branches. Noxious weeds or sod-forming grasses may be present. Over all, the windbreak fails to meet landowner objectives. Go to 2.
 2. Sod-forming grasses or noxious weeds are present. See Sod Release and Management.
 2. Sod-forming grasses or noxious weeds are not present. Go to 3.
 3. Individual trees in the windbreak appear healthy but there are large gaps (two or more adjacent trees are missing) in the windbreak. See Gap Planting.
 3. There are no large gaps in the windbreak. Go to 4.
 4. The density of the windbreak is low (less than 30 percent), especially in the lower one-third. The windbreak fails to provide sufficient wind erosion control or crop protection. See Underplanting or Supplemental Planting.
 4. The density of the windbreak is high (more than 50 percent) and there is adequate wind erosion control. However, deep snowdrifts form that restrict field access in the spring. See Thinning or Pruning.
 4. The density is about right to meet landowner objectives but there are problems not identified above. Go to 5.
 5. Individual trees have insects or diseases present. Contact a local tree care professional to determine the insect or disease present and the proper treatment. Treat only if necessary.

5. Windbreaks are in good condition and meet landowner's primary objectives but could be improved for wildlife. Consider adding a shrub row or leaving several rows of unharvested crop adjacent to the windbreak for wildlife. See Windbreaks and Wildlife <http://www.ianr.unl.edu/pubs/Forestry/ec1771.htm> or "Tree and Shrub Characteristics".
5. Windbreaks are in good condition but crop yields next to the windbreak are low. See Root Pruning.
5. Windbreaks are in good condition, but they are over 25 years old and it is time to plan for the future. See Supplemental Planting, Underplanting, or Coppicing.

Farmstead and Livestock Windbreak Key

1. The windbreak appears healthy and vigorous with few dead branches and no insect or disease problems. The trees are well spaced within rows and between rows.
 2. There is a good mix of deciduous and coniferous tree and shrub species; trees are of several ages. No renovation is needed, continue annual maintenance program.
 2. Windbreak is composed of a single species and all trees are approximated the same ages. See Supplemental Planting or Underplanting.
1. The windbreak appears unhealthy; individual trees are in poor condition; density may be too low or too high to meet landowner objectives.
 3. Sod-forming grasses or noxious weeds are present. See Sod Release and Management
 3. Sod-forming grasses or noxious weeds are not present. Go to 4.
 4. Insects or diseases are present. Contact a local tree care professional to determine the insect or disease present and the proper treatment. Treat only if necessary.
 4. Insects or diseases are not present. Go to 5.
 5. Trees are overcrowded. See Thinning.
 5. Trees are not overcrowded; density is low and wind protection is limited. See Coppicing, Underplanting, Natural Regeneration, Shearing, or Supplemental Planting.

*The Field Windbreak Key and the Farmstead and Livestock Windbreak Key were adapted from "Windbreak Renovation" University of Nebraska Cooperative Extension EC 98-1777-x; by Craig Stange, USDA Natural Resources Conservation Service; Jon Wilson and Jim Brandle, University of Nebraska; and Mike Kuhns, Utah State University

Exhibit 7-1: Web Soil Survey Soil Report Information for Selected Practices

Soil Report Considerations for:
CONSERVATION PRACTICE STANDARD
ANIONIC POLYACRYLAMIDE (PAM) APPLICATION
CODE 450

Idaho NRCS: Boise, Idaho

Soil Concerns Stated in Standard	Web Soil Survey (WSS) Related Items
peat or organic matter surface horizons	surface texture
slope	slope
sodium adsorption ratio (SAR)	soil chemical properties
soil texture (surface)	surface texture

Web Soil Survey Related Items	Soil Data Explorer Tab		
	Suitabilities and Limitations	Soil Properties and Qualities	Soil Reports
slope		Soil Qualities and Features: Representative Slope	AOI Inventory: Component Legend
surface texture		Soil Physical Properties: Surface Texture	Soil Physical Properties: Engineering Properties
Sodium adsorption ratio		Soil Chemical properties: Sodium Adsorption Ratio	Soil Chemical Properties

Note: The Suitabilities and Limitations, and the Soil Properties and Qualities options in WSS are designed to aggregate data and return a single rating or value for each map unit. The single value is typically either for the surface layer, or it is a weighted average for a specified depth range. This is done to facilitate the creation of a thematic map for the selected item. Representative values (rv's) are used, rather than the range in properties, and depth measurements are generally displayed in centimeters. The Soil Reports option generally provides the range in values for each soil component and depth measurements are generally displayed in inches or feet; however, results are tabular only.

