

INFORME TÉCNICO Y DE DIFUSIÓN

1. ANTECEDENTES GENERALES DE LA PROPUESTA

Nombre de la propuesta

PRIMER CONGRESO MUNDIAL DE AGROFORESTERÍA

Código

Postulante o Postulantes

ALBERTO ENRIQUE HOFER MEYER

Entidad Patrocinante o Responsable

SERVICIO AGRICOLA Y GANADERO

Lugar de Formación (País, Región, Ciudad, Localidad)

USA, FLORIDA, ORLANDO

Tipo o Modalidad de Formación (curso, pasantía, seminario, entre otros)

CONGRESO

Fecha de realización (Inicio y término)

27/06/2004 AL 02/07/2004

2. ALCANCES Y LOGROS DE LA PROPUESTA

2.1 Justificación y objetivos planteados inicialmente en la propuesta

El objetivo general de la participación fue actualizar los conocimientos adquiridos a través de la formación curricular del postulante y a través de ello transferirlos a los funcionarios que se desempeñan en el ámbito de los recursos naturales renovables del Servicio Agrícola y Ganadero, incorporando nuevas técnicas de conservación que servirán de base para futuras intervenciones en la recuperación de suelos degradados en nuestra Región.

Los objetivos específicos tenían relación con:

- a) Transferencia de conocimientos a funcionarios SAG en el ámbito de los sistemas agroforestales y su aplicación en el medio ambiente.
- b) Transferencia de conocimientos a funcionarios SAG en el ámbito de los sistemas agroforestales y su aplicación en el control y manejo de plagas fitosanitarias endémicas y cuarentenarias.
- c) Ejecutar cinco charlas técnicas a 44 funcionarios SAG IX Región en el tópico agroforestal.
- d) Entrega de documentos técnicos de trabajo y láminas para reforzar el proceso de transferencia tecnológica.

2.2 Objetivos alcanzados tras la realización de la propuesta

Tras la realización de la propuesta se alcanzaron los siguientes objetivos:

- Actualización de conocimientos a través de la participación en las diferentes exposiciones y temas tratados durante la realización del Congreso.
- Transferencia a funcionarios SAG de conocimientos básicos de Sistemas Silvoagrícolas y su aplicación en el cuidado del Medio Ambiente y en el Control y Manejo de plagas fitosanitarias.
- Realización de 5 Charlas con la participación de 78 funcionarios SAG (34 funcionarios más de lo programado), a quienes se les entregó un documento Técnico denominado "Establecimiento y Manejo de Sistemas Silvoagrícolas. Generalidades".

2.3 Resultados e Impactos esperados inicialmente en la propuesta

La actividad de formación participando en el evento: Primer Congreso Mundial de Agroforestería permitiría al participante en primer lugar, actualizar los conocimientos adquiridos a través de su formación curricular y a través de ello transferir a un universo de 44 funcionarios del Servicio Agrícola y Ganadero de la Región de la Araucanía, los nuevos conceptos del uso sustentable del suelo y de los sistemas productivos profundizando especialmente en los temas de mejoramiento del medio ambiente y del paisaje, temas políticos, sociales e institucionales, la agroforestería en los próximos 25 años, biodiversidad, captura de carbono y beneficios medio ambientales, transferencia de tecnologías y agua (temas todos que serán analizados en el Congreso).

En el corto plazo, se esperaba transferir y motivar respecto de los aprendizajes de los conceptos de agroforestería e intervención sustentable del medio ambiente a los funcionarios antes mencionados, para que estos a su vez lo apliquen en sus actividades institucionales cotidianas.

A mediano plazo, se esperaba que los usuarios del Servicio especialmente de los Programas y Proyectos asociados a la Protección de los Recursos Naturales Renovables, como también en temas de Defensa y Control de Plagas Fitosanitarias, conozcan y apliquen los conceptos transmitidos por los funcionarios del Servicio.

En el largo plazo, se pretendía que los procesos de degradación del uso del suelo y de impacto negativo plagas fitosanitarias endémicas y cuarentenarias tiendan a revertirse, como así mismo, las nuevas intervenciones productivas y de tratamiento de problemas sanitarios incorporen y provoquen el mejoramiento del medio ambiente y el paisaje.

Toda esta actividad permitiría además transferir antecedentes en los distintos niveles antes señalados con el objeto de internalizar los conceptos de biodiversidad, de tal forma que la comunidad en general, proyecte, ejecute y practique una relación armónica en cada una de sus áreas productivas, como también en aquellas áreas de Protección reguladas por el Servicio Agrícola y Ganadero de la Novena Región de la Araucanía.

2.4 Resultados alcanzados

Toda la actividad de transferencia de conocimientos serán internalizadas por los profesionales, técnicos y administrativos que recibieran la información, en especial aquellos que desarrollan su actividad en el área de Recursos Naturales Renovables, podrán aplicarlas en los programas y proyectos de Conservación y Rehabilitación de Suelos.

Se deberá además, intentar a futuro, incorporar prácticas agroforestales, al sistema de Incentivos para la Recuperación de Suelos Degradados.

El tratamiento de plagas y enfermedades endémicas y cuarentenarias puede mejorarse a través de la aplicación de prácticas que apuntan a incorporar los árboles en el tratamiento cuarentenario de predios infestados.

2.5 Resultados adicionales

No hubo resultados adicionales.

2.6 Aplicabilidad

Los sistemas agroforestales y sus diferentes prácticas, son perfectamente aplicables en la Conservación de Suelos, de la fauna y flora nativa en especial, como del medio ambiente en general.

Si la situación lo amerita y se deben cuarentenar predios por el tratamiento de una plaga cuarentenaria en especial, estos sistemas tienen un aplicabilidad garantizada, logrando compatibilizar una medida de control y/o erradicación, con un sistema productivo simultáneo, que le permita obtener un ingreso económico importante al productor implicado.

2.7 Detección de nuevas oportunidades y aspectos que quedan por abordar

Existen nuevas oportunidades por abordar, relacionadas con :

- Preparación de proyectos específicos para abordar problemas ecológicos en áreas frágiles.
- Incorporación de prácticas agroforestales en Políticas de Fomento de Minagri.
- Desarrollo de prácticas silvopastorales para mejorar hábitat de fauna silvestre.
- Mejoramiento de ambientes (a través de la repoblación forestal), para aumentar la población de aves rapaces y carnívoros depredadores del raton colilargo. Esto es compatible con un Proyecto que en este sentido desarrolla el SAG IX Región con la Universidad Austral de Chile.

3. ASPECTOS RELACIONADOS CON LA ORGANIZACIÓN Y EJECUCIÓN DE LA PROPUESTA

3.1 Programa de actividades

Fecha	Actividad	Objetivo	Lugar
23/06/04	Traslado Temuco-Santiago	Planificación Viaje al exterior captura documentación SAG Central.	Santiago Chile
25-26/06/04	Traslado Santiago-Orlando	Arribo a Orlando	Orlando USA
27/06/04 al 02/07/04	Participación en el Primer Congreso Mundial de Agroforestería	Adquirir conocimientos sobre el tema: "Trabajando juntos por el uso sustentable de los sistemas agroforestales"	Orlando USA
03/07/04	Traslado Orlando Santiago	Retorno al país	Santiago Chile
05/07/04	Traslado Santiago-Temuco	Retorno a la Región	Temuco
20/08/04	Charla Técnica	Dar a conocer avances agroforestería mundial y prácticas productivas sustentables.	Centro Cultural. Sala de reuniones Municipio de Imperial.

03/09/04	Charla Técnica	Dar a conocer avances agroforestería mundial y prácticas productivas sustentables.	Sala de reuniones SAG Victoria.
10/09/04	Charla Técnica	Dar a conocer avances agroforestería mundial y prácticas productivas sustentables.	Sala de reuniones SAG Angol.
27/09/04	Charla Técnica	Dar a conocer avances agroforestería mundial y prácticas productivas sustentables.	Sala de reuniones SAG Villarrica
08/10/04	Charla Técnica	Dar a conocer avances agroforestería mundial y prácticas productivas sustentables.	Sala de reuniones SAG Temuco

Las actividades programadas en la propuesta se cumplieron plenamente, aumentando de 44 a 78 el universo de funcionarios del Servicio Agrícola y Ganadero sujetos de transferir los nuevos conceptos de uso sustentable del suelo y de sistemas silvoagrícolas. **(Ver anexo 5)**

Debido a razones de compromisos laborales y otros, las actividades que se programaron para los meses de Agosto a octubre de 2004, se realizaron en el mes de Marzo de 2005, con autorización de la Fundación para la Innovación Agraria.

3.2 Contactos Establecidos

Institución/ Empresa/Organi- zación	Persona de Contacto	Cargo	Fono/Fax	Dirección	E-mail
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Ver además listado de participantes en Anexo 1					

3.3 Material Recopilado	
Tipo de Material	Caracterización (título)
Díptico	Diversifiez votre exploitation avec... L' Agroforesterie
Publicación	Australia Forest Growers
Publicación	DFID Developing Prosopis as a valuable resource for dry zones
Díptico	Productive Conservation: Growing Specialty Forest Products in Agroforestry Plantings
Folleto	Agroforestry. An Integration of Land Use Practices
Folleto	Agroforestry in Action. Tax Considerations for the Establishment of Agroforestry Practices
Folleto	Agroforestry in Action. Economic Budgeting for Agroforestry Practices
Folleto	Agroforestry in Action. Growing Chinese Chestnuts In Missouri
CD/Video	Alley Cropping
CD/Video	Wind Breaks
Documentos originales en Anexo 6	

4. PROGRAMA DE DIFUSIÓN EJECUTADO

4.1 Programa de difusión ejecutado

Fecha	Tipo de actividad	Lugar	Temas tratados	Destinatarios				Expositor	Actividad asistentes
				N°	Profesionales	Técnicos	otros		
10/03/05	Charla	Angol (Oficina SAG)	-Programa del Congreso -Establecimiento y Manejo de Sistemas Silvoagrícolas. Generalidades. -Videos sobre: Cortinas Cortavientos y Cultivos en callejones.	16	4	9	3	Alberto Hofer	Invitados
10/03/05	Charla	Victoria (Oficina SAG)	-Programa del Congreso -Establecimiento y Manejo de Sistemas Silvoagrícolas. Generalidades. -Videos sobre: Cortinas Cortavientos y Cultivos en callejones.	10	3	6	1	Alberto Hofer	Invitados
17/03/05	Charla	Temuco (Oficina SAG)	-Programa del Congreso -Establecimiento y Manejo de Sistemas Silvoagrícolas. Generalidades. -Videos sobre: Cortinas Cortavientos y Cultivos en callejones.	24	11	11	2	Alberto Hofer	Invitados

Fecha	Tipo de actividad	Lugar	Temas Tratados	Destinatarios				Expositor	Actividad asistentes
				N°	Profesionales	Técnicos	Otros		
17/03/05	Charla	Villarrica (Oficina SAG)	-Programa del Congreso -Establecimiento y Manejo de Sistemas Silvoagrícolas. Generalidades. -Videos sobre: Cortinas Cortavientos y Cultivos en callejones.	11	4	4	3	Alberto Hofer	Invitados
23/03/05	Charla	Imperial (Oficina SAG)	-Programa del Congreso -Establecimiento y Manejo de Sistemas Silvoagrícolas. Generalidades. -Videos sobre: Cortinas Cortavientos y Cultivos en callejones.	17	6	11	0	Alberto Hofer	Invitados
				78	28	41	9		

4.2 Material entregado en las actividades de difusión

Tipo de material	Nombre o identificación	Preparado por	Cantidad
Informe Técnico	Establecimiento y Manejo de Sistemas Silvoagrícolas. Generalidades.	Alberto Hofer Meyer	78
Video	Wind Breaks	Universidad de Missouri	Exibido
Video	Alley Cropping	Universidad de Missouri	Exibido

*Nota: Ver texto charla en **Anexo 2** e Informe Técnico en **Anexo 3**.*

4.3 Participantes en actividades de difusión

Ver **Anexo 4**

5. EVALUACIÓN DE LA PROPUESTA

5.1 Organización durante la actividad (Indicar con cruces)⁰

Ítem	Bueno	Regular	Malo
Recepción en país o región de destino según lo programado	X		
Cumplimiento de reserva en hoteles	X		
Cumplimiento del programa y horarios según lo establecido por la entidad organizadora	X		
Facilidad en el acceso al transporte		X	
Estimación de los costos programados para toda la actividad	x		