A soil map and map legend of the area can be generated from the WSS through the Soil Map tab. Soil maps were published at certain scales. Site specific practices may require onsite investigation.

Soil Report Considerations for:

**CONSERVATION PRACTICE STANDARD
BRUSH MANAGEMENT
CODE 314**

Idaho NRCS: Boise, Idaho

Soil Concerns Stated in Standard	Web Soil Survey (WSS) Related Items
ecological site ¹	ecological site

¹Ecological site information is available in the Web Soil Survey by clicking on a separate tab, labelled “Ecological Site Assessment”, that is located between the Soil Properties and Qualities tab and the Soil Reports tab. **Ecological site information is not available for all soils or for all areas at this time.**

Web Soil Survey Related Items	Soil Data Explorer Tab		
	Suitabilities and Limitations	Soil Properties and Qualities	Soil Reports
ecological site			

Note: The Suitabilities and Limitations, and the Soil Properties and Qualities options in WSS are designed to aggregate data and return a single rating or value for each map unit. The single value is typically either for the surface layer, or it is a weighted average for a specified depth range. This is done to facilitate the creation of a thematic map for the selected item. Representative values (rv’s) are used, rather than the range in properties, and depth measurements are generally displayed in centimeters. The Soil Reports option generally provides the range in values for each soil component and depth measurements are generally displayed in inches or feet; however, results are tabular only.

A soil map and map legend of the area can be generated from the WSS through the Soil Map tab. Soil maps were published at certain scales. Site specific practices may require onsite investigation.

Soil Report Considerations for:

**CONSERVATION PRACTICE STANDARD
CRITICAL AREA PLANTING
CODE 342**

Idaho NRCS: Boise Idaho

Soil Concerns Stated in Standard	Web Soil Survey (WSS) Related Items
erosion from wind and water	erosion factors Kw, Kf, T wind erodibility group wind erodibility index
soil conditions	map unit description

Web Soil Survey Related Items	Soil Data Explorer Tab		
	Suitabilities and Limitations	Soil Properties and Qualities	Soil Reports
erosion factors: Kw Kf T wind erodibility group wind erodibility index		Soil Erosion Factors: K Factor, Rock Free K Factor, Whole Soil T Factor Wind Erodibility Group Wind Erodibility Index	Soil Erosion: Conservation Planning Soil Physical Properties: Physical Soil Properties
map unit description			AOI Inventory: Map Unit Description (Brief, Generated)

Note: The Suitabilities and Limitations, and the Soil Properties and Qualities options in WSS are designed to aggregate data and return a single rating or value for each map unit. The single value is typically either for the surface layer, or it is a weighted average for a specified depth range. This is done to facilitate the creation of a thematic map for the selected item. Representative values (rv's) are used, rather than the range in properties, and depth measurements are generally displayed in centimeters. The Soil Reports option generally provides the range in values for each soil component and depth measurements are generally displayed in inches or feet; however, results are tabular only.

A soil map and map legend of the area can be generated from the WSS through the Soil Map tab. Soil maps were published at certain scales. Site specific practices may require onsite investigation.

Soil Report Considerations for:

**CONSERVATION PRACTICE STANDARD
FORAGE AND BIOMASS PLANTING
CODE 512**

Idaho NRCS: Boise, Idaho

Soil Concerns Stated in Standard	Web Soil Survey (WSS) Related Items
soil condition and landscape position attributes such as:	refer to items listed below
available water holding capacity ¹	available water capacity available water storage available water supply
depth	depth to soil restrictive layer
drainage class	drainage class
flooding	flooding frequency
ponding	ponding frequency
salinity	a concern for some soils in Idaho
slope	slope
soil pH	soil reaction (pH)

¹Available water capacity (AWC) is given in cm of water per cm or soil (or in per in) for each soil layer. Available water storage and available water supply are calculated as the AWC times the thickness of each soil layer, summed to a specified depth.

Web Soil Survey Related Items	Soil Data Explorer Tab		
	Suitabilities and Limitations	Soil Properties and Qualities	Soil Reports
available water capacity		Soil Physical Properties: Available Water Capacity	Soil Physical Properties: Physical Soil Properties
available water storage		Soil Physical Properties: Available Water Storage	
available water supply		Soil Physical Properties: Available Water Supply	
depth to soil restrictive layer		Soil Qualities and Features: Depth to Any Soil Restrictive Layer	Soil Qualities and Features: Soil Features
drainage class		Soil Qualities and Features: Drainage class	
flooding frequency		Water Features: Flooding Frequency Class	Water Features: Water Features
ponding frequency		Water Features: Ponding Frequency Class	
slope		Soil Qualities and Features: Representative Slope	AOI Inventory: Component Legend
soil reaction (pH)		Soil Chemical Properties: pH (1 to 1 Water), EC, SAR	Soil Chemical Properties: Chemical Soil Properties

Note: The Suitabilities and Limitations, and the Soil Properties and Qualities options in WSS are designed to aggregate data and return a single rating or value for each map unit. The single value is typically either for the surface layer, or it is a weighted average for a specified depth range. This is done to facilitate the creation of a thematic map for the selected item. Representative values (rv's) are used, rather than the range in properties, and depth measurements are generally displayed in centimeters. The Soil Reports option generally provides the range in values for each soil component and depth measurements are generally displayed in inches or feet; however, results are tabular only.

A soil map and map legend of the area can be generated from the WSS through the Soil Map tab. Soil maps were published at certain scales. Site specific practices may require onsite investigation.

Soil Report Considerations for:

**CONSERVATION PRACTICE STANDARD
HEAVY USE AREA PROTECTION
CODE 561**

Idaho NRCS: Boise, Idaho

Soil Concerns Stated in Standard	Web Soil Survey (WSS) Related Items
bearing capacity of the soil	Unified Soil Classification
sites that need drainage	depth to water table drainage class

Web Soil Survey Related Items	Soil Data Explorer Tab		
	Suitabilities and Limitations	Soil Properties and Qualities	Soil Reports
depth to water table		Water Features: Depth to Water Table	Water Features: Water Features
drainage class		Soil Qualities and Features: Drainage Class	
Unified Soil Classification		Soil Qualities and Features: Unified Soil Classification (surface)	Soil Physical Properties: Engineering Properties

Note: The Suitabilities and Limitations, and the Soil Properties and Qualities options in WSS are designed to aggregate data and return a single rating or value for each map unit. The single value is typically either for the surface layer, or it is a weighted average for a specified depth range. This is done to facilitate the creation of a thematic map for the selected item. Representative values (rv's) are used, rather than the range in properties, and depth measurements are generally displayed in centimeters. The Soil Reports option generally provides the range in values for each soil component and depth measurements are generally displayed in inches or feet; however, results are tabular only.

A soil map and map legend of the area can be generated from the WSS through the Soil Map tab. Soil maps were published at certain scales. Site specific practices may require onsite investigation.

Soil Report Considerations for:

**CONSERVATION PRACTICE STANDARD
HERBACEOUS WEED CONTROL
CODE 315**

Idaho NRCS: Boise, Idaho

Soil Concerns Stated in Standard	Web Soil Survey (WSS) Related Items
ecological site description (ESD)	ecological site ¹
organic matter	organic matter
soil erosion potential	erosion factors Kw, Kf, T
soil map	soil map tab ²
soil texture	soil texture

Web Soil Survey Related Items	Soil Data Explorer Tab		
	Suitabilities and Limitations	Soil Properties and Qualities	Soil Reports
ecological site ¹			
erosion factors: Kw Kf T		Soil Erosion Factors: K Factor, Rock Free K Factor, Whole Soil T Factor	Soil Erosion: Conservation Planning Soil Physical Properties: Physical Soil Properties
organic matter		Soil Physical Properties: Organic Matter	Soil Physical Properties: Physical Soil Properties
		Soil Health: Soil Health – Organic Matter	Soil Health: Soil Health – Organic Matter
soil texture		Soil Physical Properties: Surface Texture	Soil Physical Properties: Engineering Properties

¹Ecological site information is available in the Web Soil Survey by clicking on a separate tab, labelled “Ecological Site Assessment”, that is located between the Soil Properties and Qualities tab and the Soil Reports tab. Ecological site information is not available for all soils or for all areas at this time.