5.2 Evaluación de la actividad de formación

a) Efectividad de la convocatoria

Plenamente efectiva, con participación de 526 profesionales de diferentes países.

b) Grado de participación de los asistentes (interés, nivel de consultas, dudas, etc)

Todas las charlas programadas contaron con participantes.
c) Nivel de conocimientos adquiridos en función de lo esperado (se debe indicar si la actividad contaba con algún mecanismo para medir este punto)
Se conocen nuevos tópicos en Agroforestería y se profundizan los ya conocidos. La actividad no contaba con mecanismos de medición de conocimientos adquiridos.
d) Calidad de material recibido durante la actividad de formación
Bueno.
e) Nivel de adecuación y facilidad de acceso a infraestructura/equipamiento necesario para el logro de los objetivos de la actividad de formación.
Excelente nivel.
f) Indique las materias que fueron más interesantes, más desarrolladas a lo largo de la actividad de formación y las que generan mayor interés desde el punto de vista de la realidad en la cual se desenvuelve el participante.
Alley Cropping, Silvopasture, Riparian Forest Buffer, Wind Breaks.
g) Problemas presentados y sugerencias para mejorarlos en el futuro
No se detectaron problemas.
5.3 Aspectos relacionados con la postulación al programa de formación o promoción
a) Apoyo de la Entidad Patrocinante (cuando corresponda) ☒ bueno ☐ regular ☐ malo Justificar: Se entregaron todas las autorizaciones de salida oportunamente, como así mismo los recursos comprometidos.
b) Información recibida por parte de FIA para realizar la postulación ☒ amplia y detallada ☐ aceptable ☐ deficiente Justificar: Con la participación en jornada de difusión de Programas FIA en Temuco (Biblioteca Municipal) y luego con el apoyo de los profesionales y funcionarios de FIA (Santiago y Temuco) durante la postulación.
c) Sistema de postulación al Programa de Formación o Promoción (según corresponda) ☒ adecuado ☐ aceptable ☐ deficiente Justificar: Sistema simple, rápido y desburocratizado.

d) Apoyo de FIA en la realización de los trámites de viaje (pasajes, seguros, otros) (sólo cuando corresponda)

☒ X buen

☐ regular

☐ malo

Justificar: Se contaron con todos los requisitos y trámites para viajar oportunamente.

e) Recomendaciones

Delegar, cuando corresponda, la realización de trámites administrativos a través de la Oficina de Temuco.

ANEXO 1

Listado de participantes en el Congreso

1st World Congress of Agroforestry: Working Together for Sustainable Land-use Systems
Orlando, Florida, USA
27 June to 02 July, 2004

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1st World Congress of Agroforestry: Working Together for Sustainable Land-use Systems
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1st World Congress of Agroforestry: Working Together for Sustainable Land-use Systems
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ANEXO 2

Charla Difusión Congreso

1ST WORLD CONGRESS OF **AGROFORESTRY**

Working Together for Sustainable Land-use Systems

1er Congreso Mundial de Agroforestería



EL PROGRAMA DEL CONGRESO

- I. Agroforestería y Seguridad Alimentaria
- II. Biodiversidad
- III. Captura de Carbono
- IV. Bases Ecológicas de la Agroforestería en Norteamérica
- V. Tránsito Tecnológico
- VI. Árboles y Mercados
- VII. Problemas de Agua

I. Adopción, Seguridad Alimentaria y superación de la Pobreza

Los temas relacionaron a las sesiones en:

- Adopción de la Agroforestería(Tropical y Templado),
- Agroforestería y Seguridad Alimentaria,
- Agroforestería para la Nutrición y Salud (SIDA/VIH), Superación de la Pobreza y Sustentabilidad)

II. Biodiversidad Ecoagricultura y Huertos Familiares

Los temas relacionaron a las sesiones en:

- Biodiversidad,
- Ecoagricultura,
- Plantas Medicinales y Aromáticas en Agroforestería y
- Huertos Familiares Tropicales

III. Aspecto Biofísicos

Los temas relacionaron a las sesiones en:

- Interacciones Biofísicas
- Captura de Carbono y Paisaje
- Ecología en el Oeste de Europa,
- Captura de Carbono y Beneficios Ambientales,
- Herramientas de Apoyo para las decisiones
- Mejoramiento Medioambiental, y Cambio Climático

IV. Aspectos Económicos y Sociales

Los temas relacionaron a las sesiones:

- Analisis Economicos,
- Tenencia de la tierra y Problemas de Género,
- Conocimiento Local de Agroforestería en el contexto Global,
- Leyes e Instituciones,
- Aumentando los beneficios de la Agroforestería, y
- Mecanización

V. Regiones Semiáridas, Fertilidad de Suelos y Educación Agroforestal

Los temas relacionaron a las sesiones en:

- Agroforestería en Regiones Semiáridas,
- Sesión de Propietarios,
- Suelo en Pequeñas Granjas
- Estrategias de Manejo de Fertilidad y
- Educación Agroforestal

VI. Manejo y Domesticación de Árboles

Los temas relacionaron a las sesiones en:

- Manejando la Diversidad Genética,
- Rotación Corta de Cultivos y Árboles,
- Phytoremediación,
- Árboles y Elementos de Manejo,
- Domesticación de Árboles y
- Árboles en Paisajes Fragmentados

VII. Problemas de Agua

Los temas relacionaron a las sesiones en:

- Agroforestería en zonas riverañas (protección) para la Calidad del Agua
- Control Erosion del Suelo, Reconstrucción de Ecosistemas, y Reducción de Sedimentos en el Rio Amarillo en China
- Restauración Forestal Riveraña: mejorando el habitat en cursos de agua (MENOCO), Funciones de Ecosistemas, y el proceso de contaminación de las aguas en zonas Agrícolas
- Agroforestería: Una Opción Sustentable para la perdida de agua re-usada en países en vías de desarrollo

ESTABLECIMIENTO Y MANEJO DE SISTEMAS SILVOAGRÍCOLAS



GENERALIDADES

GENERALIDADES

SISTEMAS SILVOAGRÍCOLAS

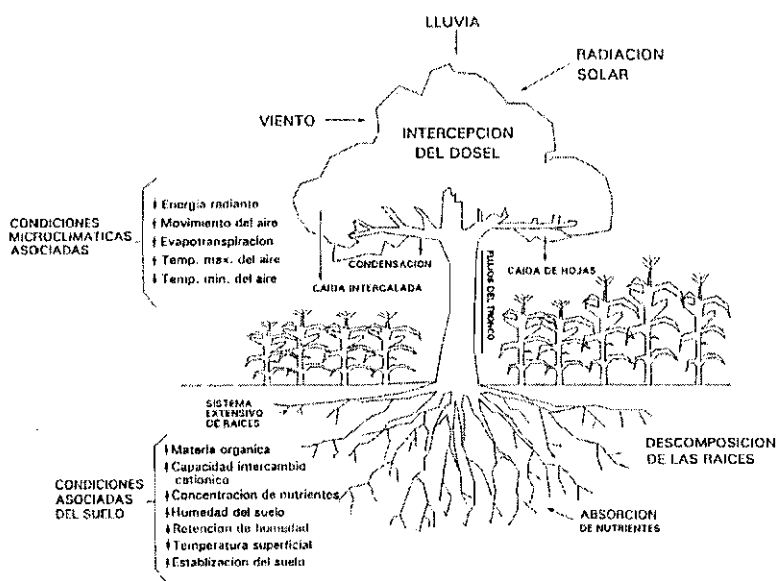
Concepto De Sistemas Silvoagrícolas:

FAO: "Un Sistema de manejo sostenido de la tierra, que incrementa el rendimiento de ésta, combina la producción de cultivos y plantas forestales (y/o frutales), simultanea o consecutivamente, en la misma unidad de terreno, y aplica prácticas de manejo que son compatibles con las prácticas culturales de la población local."

CARACTERÍSTICAS

- ESTRUCTURA
- PERMANENCIA
- ASPECTOS SOCIOECONÓMICOS
- ROL POTENCIAL DE LOS ÁRBOLES
- SUELO
- MICROCLIMA
- HIDROLOGÍA
- COMPONENTES BIOLÓGICOS ASOCIADOS
- ROL PRODUCTIVO DE LOS ÁRBOLES

Influencia de los árboles en el Ambiente del crecimiento del maíz (Farrell 1984)



MANEJO DE SISTEMAS SILVOAGRÍCOLAS

- **MANEJO DE PLANTAS**
 - Elección de especies
 - Diseño de Sistemas
- **MANEJO DE COMPONENTES**
- **MANEJO DE SUELOS**
 - Métodos de limpieza de terrenos
 - Prácticas de labranza
 - Control erosión
 - Mantenimiento de la fertilidad
 - Uso árboles fijadores de nitrógeno
 - Uso abonos verdes y cobertura de
- **MANEJO DE PLAGAS**

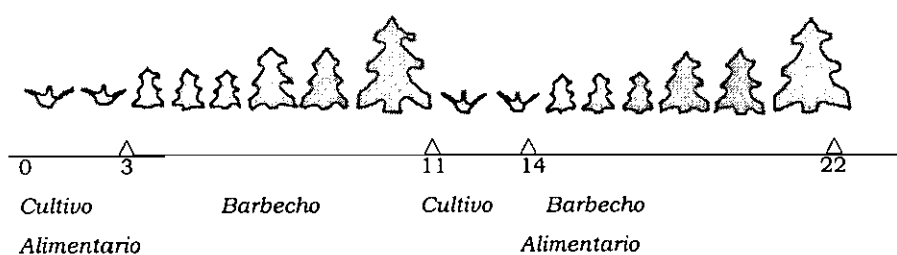
MANEJO DE SISTEMAS

➤ SISTEMAS SILVOAGRÍCOLAS SECUENCIALES

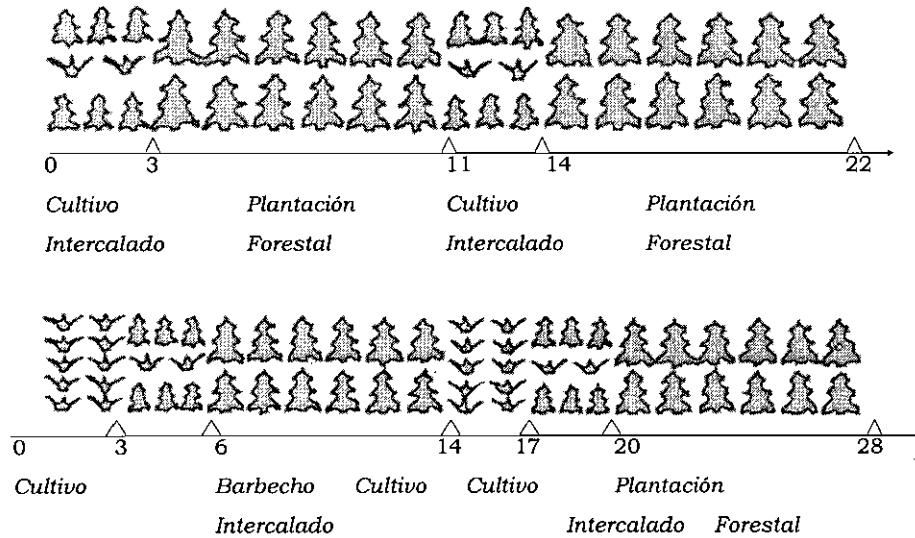
En estos existe una relación cronológica entre las cosechas anuales y los productos arbóreos; es decir, que los cultivos anuales y las plantaciones de árboles se suceden en el tiempo.