Note: The Suitabilities and Limitations, and the Soil Properties and Qualities options in WSS are designed to aggregate data and return a single rating or value for each map unit. The single value is typically either for the surface layer, or it is a weighted average for a specified depth range. This is done to facilitate the creation of a thematic map for the selected item. Representative values (rv’s) are used, rather than the range in properties, and depth measurements are generally displayed in centimeters. The Soil Reports option generally provides the range in values for each soil component and depth measurements are generally displayed in inches or feet; however, results are tabular only.

²A soil map and map legend of the area can be generated from the WSS through the Soil Map tab. Soil maps were published at certain scales. Site specific practices may require onsite investigation.

Soil Report Considerations for:

**CONSERVATION PRACTICE STANDARD
PRESCRIBED BURNING
CODE 338**

Idaho NRCS: Boise, Idaho

Soil Concerns Stated in Standard	Web Soil Survey (WSS) Related Items
ecological sites	ecological site ¹
location of wetlands	hydric soils ²
soil and site conditions	map unit description

¹Ecological site information is available in the Web Soil Survey by clicking on a separate tab, labelled “Ecological Site Assessment”, that is located between the Soil Properties and Qualities tab and the Soil Reports tab. **Ecological site information is not available for all soils or for all areas at this time.**

²Hydric soils are not synonymous with wetlands, but hydric soils are one of the 3 wetland factors/parameters required for an area to be considered a wetland.

Web Soil Survey Related Items	Soil Data Explorer Tab		
	Suitabilities and Limitations	Soil Properties and Qualities	Soil Reports
hydric soils	Land Classifications: Hydric Rating by Map Unit		Land Classifications: Hydric Soils
map unit description			AOI Inventory: Map Unit Description (Brief, Generated)

Note: The Suitabilities and Limitations, and the Soil Properties and Qualities options in WSS are designed to aggregate data and return a single rating or value for each map unit. The single value is typically either for the surface layer, or it is a weighted average for a specified depth range. This is done to facilitate the creation of a thematic map for the selected item. Representative values (rv’s) are used, rather than the range in properties, and depth measurements are generally displayed in centimeters. The Soil Reports option generally provides the range in values for each soil component and depth measurements are generally displayed in inches or feet; however, results are tabular only.

A soil map and map legend of the area can be generated from the WSS through the Soil Map tab. Soil maps were published at certain scales. Site specific practices may require onsite investigation.

Soil Report Considerations for:

**CONSERVATION PRACTICE STANDARD
PRESCRIBED GRAZING
CODE 528**

Idaho NRCS: Boise Idaho

Soil Concerns Stated in Standard	Web Soil Survey (WSS) Related Items
ecological site or forage suitability group	ecological site ¹
flooding	flooding

¹Ecological site information is available in the Web Soil Survey by clicking on a separate tab, labelled “Ecological Site Assessment”, that is located between the Soil Properties and Qualities tab and the Soil Reports tab. **Ecological site information is not available for all soils or for all areas at this time.**

Web Soil Survey Related Items	Soil Data Explorer Tab		
	Suitabilities and Limitations	Soil Properties and Qualities	Soil Reports
flooding		Water Features: Flooding Frequency Class	Water Features: Water Features

Note: The Suitabilities and Limitations, and the Soil Properties and Qualities options in WSS are designed to aggregate data and return a single rating or value for each map unit. The single value is typically either for the surface layer, or it is a weighted average for a specified depth range. This is done to facilitate the creation of a thematic map for the selected item. Representative values (rv’s) are used, rather than the range in properties, and depth measurements are generally displayed in centimeters. The Soil Reports option generally provides the range in values for each soil component and depth measurements are generally displayed in inches or feet; however, results are tabular only.

A soil map and map legend of the area can be generated from the WSS through the Soil Map tab. Soil maps were published at certain scales. Site specific practices may require onsite investigation.