- Corta y Quema o Cultivo Migratorio
- Taungya

Cultivo Migratorio



Sistema Taungya (Dos tipos)

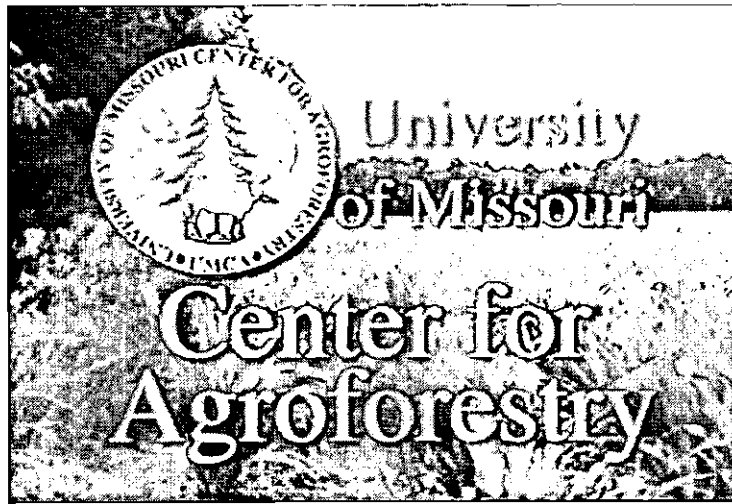
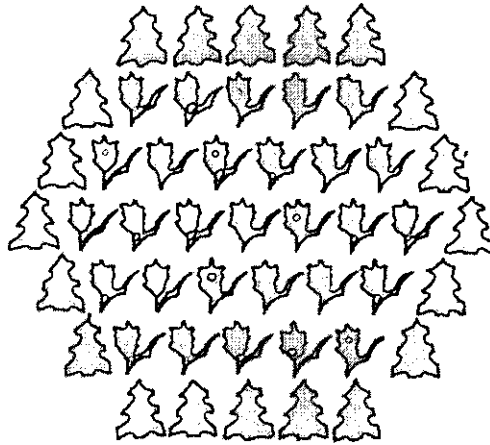


➤ **SISTEMAS SILVOAGRÍCOLAS SILMULTÁNEOS**

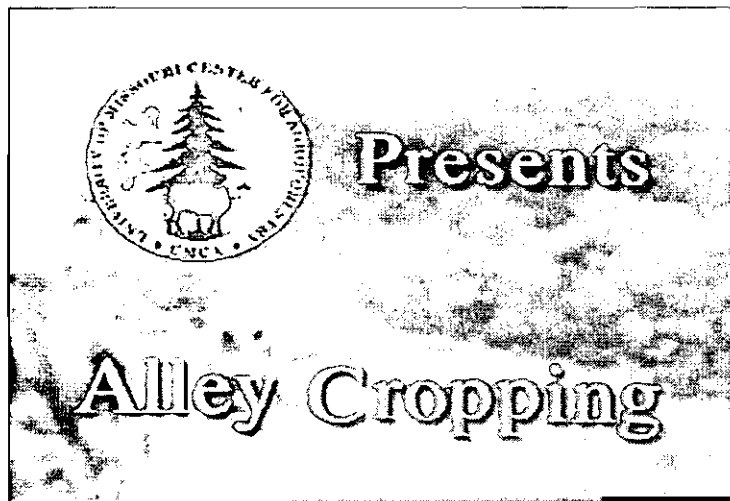
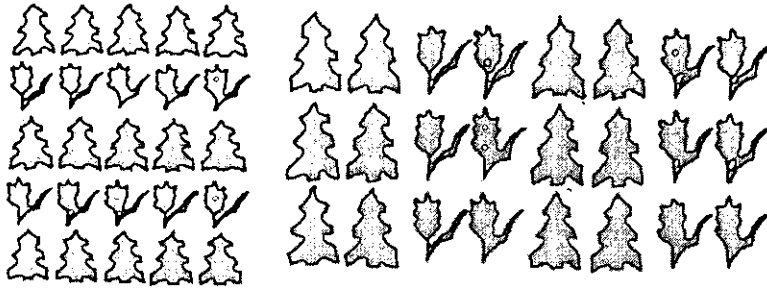
Consisten en la integración simultánea y continua de cultivos anuales o perennes y árboles maderables o de uso múltiple.

- Plantación de árboles en bordes
- Hileras alternadas y fajas alternadas
- Combinación Aleatoria

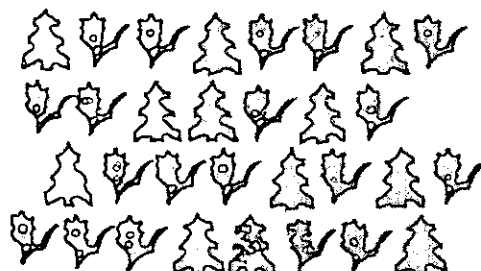
Árboles en bordes



Hileras y fajas alternadas



Combinación aleatoria



Categorías

- *Arboles productores de madera comercial en los cultivos.*
- *Arboles frutales asociados con cultivos.*
- *Arboles de sombra o mejoradores de suelo en cultivos.*

VENTAJAS DE LOS SISTEMAS SILVOAGRÍCOLAS

- *Se captura una mayor cantidad de energía solar.*
- *Se logra un mayor aprovechamiento del espacio vertical y se simulan, hasta cierto punto, los modelos ecológicos naturales en su forma y estructura*
- *Se reducen los daños causados por vientos fuertes, impacto directo de la precipitación e intensa radiación solar.*
- *Se retorna al suelo mayor cantidad de materia orgánica.*
- *Se mejora la estructura del suelo y la eficiencia en el reciclaje por la acción radicular a diferentes y mayores profundidades.*
- *Se reducen los problemas de malezas por la disminución en la cantidad de luz que llega al suelo y posibles efectos de "mulching", lo que a su vez, disminuye la evaporación de agua.*
- *Se mejora la fertilidad del suelo al emplear especies fijadoras de nitrógeno.*

- *Se promueve la diversidad vegetal, lo que contribuye a prevenir el ataque de plagas y enfermedades.*
- *Se obtiene a menudo beneficios económicos de los árboles satisfaciendo necesidades de leña, postes, varas, maderas para aserrío, frutos, forrajes, flores para la miel, y productos medicinales.*
- *Los árboles maderables constituyen un capital estable y un seguro para resolver emergencias en caso de necesidad inmediata de dinero.*
- *Se reducen las necesidades de importar o pagar la energía, sobre todo combustibles y otros productos traídos del exterior del sistema.*
- *Algunos modelos de producción permiten un cambio gradual de prácticas destructivas del uso de la tierra hacia sistemas más estables, sin reducir la productividad y que son susceptibles a modificaciones según las experiencias locales y/o mundiales.*

DESVENTAJAS DE LOS SISTEMAS SILVOAGRÍCOLAS

- *Se promueve una competencia por la luz en los estratos inferiores, lo cual, puede disminuir los rendimientos y calidad de la producción.*
- *Se promueve la competencia por el agua del suelo, sobre todo en los tiempos de escasez.*
- *Los árboles retienen parte de la precipitación en sus copas, lo cual puede ser relevante si las lluvias son ligeras*
- *La cosecha de los árboles puede causar daños mecánicos asociados.*
- *La mecanización se dificulta, a veces.*
- *La humedad relativa más alta en las cercanías del cultivo asociado puede favorecer la proliferación de enfermedades fungosas.*

- *A menudo los rendimientos de los cultivos, pueden ser menores que en monocultivos. Aunque el valor combinado de cultivos y árboles puede ser mayor, esto igualmente ocurre a largo plazo.*
- *Puede ser necesaria una mayor utilización de mano de obra, factor negativo si ésta es escasa, por ende la mecanización resulta ser una mejor alternativa.*
- *Existen una gran escasez de personal entrenado que maneje o mejore sistemas agroforestales existentes, que diseñe nuevos sistemas e instale parcelas demostrativas, lo cual puede dificultar la transmisión de tecnología.*

ANEXO 3

Informe Técnico: “Establecimiento y Manejo de Sistemas Silvoagrícolas. Generalidades”



GOBIERNO DE CHILE
FUNDACION PARA LA
INNOVACION AGRARIA



GOBIERNO DE CHILE
SERVICIO AGRICOLA Y GANADERO



ESTABLECIMIENTO Y MANEJO DE SISTEMAS SILVOAGRICOLAS. GENERALIDADES

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- 2004 -

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ESTABLECIMIENTO Y MANEJO DE SISTEMAS SILVOAGRICOLAS. GENERALIDADES

1.- INTRODUCCION

Durante miles de años han existido las relaciones ecofisiológicas de los bosques con su entorno natural. Son conocidas las múltiples influencias de éste sobre el clima, los suelos, el ciclo hidrológico, los cultivos y los animales, por mencionar los más importantes.

La relación bosque - agricultura, siempre se ha considerado problemática en el momento de establecer prioridades para satisfacer las necesidades del hombre, pero es después de muchos años que se ha empezado a comprender la necesidad de la convivencia equilibrada entre estos elementos del Medio Ambiente.

Dentro de este equilibrio que hoy día el hombre trata de mantener, está el de garantizar la ocupación del espacio ambiental en las mejores condiciones de Manejo y Productividad. Los sistemas silvoagrícolas son considerados como una buena opción, para mantener el equilibrio de estos ecosistemas terrestres por el hombre, sin menoscabar su productividad; siendo por lo tanto una forma de proporcionarle a las generaciones futuras, la perpetuidad de bienes que requieren para su crecimiento y desarrollo.

En las últimas décadas ha aumentado el interés por los sistemas integrados de producción agrícola, en donde se mezclan árboles y cultivos, tanto en el espacio como en el tiempo.

Este tipo de sistemas integrados han sido promovidos para situaciones particularmente frágiles, como es el caso de las cuencas hidrográficas donde la

agricultura migratoria esta destruyendo la cubierta forestal, así como también son ampliamente utilizadas en zonas áridas en peligro de desertificación. Sin embargo, están constituyendo además una interesante alternativa de productos de elevada calidad (madera) y simultáneamente producciones agrícolas muy rentables.

El presente trabajo tiene por objetivo establecer algunas generalidades respecto al establecimiento y manejo de los sistemas silvoagrícolas.

2.- SISTEMAS SILVOAGRICOLAS

2.1.- Concepto de Sistemas silvoagrícolas.

Los sistemas silvoagrícolas, enmarcados dentro de la agroforestería, son formas o patrones de uso de la tierra muy antiguos y ampliamente practicados, en donde los árboles son deliberadamente plantados dentro de la misma parcela de terreno junto a los cultivos agrícolas, como parte de un arreglo espacial o dentro de una secuencia temporal. Sin embargo, es en los últimos tiempos que se han desarrollado conceptos modernos de agroforestería; pudiendo destacarse la definición de FAO como "Un Sistema de manejo sostenido de la tierra, que incrementa el rendimiento de ésta, combina la producción de cultivos y plantas forestales (y/o frutales), simultanea o consecutivamente, en la misma unidad de terreno, y aplica prácticas de manejo que son compatibles con las prácticas culturales de la población local."

2.2.- Características de los Sistemas Silvoagrícolas.

2.2.1.- Estructura: *A diferencia de la agricultura y de la silvicultura, de las prácticas silvoagrícolas combinan árboles y cultivos, integrando elementos de tales disciplinas. En el pasado, raramente los agricultores consideraban los árboles como una parte útil del predio, mientras que los técnicos verán los bosques simplemente como hábitat para el crecimiento de los árboles.*

2.2.2.- Permanencia: *El énfasis está puesto sobre la optimización de los efectos benéficos de las interacciones entre especies maderables y cultivos, reconociendo las características productivas y de protección de los árboles, como su componente clave dentro del Sistema. Utilizando los sistemas naturales como modelo y aplicando sus características ecológicas, se espera que la productividad pueda ser mantenida por largo tiempo sin degradación de la tierra; esto es particularmente*

importante, considerando el actual interés por aplicar estas prácticas en áreas de tierras marginales con bajos insumos disponibles.

2.2.3.- Incremento de la producción: *Como resultado de las relaciones complementarias, entre componentes de la finca, condiciones de crecimiento mejoradas y uso eficiente de recursos naturales (espacio, suelo, agua, luz, etc.), se espera que la producción total sea mayor en sistemas agrosilvícolas que en sistemas convencionales de uso de la tierra.*

2.2.4.- Aspectos socioeconómicos y culturales: *Aunque los sistemas silvoagrícolas pueden ser apropiados y ser utilizados para una amplia gama de tamaños de terreno y de condiciones socioeconómicas, su potencial ha sido culturalmente reconocido por pequeños agricultores de áreas marginales y pobres. Considerando que los campesinos están usualmente incapacitados de adoptar tecnologías modernas de alto costo, que no tienen conocimientos de las investigaciones agrícolas recientes y ante las frecuentes presiones por hacer productivas las tierras erosionadas, la creciente escasez de proveedores de madera combustible y la necesidad de un gran número de familias de obtener recursos básicos a partir de un terreno cada vez más pequeño, se torna vital desarrollar sistemas de uso de la tierra que asocien o articulen claramente la agricultura con la silvicultura, que conserven el ambiente y que al mismo tiempo produzcan tanto alimentos como madera.*

2.2.5.- Rol potencial de los árboles: *En general los árboles han sido subempleados en la agricultura, y aún cuando es mucho lo que se ha escrito sobre sus virtudes, su potencial ha quedado relativamente inexplorado. Ellos influyen sobre el resto de los componentes del sistema agrícola en virtud a su forma y sus hábitos de crecimiento (Figura 1). Sus frondosas copas influyen en la radiación solar, la precipitación y el movimiento del aire, mientras que sus extensos sistemas radiculares llenan grandes volúmenes del suelo. El sustrato o suelo donde crecen también puede ser alterado por la absorción de agua y de nutrientes, la redistribución de éstos últimos como*

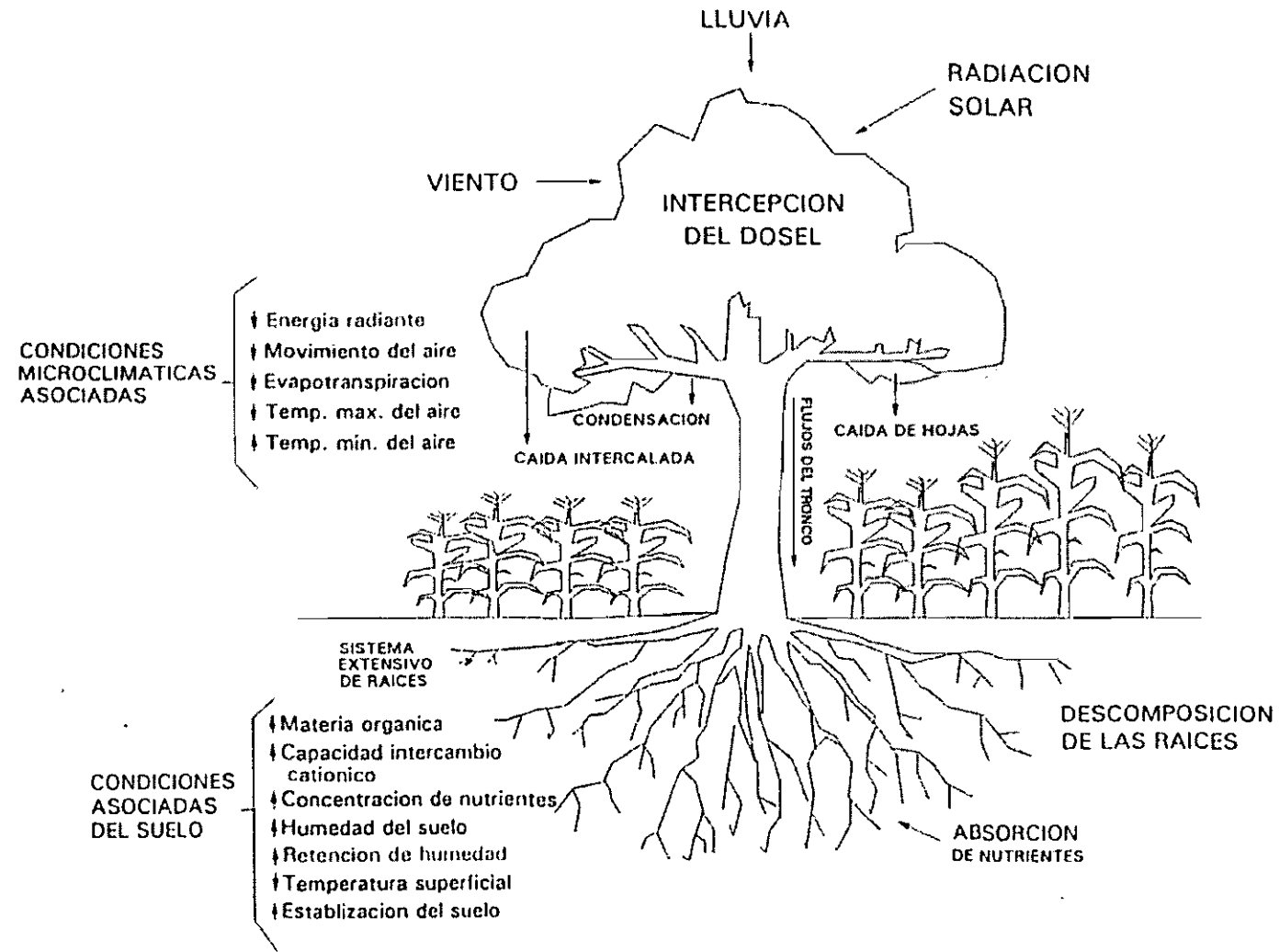


Figura 1.-

Influencia de los arboles en el Ambiente del crecimiento del maiz (Farrell 1984)

desechos de hojas, al igual que el movimiento disturbador de las raíces y sus posibles asociaciones con hongos y bacterias.

Los árboles pueden mejorar la productividad de un agroecosistema debido a su influencia en las características del suelo, en el microclima, la hidrología y otros componentes biológicos asociados.

2.2.6.- Características del suelo: *Los árboles pueden afectar la fertilidad o el contenido de nutrientes del suelo al explotar las reservas minerales ubicadas a mayor profundidad, ya sea en el sustrato o en la roca madre, y al recuperar los nutrientes lixiviados y depositarlos en la superficie como desechos de hojas. Esta materia orgánica incrementa el contenido del humus del suelo, lo que a su vez acrecienta su capacidad de intercambio de cationes y disminuye las pérdidas de nutrientes. La materia orgánica añadida también modera la reacción del suelo (pH) y por consiguiente la disponibilidad tanto de nutrientes esenciales como de elementos tóxicos. Dado que el nitrógeno, el fósforo y el azufre son retenidos principalmente bajo su forma orgánica, para hacerlos disponibles resulta especialmente importante tener altos contenidos de materia orgánica. La asociación de árboles con bacterias fijadoras del nitrógeno y con micorrizas, también incrementan los niveles disponibles de nutrientes. La actividad de los microorganismos tiende a aumentar debajo de los árboles debido al incremento de la materia orgánica (una mejor provisión alimenticia) y a un mejor medio de crecimiento (temperatura y humedad del suelo).*

Los árboles pueden también influir en las propiedades físicas del suelo, de las cuales la más importante es la estructura. Esta mejora debido a una mayor cantidad de materia orgánica (hojas, raíces), así como por la acción disturbadora de las raíces del árbol y de la actividad microbiana, todo lo cual ayuda a desarrollar agregados más estables. La temperatura del suelo es regulada por la sombra y la cubierta de desechos.

El Rol que los árboles pueden jugar en la protección del suelo es bien reconocido. Además de reducir la velocidad del viento las copas de los árboles disminuyen el impacto potencial de las gotas de lluvia al golpear la superficie del suelo. La capa de hojas que cubre la tierra, además de contribuir a mejorar la estructura, también ayuda a reducir la erosión superficial. El sistema radicular pivotante difuso que tienen muchas especies de árboles cumple la función importante que es, dar estabilidad al terreno, especialmente en suelos de laderas empinadas.

2.2.7.- Microclima: *En general los cambios de temperatura se ven atenuados por los árboles: generalmente se registran temperaturas máximas inferiores y mínimas más altas bajo las copas de los mismos, que en los espacios abiertos. Una baja temperatura producida por la sombra de las copas, así como un menor movimiento del viento, tendrán como resultado una reducción del índice de evaporación. También se encuentra una humedad relativa mayor, bajo los árboles que en las áreas abiertas.*

2.2.8.- Hidrología: *El balance hidrológico de un lugar dado, o de una finca o región, es afectado por las características estructurales y funcionales de los árboles. Dependiendo de la densidad de las copas y las características específicas de las hojas, las precipitaciones pasan a través de ellas hasta la superficie del suelo donde son interceptadas, luego son evaporadas, o pueden ser redistribuidas en forma de precipitación interna (gotas de niebla), la que es una fuente bastante significativa de agua en las regiones húmedas o de neblina. Como resultado de una estructura de suelo mejorada y la presencia de un mantillo de hojas, el agua que llega al suelo se utiliza mejor, debido a una mayor infiltración y permeabilidad en la superficie. A una escala mayor, especialmente en áreas propensas a inundaciones, los árboles pueden desempeñar un papel importante al aumentar la infiltración de agua hacia el subsuelo.*

2.2.9.- Componentes biológicos asociados: *Varios componentes biológicos de los agroecosistemas (p.e. cultivos, insectos, lombrices, etc.) pueden beneficiarse por la*

presencia de árboles compatibles. Aunque los mecanismos específicos son todavía poco comprendidos, ellos generalmente se relaciona con un clima más favorable, un mejor régimen de humedad, un buen contenido de materia orgánica y una mayor disponibilidad de nutrientes.

2.2.10.- Rol productivo de los árboles: *Una de las más valiosas características de los árboles, es que mucho de ellos producen un sinnúmero de productos diferentes e importantes tanto para los humanos como para los animales. No solo son fuente de alimento y forraje, sino que también proporcionan madera, subproductos tales como aceites y tinturas, y se utilizan con fines medicinales. La "robinia" (Robinia pseudoacacia) por ejemplo, es una importante planta para la producción de la miel, fija nitrógeno y sirve para postes muy durables. La leucanea, otra leguminosa con propiedades de fijar nitrógeno, es valiosa como alimento para aves y el ganado en las zonas tropicales, por su alto contenido de vitaminas y proteínas; es asimismo una fuente importante de leña. Los árboles también pueden proporcionar un suplemento importante a la producción de granos. Especies como la castaña (Castanea sp.), y el algarrobo (Ceratonia sp.), tienen un valor alimenticio más alto en proteínas, carbohidratos y grasas que algunos de los granos más comunes, además tienen la ventaja de crecer en tierras marginales sin necesidad de ser cultivadas. En Chile, el tamarugo (Prosopis tamarugo) y el encino (Quercus sp) reúnen también algunas de las características mencionadas.*

3.- MANEJO DE SISTEMAS SILVOAGRICOLAS

El manejo tiene como objetivo recuperar, mantener o aumentar el nivel de productividad del sistema a largo plazo y favorecer la conservación de los recursos disponibles. En consecuencia, las técnicas generales de manejo están dirigidas a proteger el suelo contra la pérdida de la capacidad productiva, mantener el balance del ciclo de nutrientes y asegurar el suministro de agua y nutrientes para los cultivos, a la vez que lograr un buen nivel de producción. El manejo incluye: el establecimiento y cuidado de cultivos y de otras plantas asociadas, el uso de los suelos, el control de plagas y, en un sentido amplio, el uso óptimo del sistema desde el punto de vista de los beneficios por obtener.

3.1.- Manejo de plantas en Sistemas Silvoagrícolas.

3.1.1.- Elección de especies: *Las especies son escogidas utilizando los siguientes criterios:*

- a) intentar modificar un sistema existente, en lugar de introducir uno nuevo;*
- b) dar preferencia a especies locales conocidas por los agricultores;*
- c) tratar de lograr un uso complementario de los recursos; y,*
- d) evitar efectos alelopáticos.*

Es preferible modificar un sistema existente que llevar a cabo una innovación total, pues las posibilidades de aceptación y de éxito son mayores si se trata de técnicas ya conocidas. En la elección de especies de plantas adecuadas se puede seguir un criterio semejante y favorecer a las especies locales, o bien a aquellas cuyo uso es conocido por los agricultores; de ese modo resulta más probable que la modificación sea adoptada y utilizada con éxito.