Soil Report Considerations for:

**CONSERVATION PRACTICE STANDARD
RESTORATION AND MANAGEMENT
OF RARE OR DECLINING HABITATS
CODE 643**

Idaho NRCS: Boise, Idaho

Soil Concerns Stated in Standard	Web Soil Survey (WSS) Related Items
ecological site Description (ESD)	ecological site ¹

¹Ecological site information is available in the Web Soil Survey by clicking on a separate tab, labelled “Ecological Site Assessment”, that is located between the Soil Properties and Qualities tab and the Soil Reports tab. **Ecological site information is not available for all soils or for all areas at this time.**

	Soil Data Explorer Tab		
Web Soil Survey Related Items	Suitabilities and Limitations	Soil Properties and Qualities	Soil Reports

Note: The Suitabilities and Limitations, and the Soil Properties and Qualities options in WSS are designed to aggregate data and return a single rating or value for each map unit. The single value is typically either for the surface layer, or it is a weighted average for a specified depth range. This is done to facilitate the creation of a thematic map for the selected item. Representative values (rv’s) are used, rather than the range in properties, and depth measurements are generally displayed in centimeters. The Soil Reports option generally provides the range in values for each soil component and depth measurements are generally displayed in inches or feet; however, results are tabular only.

A soil map and map legend of the area can be generated from the WSS through the Soil Map tab. Soil maps were published at certain scales. Site specific practices may require onsite investigation.

Soil Report Considerations for:
CONSERVATION PRACTICE STANDARD
SILVOPASTURE
CODE 381

Idaho NRCS: Boise, Idaho

Soil Concerns Stated in Standard	Web Soil Survey (WSS) Related Items
description of the soils	map unit description
ecological sites	ecological site ¹
soil conditions of the site	map unit description
soils map	soil map ²

Web Soil Survey Related Items	Soil Data Explorer Tab		
	Suitabilities and Limitations	Soil Properties and Qualities	Soil Reports
ecological site ¹			
map unit description			AOI Inventory: Map Unit Description (Brief, Generated)

¹Ecological site information is available in the Web Soil Survey by clicking on a separate tab, labelled “Ecological Site Assessment”, that is located between the Soil Properties and Qualities tab and the Soil Reports tab. Ecological site information is not available for all soils or for all areas at this time.

Note: The Suitabilities and Limitations, and the Soil Properties and Qualities options in WSS are designed to aggregate data and return a single rating or value for each map unit. The single value is typically either for the surface layer, or it is a weighted average for a specified depth range. This is done to facilitate the creation of a thematic map for the selected item. Representative values (rv’s) are used, rather than the range in properties, and depth measurements are generally displayed in centimeters. The Soil Reports option generally provides the range in values for each soil component and depth measurements are generally displayed in inches or feet; however, results are tabular only.

²A soil map and map legend of the area can be generated from the WSS through the Soil Map tab. Soil maps were published at certain scales. Site specific practices may require onsite investigation.

Soil Report Considerations for:

**CONSERVATION PRACTICE STANDARD
WATER HARVESTING CATCHMENT
CODE 636**

Idaho NRCS: Boise, Idaho

Soil Concerns Stated in Standard	Web Soil Survey (WSS) Related Items
rock outcrops ¹	depth to bedrock (lithic bedrock)

¹Some small areas of rock outcrop may be designated as spot symbols on the maps in the WSS.

Web Soil Survey Related Items	Soil Data Explorer Tab		
	Suitabilities and Limitations	Soil Properties and Qualities	Soil Reports
depth to bedrock (lithic bedrock)		Soil Qualities and Features: Depth to a Selected Soil Restrictive Layer (lithic bedrock)	Soil Qualities and Features: Soil Features

Note: The Suitabilities and Limitations, and the Soil Properties and Qualities options in WSS are designed to aggregate data and return a single rating or value for each map unit. The single value is typically either for the surface layer, or it is a weighted average for a specified depth range. This is done to facilitate the creation of a thematic map for the selected item. Representative values (rv's) are used, rather than the range in properties, and depth measurements are generally displayed in centimeters. The Soil Reports option generally provides the range in values for each soil component and depth measurements are generally displayed in inches or feet; however, results are tabular only.