La información sobre la biología y ecología de una especie indicará cuales son los requerimientos de luz, de nutrientes y de agua de cada cultivo. Por ejemplo,

con respecto a los requerimientos de luz, como el maíz no es tolerante a la sombra se elegirá esta especie para sistemas de cultivos en callejones, o "taungya", pero no se le asociará con árboles que provean una sombra densa al cultivo. El trigo y el arroz son tolerantes a altas densidades de siembra pero no resisten la sombra durante el llenado y maduración de los granos, de modo que deben asociarse de manera que puedan recibir bastante luz en este período. Las especies tolerantes a la sombra son, en general, aquellas de las cuales se aprovechan sus partes vegetativas, especialmente las hojas, como por ejemplo, árboles para la producción de hojarasca o forraje, el té, tabaco, pastos, leguminosas forrajearas. Las especies que producen raíces y tubérculos comestibles como la mandioca, batata y ñame pueden tolerar hasta un 50% de sombra sin que se vean afectados sus rendimientos. Los árboles frutales y las palmas son intolerables a la sombra; por ejemplo, en el banano y la palma africana el exceso de sombra puede aumentar los problemas de plagas y retrasar la maduración de los frutos.

La fenología de una especie indica cual es el momento y cuales son las condiciones ecológicas favorables para las diferentes etapas en el ciclo biológico de la misma: crecimiento vegetativo, desarrollo, reproducción, fructificación. Considera, asimismo, cuales son los períodos y condiciones más favorables para las prácticas de poda, fertilización y cosecha, y en que condiciones las especies son más susceptibles a problemas como sequía, escasez de nutrientes e incidencia de plagas u otros factores que puedan afectar la producción.

*Además, es importante tomar en cuenta el concepto de interferencia entre plantas, ya sea específica o interespecífica. La **interferencia** se refiere a la adición de algo que produce un impacto negativo sobre las plantas asociadas, a diferencia de la **competencia**, que consiste en la remoción de algo esencial para el crecimiento o desarrollo vegetal. Los efectos de **alelopatía** son un buen ejemplo de interferencia como resultado de la adición de sustancias; ciertos productos químicos producidos por una planta pueden tener efecto inhibitorio o estimulante para otras.*

3.1.2.- Diseño de Sistemas silvoagrícolas: Los ecosistemas naturales pueden servir de modelos para diseñar sistemas agrícolas sostenibles. El rasgo más conspicuo de los bosques naturales es su organización estratificada, utilizando así diferentes niveles de energía y de recursos, cada estrato vegetal contribuye al funcionamiento del sistema como un todo. Como resultado, los estratos de copa disminuyen el impacto de las gotas de lluvia al golpear el suelo y reducen la cantidad de luz solar que llega directamente al mismo. Esto minimiza el potencial de pérdida de suelo, la evaporación se reduce y la velocidad de descomposición de la materia orgánica se hace más lenta. Generalmente hay poco movimiento de viento a nivel del suelo. En la superficie del terreno, el mantillo de las plantas en descomposición proporciona una cubierta protectora y una fuente de nutrientes que luego serán reciclados. Todas estas condiciones crean un medio ambiental ideal para la microflora, la fauna, y para los insectos y gusanos que aceleran la descomposición y la incorporación de la materia orgánica al suelo, creando así una buena estructura del mismo, la que a su vez aumenta la aireación y mejora la infiltración del agua. Existe una variedad de insectos presentes, algunos de los cuales son herbívoros, pero muchos de ellos potencialmente dañinos a la vegetación son mantenidos en regla por los predadores y parásitos presentes. Bajo la superficie del suelo, se genera una multicapa rica en nutrientes, la que es utilizada por las raíces de varias plantas que exploran diferentes volúmenes de suelo. Es así como, aquellos nutrientes que se filtran más abajo de la zona donde se extienden las raíces más pequeñas de las plantas, son interceptadas por las raíces de árboles de penetración más profunda y devueltos a la superficie por las hojas caídas.

Entender estos procesos en un sistema natural es esencial para establecer sistemas de agricultura ecológicamente estables.

El diseño incluye la disposición de las plantas en el terreno, densidad de siembra o plantación y distribución a través del tiempo en un plan de rotación. El conocimiento de la biología, ecología y fenología de las especies adquiere una importancia particular en este punto.

*La densidad de siembra o plantación influye sobre la competencia **intraespecífica**, es decir entre individuos pertenecientes a la misma especie y la competencia **interespecífica**, entre individuos de diferentes especies. En el primer caso, dado que las plantas pertenecen a la misma especie, tienen requerimientos semejantes de luz, agua, y nutrientes. En consecuencia, se trata de lograr una densidad tal que los recursos disponibles sean utilizados de manera eficiente: la **densidad óptima** es aquella en la cual se produce más; cuando empieza a bajar la producción se supone que ello sucede por efecto de la competencia. Tales son los criterios seguidos generalmente al diseñar monocultivos; una densidad de siembra elevada posee, en este caso, la ventaja de dificultar el establecimiento de malezas.*

¿Cuándo se produce competencia interespecífica? Como en los sistemas agroforestales existen asociaciones de diferentes especies, es posible que éstas compitan por el uso de recursos, es decir, que interfieran con el desarrollo de las otras. En este caso, se intenta diseñar la asociación de manera que las plantas se complementen en sus requerimientos en lugar de competir. En cultivos en callejones con leucaena se hallaron pocas raíces en los primeros 20 cm. de suelo, que es la capa ocupada por la mayoría de los cultivos anuales; en consecuencia, se supone que la competencia entre los árboles y los cultivos no resultaría un problema con esta especie.

La orientación de las hileras de los árboles afecta la utilización de la luz por parte de los cultivos entre las líneas. En zonas tropicales, la disposición de norte a sur recibe luz directa en el centro del espacio entre las hileras solamente a mediodía, mientras que una hilera de este a oeste la recibe el día entero. Hileras con orientación irregular en el terreno recibirán luz de una manera desigual. Todo esto cambia de acuerdo a la latitud del sitio. En general, la disposición en hileras de cultivos y árboles facilita el manejo del sistema posibilitando tareas como la poda, retirada de residuos o de árboles que se requieran cosechar.

Si las plantas hacen uso diferente de los recursos a lo largo del año, se puede diseñar el sistema espaciando las fases del ciclo de vida de los diversos cultivos de manera adecuada. Por ejemplo, en algunas especies las plántulas son tolerantes a la sombra, pero no lo son etapa adulta. En ese caso, en el diseño del sistema se contemplará que cada especie llegue al estado adulto en un momento diferente. Esto se puede lograr del siguiente modo:

- 1.- Plantando cultivos que alcancen la misma altura, pero que tengan diferentes ciclos de vida.*
- 2.- Plantando especies que alcancen diferentes alturas.*
- 3.- Plantando cultivos en diferentes momentos.*
- 4.- Minimizando la sombra que produce la especie más alta, utilizando especies de hojas erectas.*

3.2.- Manejo de los componentes.

Varios factores deben ser considerados en la disposición de las especies de plantas componentes, tanto en el espacio como en el tiempo.

Estos factores pueden incluir los requerimientos del cultivo y de las especies involucradas cuando crecen juntas, a su forma de crecimiento (tanto encima como debajo del suelo) y a su fenología, a los requerimientos del manejo de todo sistema y a la necesidad de acciones complementarias como la conservación del suelo o la mejora del microclima. De este modo los patrones de disposición de las plantas son específicos a los lugares. Los patrones posibles incluyen:

- a) El cultivo intercalado de especies con plantaciones anuales, sembrándose especies herbáceas y leñosas simultáneamente (o en la misma temporada). El*

espaciamiento de las especies leñosas variará considerablemente, pero en las regiones secas generalmente estarán más distanciadas.

- b) El clareó de franjas de un metro de ancho en bosques primarios o secundarios, a intervalos convenientes y plantando especies agrícolas perennes que toleren la sombra, como el cacao. A continuación la vegetación del bosque será entresacada selectivamente -a medida que las especies sembradas crezcan- y en unos cinco años habrá un dosel de dos o tres capas que consistirá en especies agrícolas perennes y las especies forestales seleccionadas.*
- c) La introducción de prácticas de manejo como el raleo y la poda para permitir que más luz penetre al suelo de la plantación, y la siembra de especies de cultivos seleccionados entre hileras de árboles. El grado de entresacado o de poda dependerá de la cantidad de los árboles, la estructura de la copa, etc.*
- d) En zonas montañosas se puede plantar especies de árboles en hileras a través de la pendiente (siguiendo las curvas de nivel), en distintas disposiciones de plantación (hileras solas, dobles, alternas, etc.), y con un distanciamiento variable entre ellas; entre los árboles y a lo largo de las líneas de contorno pueden establecerse pastos conservadores del suelo. La superficie que queda entre las hileras puede ser usada con especies agrícolas.*
- e) Las cortinas o barreras de árboles de uso múltiple alrededor de parcelas o campos de cultivo. Los árboles formarán setos vivos y rompevientos, proporcionarán forraje y combustible y señalarán los límites de las parcelas agrícolas. El esquema es especialmente adecuado para áreas de uso extensivo de la tierra.*

- f) *El dispersado de árboles en forma regular o al azar en zonas de agricultura intensiva. Este sistema es popular en las áreas cultivadas de Asia, el Pacífico, Africa y América del Sur.*

El medio más utilizado para cambiar las condiciones de luz en un sistema es la poda. La intercepción de la luz por la copa de los árboles es función del área foliar; sin embargo, no existe una función directa, porque después de cierto límite, una hilera más de follaje no puede afectar mucho más condiciones lumínicas del sitio. En otras palabras, la eliminación de parte del área foliar de un árbol por medio de la poda va a afectar menos la disponibilidad de la luz que la eliminación de árbol completo por medio de un raleo. Esto es importante porque indica que se pueden podar algunos árboles para obtener leña sin afectar mucho las condiciones del sistema. Para afectar significativamente las condiciones lumínicas por medio de la poda es necesario que ésta sea severa.

Con la inclusión de árboles de uso múltiple en los sistemas silvoagrícolas, también debe pensarse en manejo múltiple, es decir, adecuar los componentes del sistema a la utilización que se dé a cada uno. Por ejemplo, el espaciamiento amplio es preciso para los árboles cuyo propósito principal es la cosecha de madera y se deben emplear para ellos prácticas como la poda de ramas bajas para favorecer la forma. De estas podas se puede obtener leña; además entre estos árboles existe espacio para intercalar cultivos.

3.3.- Manejo de Suelos

Se recomiendan técnicas de manejo de suelos tendientes a disminuir los riesgos de erosión y a mantener o mejorar la fertilidad. Con tal propósito, las técnicas de manejo están diseñadas de modo que se cumplan los siguientes objetivos:

- 1.- *Conservar una cubierta vegetal o de hojarasca durante la mayor parte del año para proteger la superficie del suelo; de esa manera se reduce el impacto del sol y de la lluvia sobre el suelo y disminuyen los riesgos de erosión.*
- 2.- *Asegurar el contenido de materia orgánica en los estratos superficiales del suelo, con el fin de mejorar la retención de nutrientes y del agua. Al incrementar la capacidad de retención de nutrientes, la materia orgánica no sólo puede aumentar la eficiencia en el uso de fertilizantes, sino también contribuir además a suministrar nutrientes que se van a mineralizando lentamente, quedando de esa manera temporalmente protegidos de la lixiviación.*
- 3.- *Mantener un sistema de raíces superficiales que contribuyan a conservar la estructura del suelo y absorber los nutrientes que se encuentran en la capa superficial. De esa manera disminuyen las pérdidas de nutrientes por lixiviación.*
- 4.- *Minimizar en lo posible la remoción de materia orgánica y nutrientes a través de la cosecha. En este caso se trata de dejar sobre el terreno la mayor cantidad posible de residuos después de la cosecha, de modo que protejan al suelo, además de aportar materia orgánica y nutrientes.*
- 5.- *Tratar de disminuir en lo posible las quemas frecuentes, para evitar pérdidas de nutrientes a través de volatilización y lixiviación. Es posible aprender el manejo de la quema para utilizarla como una herramienta del agricultor. El objetivo es obtener sus beneficios (limpieza del terreno, provisión de nutrientes al suelo por medio de las cenizas, etc.), sin sus posibles efectos detrimentales (pérdidas excesivas de nutrientes, eliminación de materia orgánica, etc.).*

3.3.1.- Métodos de limpieza de terreno: *Las prácticas más utilizadas del terreno para la siembra incluyen métodos manuales, mecánicos, químicos y la quema.*

El corte manual del bosque, incluso con utilización de motosierra, es preferible al uso de maquinaria pesada, para evitar la compactación de los suelos y perturbación de los estratos superficiales que produce su uso. Si por razones económicas debe utilizarse maquinaria, el corte de los árboles lo más bajo posible resulta casi equivalente a la limpieza manual.

La quema del bosque, a pesar de las pérdidas de nutrientes que ocasiona, es preferible al uso de maquinaria. La quema causa pérdidas por volatilización de la mayor parte del carbono, nitrógeno y azufre contenidos en la biomasa, mientras que el fósforo, potasio y calcio son retenidos en las cenizas. Generalmente se supone que los nutrientes de las cenizas son incorporados al suelo en su totalidad; sin embargo, en una quema demasiado caliente pueden haber pérdidas sustanciales en forma de partículas que son elevadas por el calor y luego llevadas por el viento; de esa manera pueden perderse cantidades sustanciales de potasio, calcio, y fósforo. Por otro lado, una quema moderada e incompleta acelera la mineralización de nutrientes en comparación con la descomposición de la hojarasca en situaciones normales. Finalmente, una alternativa consiste en dejar los restos de vegetación cortados para que se descompongan bajo una cubierta verde de leguminosas; esto evitaría las pérdidas de carbono y nitrógeno que inevitablemente ocurren con la quema.

El uso de herbicidas es otra alternativa que debe tenerse en consideración para tratar de evitar el corte y desmalezado mecánico, aunque con el inconveniente de los efectos residuales que posiblemente afectarán a los cultivos; además, los herbicidas son caros y algunas veces peligrosos cuando son mal utilizados.

3.3.2.- Prácticas de Labranza: *El objetivo es la preparación del suelo para la siembra o plantación y la eliminación de malezas. Las prácticas más frecuentes son: el uso del arado, la labranza manual y la "labranza mínima".*

La labranza frecuente y excesiva, en condiciones de precipitación abundante y temperaturas elevadas, pueden ocasionar el deterioro de los suelos tropicales. El uso

repetido de implementos de labranza pesados tiende a destruir la estructura, invertir los horizontes y compactar al suelo. Esto disminuye la infiltración, con lo cual aumenta la escorrentía, con los consiguientes riesgos de erosión; además, se deja al suelo temporalmente expuesto, sin cobertura. También resulta afectado el crecimiento de las raíces y su capacidad para la absorción de nutrientes y agua.

Debido a que una de las razones para efectuar la labranza es el control de malezas, es preferible reemplazar esta práctica por otras técnicas que logren el mismo objetivo. Cuando se realiza un control de malezas adecuado, los rendimientos de las cosechas en los sistemas sin labranza pueden ser equivalentes a los obtenidos con el empleo de métodos de labranza convencionales. El sistema de cultivo sin labranza disminuye la erosión y aumenta el contenido de materia orgánica del suelo. De ese modo se pueden mantener niveles de producción elevados, mientras que se han observado reducciones drásticas en el rendimiento cuando se realiza labranza continua en los suelos tropicales, aun durante los 3 - 5 primeros años de cultivo.

A pesar de los beneficios de los sistemas sin labranza, es necesario tener en cuenta que con frecuencia la labranza es una manera conveniente de eliminar las malezas y preparar el suelo para la siembra; además, se evita la dependencia del uso del herbicidas. La conveniencia de la labranza está determinada por las características del suelo y la abundancia de malezas; más que "Sistemas sin labranza". Sería apropiado hablar de "Sistemas de labranza mínima", en los cuales se trata de disminuir en lo posible el uso de implementos para trabajar el suelo y se utilizan otros métodos para el control de malezas, tales como aumentar la densidad de siembra para dificultar el crecimiento de las malezas, el uso de coberturas verdes, o la aplicación de herbicidas.

3.3.3.- Control de la erosión: *Algunas técnicas aconsejables para disminuir los riesgos de erosión en las áreas con pendientes pronunciadas son: el cultivo en terrazas (siguiendo las curvas de nivel), la construcción de barreras y el uso de acequias de infiltración.*

3.3.4.- Mantenimiento de la fertilidad del suelo: *La utilización de fertilizantes es a menudo ineficiente en suelos de regiones tropicales, debido a las pérdidas de nutrientes por escorrentía, erosión, lixiviación y la volatilización causada por las temperaturas elevadas. En consecuencia, suele ser un método relativamente caro; por otra parte, tiende a ser menos conveniente depender exclusivamente del uso de fertilizantes para mantener la producción de los suelos en un nivel económicamente factible.*

Además, los precios de los fertilizantes a menudo no están al alcance de los agricultores, de manera que puede ser más adecuada la utilización de otras técnicas para el mantenimiento de la fertilidad, especialmente en los casos en que los recursos económicos son limitados.

3.3.4.1.- Uso de árboles fijadores de Nitrógeno: *Al utilizar árboles fijadores de nitrógeno es necesario tener en cuenta algunos aspectos de manejo. Es preciso escoger las especies y orígenes de árboles fijadores de nitrógeno de acuerdo con su capacidad fijadora, sus requerimientos en cuanto a fertilidad de los suelos y la susceptibilidad al daño producido por nemátodos y termitas.*

En muchos casos puede ser necesario inocular los arbolitos con cepas específicas de bacterias fijadoras de nitrógeno. La inoculación con nódulos de otros árboles (triturándolos y mezclándolos con las raíces de los arbolitos) no es recomendable debido a la posibilidad de propagar patógenos.

3.3.4.2.- Uso de abonos verdes y cobertura de hojarasca: *Se utilizan como abonos verdes especies cuyo objetivo principal es la cobertura del suelo para contribuir a su protección, suministro de nutrientes como nitrógeno, y disminución de la competencia.*

El uso de abonos verdes tiene la ventaja de que las raíces del cultivo utilizado como abono ayudan a mantener la estructura del suelo. Por otro lado, la

contribución de materia orgánica y nutrientes puede ser menor o más lenta que cuando se emplea una cobertura de hojarasca.

A pesar de las ventajas del uso de coberturas de hojarasca, es conveniente notar que se necesita una cantidad considerable de materia seca por hectárea para que se logren efectos significativos. En sistemas agroforestales las hojarasca del cultivo y de los árboles asociados puede proveer protección, si ésta tiene una tasa de descomposición relativamente lenta; o puede ser una fuente más o menos rápida de nutrientes para el suelo, si su descomposición es relativamente rápida; de manera que según sea el efecto preferido (protección o suministro de nutrientes) debe elegirse las especies adecuadas, basándose en datos conocidos sobre su tasa de descomposición y de liberación de nutrientes.

3.4.- Manejo de Plagas.

En un hábitat diverso es más probable encontrar mayor diversidad de enemigos naturales de las especies dañinas a los cultivos. Asimismo, cuando el ecosistema es heterogéneo, las plantas no hospederas actúan como barreras que impiden el fácil desplazamiento de insectos y reducen de ese modo su efecto. Lo opuesto ocurre en monocultivos, en los cuales se facilita el movimiento de insectos de planta a planta. En un ambiente más diversificado también existen mayores probabilidades que existan especies vegetales que produzcan sustancias aleloquímicas, es decir, compuestos que son tóxicos o poseen algún tipo de acción contra algunos herbívoros.

Un aspecto importante, es seleccionar cuidadosamente las especies de la asociación y de la rotación, procurando que no tengan plagas en común o sirvan de hospederas de parásitos que afecten a otras.

Otro aspecto clave se refiere a la aplicación de plaguicidas. Su uso tiene las desventajas de los costos, la relativa ineficacia en el control de ciertas plagas y los

problemas de contaminación de alimentos y suelos. Además, la utilización indiscriminada puede conducir a la eliminación de enemigos naturales de especies dañinas a los cultivos y de otras especies benéficas (polinizadores en general, como las abejas).

Existe un conjunto de técnicas conocidas con el nombre generalizado del "Manejo Integrado de Plagas". La selección de especies adecuadas en una asociación con respecto a la susceptibilidad a plagas, la presencia de hospederos intermediarios, la acción de depredadores y la necesidad del uso racional de plaguicidas, son aspectos a considerar en estas prácticas del manejo.

Técnicas del manejo integrado de plagas incluyen el uso de plaguicidas selectivos es decir que combaten sólo a las especies dañinas, sin perjudicar a las benéficas. La eliminación de malezas también constituye una práctica aconsejable cuando éstas sirven de hospederas temporarias de plagas que afectan a los cultivos.

También se incluyen entre las técnicas de control integrado de plagas aquellas que evitan la predisposición de las plantas al ataque de insectos y enfermedades. Ciertas condiciones desfavorables para el crecimiento vegetal, tales como deficiencias de agua y nutrientes, debilitan a las plantas y las hacen más susceptibles al ataque de insectos y enfermedades. En contraste, el exceso de nitrógeno en el suelo puede hacer a las plantas más palatables para los insectos. Esto ocurre a veces cuando se aplican fertilizantes nitrogenados y cuando se siembra una gramínea en asociación o siguiendo a una leguminosa fijadora de nitrógeno, en un plan de rotación. Finalmente, la sombra y la humedad excesiva pueden favorecer las condiciones para la reproducción y la incidencia de ciertas enfermedades producidas por hongos, como ocurre con la roya del cafeto.

3.4.1.- Control Cuarentenario: *La IX Región de la Araucanía posee la condición de zona libre de enfermedades cuarentenarias del cultivo de la papa, como son Angiosorus*

solani, (Carbón de la papa), Globodera rostochiensis, (Nematodo Dorado) y Pseudomona solanacearum (Marchitez Bacteriana).

Durante el año 1997, se descubrió un foco de carbón de la papa y que comprometía a 96,2 hectáreas, distribuidas en 12 predios de las comunas de Carahue y Puerto Saavedra.

Dada su condición de área libre de enfermedades cuarentenarias se inicio un programa de control y erradicación de la plaga, de tal forma de evitar la diseminación de la enfermedad y continuar con el proceso exportador del tubérculo. Este programa contempló el "Sellado" de los potreros infectados, a través de una medida cuarentenaria por 10 años, de total inmovilidad del sustrato (suelo), a través de prohibir los cultivos anuales y sólo permitir la producción de pasto con fines de corte y conservación y/o la repoblación forestal. (Figura 4).

Después de un importante análisis con los propios agricultores afectados, se determinó implementar un sistema Silvoagrícola de producción, a través de la plantación de Populus mussolino (alamo mussolino) y Populus híbrido (alamo híbrido), en densidades de 264 árboles por hectárea, en plantaciones de 3 metros sobre hileras y 12 metros entre hilera. De esta manera, se estableció una medida de protección sanitaria, compatible, con una medida productiva, al permitir la producción anual de forraje para corte y el crecimiento simultáneo de una especie forestal.

Una vez levantada la cuarentena de 10 años, se pueden explotar los alamos y/o iniciar un programa de producción de cultivos anuales en callejones.

Figura 2

Protección sanitaria a través de Sistema Silvoagrícola



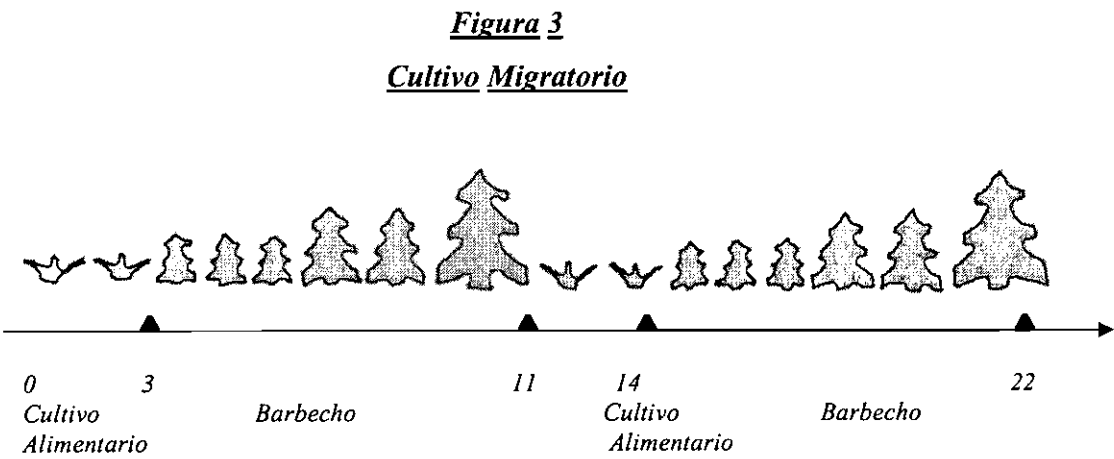
3.5.- Manejo de Sistemas Silvoagrícolas.