A soil map and map legend of the area can be generated from the WSS through the Soil Map tab. Soil maps were published at certain scales. Site specific practices may require onsite investigation.

Soil Report Considerations for:

**CONSERVATION PRACTICE STANDARD
WATERING FACILITY
CODE 614**

Idaho NRCS: Boise, Idaho

Soil Concerns Stated in Standard	Web Soil Survey (WSS) Related Items
suitable soils	map unit description

Web Soil Survey Related Items	Soil Data Explorer Tab		
	Suitabilities and Limitations	Soil Properties and Qualities	Soil Reports
map unit description			AOI Inventory: Map Unit Description (Brief, Generated)

Note: The Suitabilities and Limitations, and the Soil Properties and Qualities options in WSS are designed to aggregate data and return a single rating or value for each map unit. The single value is typically either for the surface layer, or it is a weighted average for a specified depth range. This is done to facilitate the creation of a thematic map for the selected item. Representative values (rv's) are used, rather than the range in properties, and depth measurements are generally displayed in centimeters. The Soil Reports option generally provides the range in values for each soil component and depth measurements are generally displayed in inches or feet; however, results are tabular only.

A soil map and map legend of the area can be generated from the WSS through the Soil Map tab. Soil maps were published at certain scales. Site specific practices may require onsite investigation.

Exhibit 8-1: Enhancement Bundle Worksheet



CROPLAND ENHANCEMENT BUNDLE

B000CPL9

CONSERVATION STEWARDSHIP PROGRAM

Crop Bundle #9 - "Organic", Wind Erosion

Conservation Practices 340: Cover Crop; 328: Conservation Crop Rotation; 345: Residue and Tillage Management, Reduced Till; 590: Nutrient Management; and an option for 595: Integrated Pest Management or 327: Conservation Cover

APPLICABLE LAND USE: Crop (annual & mixed)

RESOURCE CONCERNS ADDRESSED: Soil Erosion, Soil Quality Degradation, Water Quality Degradation and/or Fish/Wildlife Habitat

BUNDLE LIFE SPAN: 5 years

Enhancement Description

By implementing this combination of enhancements together, a synergy is achieved that should result in more conservation benefits than would be expected from implementing the enhancements individually. Applicants that choose to implement this bundle will receive additional ranking points and a higher payment rate.

Criteria

- All of the component enhancements in the required group, along with one additional component enhancement, must be adopted as shown in the table below.
- If an applicant has already adopted one or more component enhancements within a bundle, the applicant may schedule the bundle as long as the applicant is newly adopting the majority (more than 50 percent) of the component enhancements within the bundle.
- Applicants may choose to adopt a bundle on any portion of the agricultural operation and will be required to install component enhancements on all applicable acres where the bundle is adopted.

B000CPL9 – Crop Bundle #9 – “Organic”, Wind Erosion	January 2018	Page 1
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CONSERVATION STEWARDSHIP PROGRAM

- The bundle is scheduled in the year in which all component enhancements in the bundle are applied but no later than the third fiscal year of the contract.
- The bundle, once adopted, may continue to be implemented in all subsequent years through the end of the contract.



Documentation and Implementation Requirements

**CONSERVATION
STEWARDSHIP
PROGRAM**

Participant will:

- Follow the documentation and implementation requirements outlined in the respective enhancement job sheets to document the implementation of each component enhancement in the bundle.
- Prior to and after implementation, document the planned amount, fields, applied amount and the year each component enhancement in the bundle is applied:

Component Enhancement Code	Tract, Field No. or Name	Planned Amount (units)	Applied Amount (units)	Year(s)
ADOPT ALL REQUIRED COMPONENT ENHANCEMENTS FROM THIS GROUP				
E340102Z				
E328106Z2				
E345106Z				
E590118Z				
ADOPT ONE ADDITIONAL COMPONENT ENHANCEMENT FROM THIS GROUP				
E327136Z1				
E327137Z				
E595116Z				



CONSERVATION STEWARDSHIP PROGRAM

NRCS Documentation Review:

I have reviewed all required participant documentation and have determined the participant has implemented the bundle and met all criteria and requirements.

Participant Name _____ Contract Number _____

Total Amount Applied _____ Fiscal Year Completed _____

NRCS Technical Adequacy Signature

Date