3.5.1.- Sistemas Silvoagrícolas Secuenciales: En estos existe una relación cronológica entre las cosechas anuales y los productos arbóreos; es decir, que los cultivos anuales y las plantaciones de árboles se suceden en el tiempo.

3.5.1.1.- Corta y Quema o Cultivo Migratorio: Es el más antiguo de los sistemas silvoagrícolas y se remonta al tiempo en que el hombre, paso por primera vez de la fase de caza y recolección al sistema de vida basado en el cultivo de plantas.

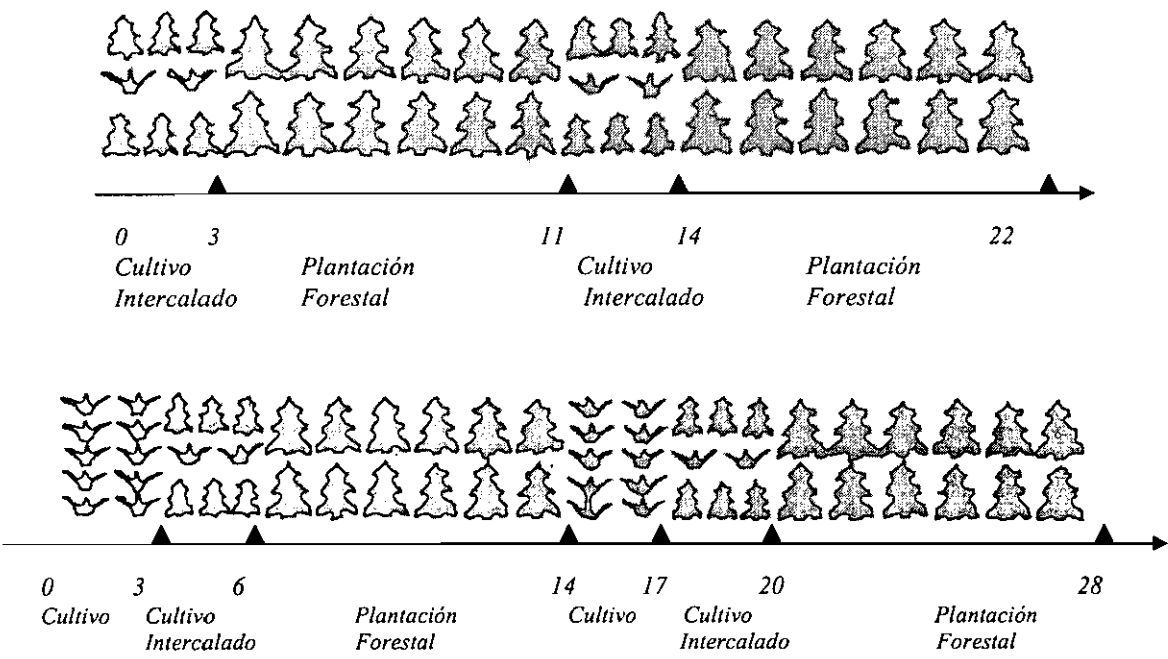
El bosque se corta, seca y quema con objeto de desbrozar la tierra y devolver al suelo los nutrientes contenidos en la biomasa forestal, para poder sembrar los cultivos alimenticios.

El cultivo dura 2 a 3 años, y después de la tierra se deja "descansar"(barbecho) durante un periodo mas largo (8 a 10 años) a fin de restaurar el suelo y preparado para el próximo ciclo de quema y cultivo (figura 2).



3.5.1.2.- *Taungya*: Consiste básicamente en la repoblación de un área, mediante la remoción del bosque natural y el establecimiento de cultivos agrícolas bajo la plantación forestal hasta que, debido al crecimiento de los árboles, no sea posible continuar cultivando la tierra bajo el bosque, trasladándose eventualmente los campesinos a otros sectores predefinidos donde se repite la misma operación hasta dejar establecida la plantación forestal en toda el área. Las diversas manifestaciones de este sistema suelen ocurrir también en áreas desnudas (Figura 3).

Figura 4
Sistema Taungya (Dos tipos)

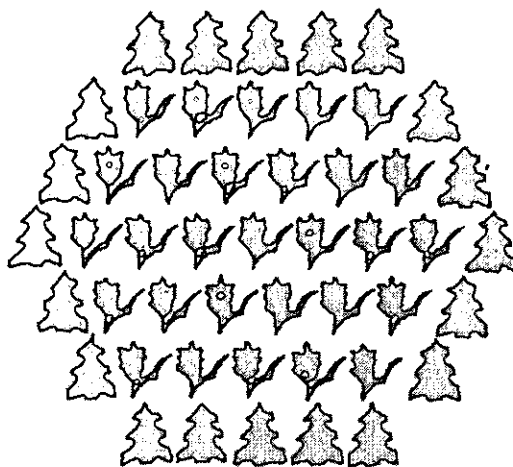


3.5.2.- Sistemas Silvoagrícolas Simultáneos: Consisten en la integración simultánea y continua de cultivos anuales o perennes y árboles maderables o de uso múltiple

3.5.2.1.- Plantación de árboles en bordes (Cercas vivas y cortinas rompevientos): Estos sistemas muy utilizadas en el sector rural americano, se presentan comúnmente asociadas, tanto para cultivos como para praderas. La denominación de esta práctica expresa claramente los objetivos fundamentales perseguidos. Sin embargo, el uso de la madera producida para leña y carbón, postes, y a veces para aserrío, esta dando una importancia especial a estas prácticas recientemente.

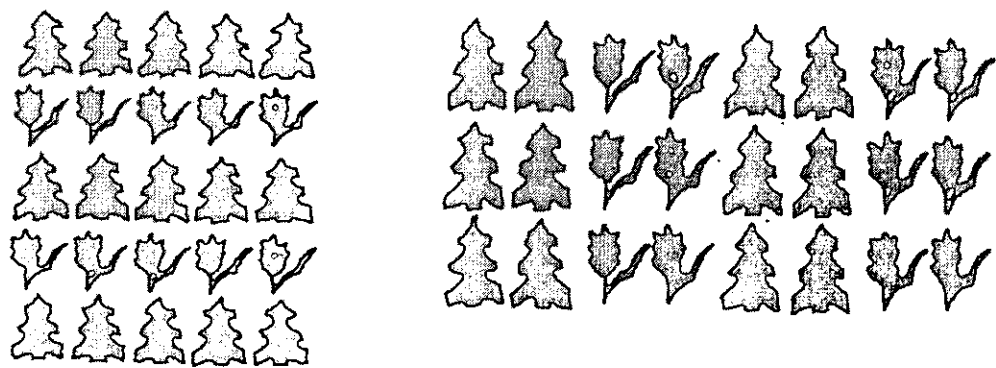
Las cercas vivas son generalmente hechas con especies de vigorosa capacidad de renuevo. Las leguminosas usadas son Erytrina spp y Gliricida sepium y otras especies tales como higueras, cactus y euphorbia. Las especies maderables seleccionadas para cortinas rompevientos usualmente tienen el mismo valor económico, se prefieren pinos, cipreses, eucaliptus, entre otras (figura 4).

Figura 5
Árboles en bordes



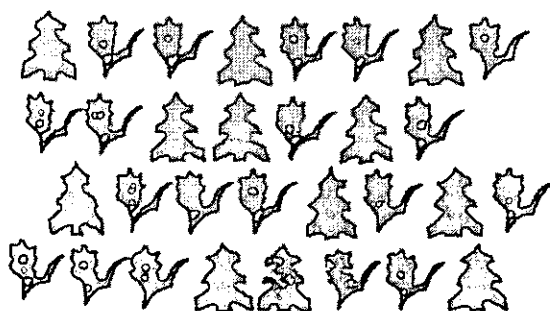
3.5.2.2.- *Hileras alternadas y fajas alternadas:* También se denominan callejones, avenidas, corredores, zonas o setos. Una faja difiere de una hilera, en que está compuesta de dos o más hileras. Para tierras ubicadas en laderas se ha ideado este sistema de hileras y fajas alternadas, en razón a que están plantadas a muy poca distancia, formando setos y siguiendo las curvas de nivel. Son el medio vegetativo más efectivo para estabilizar y conservar los suelos de las laderas (figura 5).

Figura 6
Hileras y fajas alternadas



3.5.2.3.- Combinación Aleatoria: Es un sistema en que no hay una disposición específica u ordenada de los cultivos componentes (Fig. 6) Si bien la disposición parece caótica, en realidad las plantas ocupan los lugares ecológicamente apropiados y pueden coexistir muy bien.

Figura 7
Combinación aleatoria



En esta categoría se pueden describir tres sistemas:

a).- Árboles productores de madera comercial en los cultivos: Una gran variedad de experiencias se reporta sobre este sistema para casi todos los países. En general, el espaciamiento aplicado entre los árboles, determina una densidad inferior a las plantaciones forestales con fines madereros exclusivos. En plantaciones de coníferas se suele plantar 250 árboles/ha. y en latifoliadas alrededor de 200 árboles/ha.

Muchas especies forestales han sido utilizadas en asociaciones de té, café, cacao, como también con cultivos anuales soya, maíz, arroz en las que destacan Cordia alliodora y Cedrela odorata en América tropical; Grevillea robusta, Acrocarpus fraximifolius y Terminalia superba en África. Asociados a cultivos de

cereales y leguminosas se usan Nothofagus, pinus, populus, Pawlonia tomentosa, y otros en el sur de América.

b).- Árboles frutales asociados con cultivos. Los árboles frutales pueden ser fácilmente combinados con cultivos, en plantaciones relativamente densas; plantaciones puras de árboles frutales son posibles Citrus sp. y ciertas palmas (cocos nucifera y Elaeis guianensis). La producción de fruta de especies forestales, ha sido también usada con éxito, tal como el marey (Anacardium occidentale), la nuez del Brazil (Bertholletia excelsa), y la macadamia (Macadamia integrifolia) y la castaña en Chile (Castanea sativa).

c).- Árboles de sombra o mejoradores de suelo en cultivos. Cultivos perennes de bosques tropicales, principalmente el café y el cacao, han sido cultivados por muchos años bajo la sombra. En el orden de tener un mejor control de la sombra de los árboles se seleccionan especies secundarias de crecimiento rápido con una buena capacidad de retoño. Los árboles son entonces podados regularmente, en especial durante el periodo de fructificación del cultivo.

Muchos árboles leguminosos son usados frecuentemente: Erythrina spp., Inga spp., Gliricida sepium, Leucaena leucocephala, entre otros.

4.- VENTAJAS Y DESVENTAJAS DE LOS SISTEMAS SILVOAGRICOLAS.

La comparación entre sistemas de producción agropecuaria basados en monocultivos de plantas anuales o perennes con técnicas agroforestales es una tarea difícil, ya que frecuentemente los monocultivos no tienen paralelo en agroforestería o, si bien existe, pueden no encontrarse bajo condiciones comparables. Las evaluaciones se complican por las proyección económicas a corto y largo plazo sobre el valor de la madera o por la estimación actual y/o futura del impacto ambiental. Incluso, la evolución dinámica de los factores sociales y culturales complican estas evaluaciones. Es por esto que la promoción de técnicas agroforestales debe basarse en una consideración científica y cuidadosa.

4.1.- Ventajas:

- a).- Se captura una mayor cantidad de energía solar.*
- b).- Se logra un mayor aprovechamiento del espacio vertical y se simulan, hasta cierto punto, los modelos ecológicos naturales en su forma y estructura*
- c).- Se reducen los daños causados por vientos fuertes, impacto directo de la precipitación e intensa radiación solar.*
- d).- Se retorna al suelo mayor cantidad de materia orgánica.*
- e).- Se mejora la estructura del suelo y la eficiencia en el reciclaje por la acción radicular a diferentes y mayores profundidades.*
- f).- Se reducen los problemas de malezas por la disminución en la cantidad de luz que llega al suelo y posibles efectos de "mulching", lo que a su vez, disminuye la evaporación de agua.*
- g).- Se mejora la fertilidad del suelo al emplear especies fijadoras de nitrógeno.*
- h).- Se promueve la diversidad vegetal, lo que contribuye a prevenir el ataque de plagas y enfermedades.*

- i).- *Se obtiene a menudo beneficios económicos de los árboles satisfaciendo necesidades de leña, postes, varas, maderas para aserrio, frutos, forrajes, flores para la miel, y productos medicinales.*
- j).- *Los árboles maderables constituyen un capital estable y un seguro para resolver emergencias en caso de necesidad inmediata de dinero.*
- k).- *Se reducen las necesidades de importar o pagar la energía, sobre todo combustibles y otros productos traídos del exterior del sistema.*
- l).- *Algunos modelos de producción permiten un cambio gradual de prácticas destructivas del uso de la tierra hacia sistemas más estables, sin reducir la productividad y que son susceptibles a modificaciones según las experiencias locales y/o mundiales.*

4.2.-Desventajas:

- a).- *Se promueve una competencia por la luz en los estratos inferiores, lo cual, puede disminuir los rendimientos y calidad de la producción.*
- b).- *Se promueve la competencia por el agua del suelo, sobre todo en los tiempos de escasez.*
- c).- *Los árboles retienen parte de la precipitación en sus copas, lo cual puede ser relevante si las lluvias son ligeras*
- d).- *La cosecha de los árboles puede causar daños mecánicos asociados.*
- e).- *La mecanización se dificulta, a veces.*
- f).- *La humedad relativa más alta en las cercanías del cultivo asociado puede favorecer la proliferación de enfermedades fungosas.*
- g).- *A menudo los rendimientos de los cultivos, pueden ser menores que en monocultivos. Aunque el valor combinado de cultivos y árboles puede ser mayor, esto igualmente ocurre a largo plazo.*
- h).- *Puede ser necesaria una mayor utilización de mano de obra, factor negativo si ésta es escasa, por ende la mecanización resulta ser una mejor alternativa.*

i).- Existen una gran escasez de personal entrenado que maneje o mejore sistemas agroforestales existentes, que diseñe nuevos sistemas e instale parcelas demostrativas, lo cual puede dificultar la transmisión de tecnología.

5.- CONCLUSIONES.

- *Los sistemas silvoagrícolas nacen como una alternativa ante la problemática del manejo adecuado de las tierras en las regiones tropicales y subtropicales del mundo.*
- *Los sistemas silvoagrícolas y los sistemas agroforestales en general, pueden contribuir al desarrollo rural mediante el suministro de productos derivados del manejo de estos sistemas y bienes fundamentales para la población rural, por medio de la conservación de la estabilidad ambiental necesaria para una producción constante de alimentos y mediante el aporte de empleos e ingresos agrícolas y forestales.*
- *Existe a nivel mundial un sinnúmero de experiencias, investigaciones y literatura especializada que tratan el tema agroforestal y que están a disposición de agricultores, técnicos y especialistas, con el objeto de iniciar programas masivos de difusión y aplicación.*
- *Cada región y cada agricultor en particular deberá analizar las diferentes alternativas de intervención de su predio, para implementar, algún sistema silvoagrícola, que se adapte a sus necesidades y se pueda desarrollar en armonía con su entorno y de acuerdo a los recursos disponibles en su sector.*

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ANEXO 4

Nómina Participantes Charlas de Difusión

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PROYECTO FIA**

Día 10 Marzo de 2005 - 10³⁰ hrs

OFICINA SAG

Angol

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PARTICIPANTES EN ACTIVIDADES DE DIFUSIÓN

Fedra: 10-03-05 Hora: 15⁰⁰

OFICINA SAG *VICTORIA*

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PARTICIPANTES EN ACTIVIDADES DE DIFUSIÓN

PROYECTO FIA

Fecha: 17.03.2005

Hora: 9 hrs.

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PROYECTO FIA**

Fecha: 17/03/01

Lugar: 1500

OFICINA SAG Villarrica

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**PARTICIPANTES EN ACTIVIDADES DE DIFUSION
PROYECTO FIA**

Fecha: 23/03/2005

Hora: 9:00 AM.

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ANEXO 5

Imágenes (Fotografías) de actividades de difusión



Charla Oficina SAG Angol



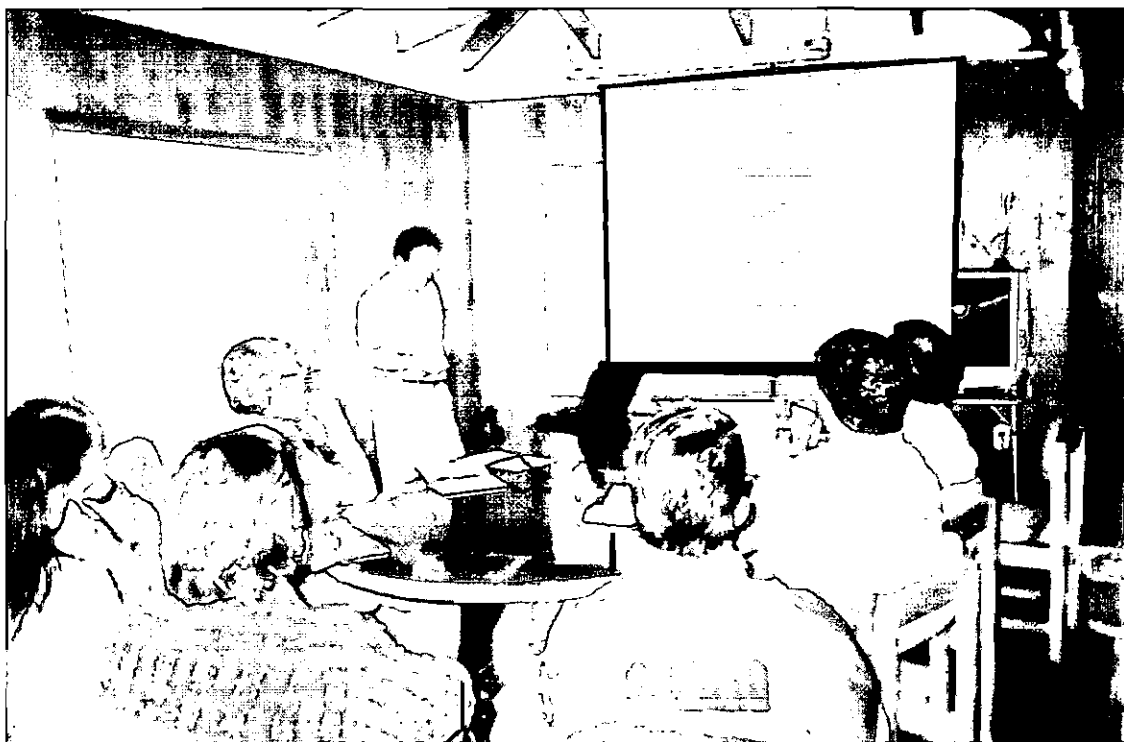
Entrega Informe Técnico Oficina Angol



Charla Oficina SAG Victoria



Entrega Informe Técnico Oficina Victoria



Charla Oficina SAG Villarrica



Entrega Informe Técnico Oficina Villarrica



Charla Oficina SAG Temuco



Charla Oficina SAG Imperial



Entrega Informe Técnico Oficina Imperial

ANEXO 6

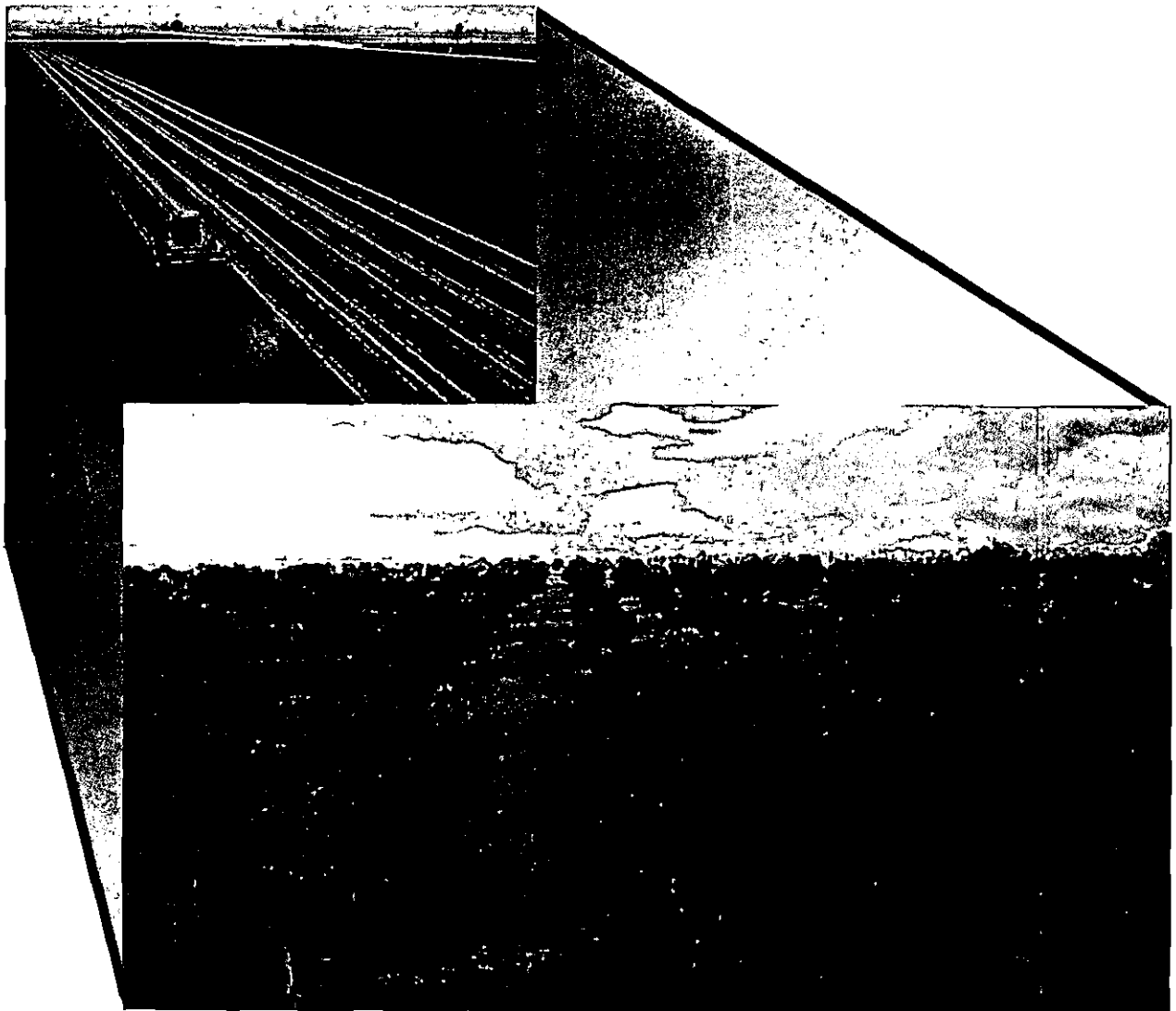
Material Recopilado

AGROFORESTRY

UMCA - 1 - 2000

AN INTEGRATION OF LAND USE PRACTICES

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University of Missouri Center for Agroforestry

Written and Designed by
Sara M. Peters

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The University of Missouri Center for Agroforestry (UMCA) is an interdisciplinary research, teaching and technology transfer program that draws on the expertise of university faculty in forestry, fisheries and wildlife, entomology, plant pathology, agronomy, animal science, agricultural economics, rural sociology and horticulture. The Center coordinates agroforestry activities for use in Missouri and adjacent areas of the Midwest. Its mission is to initiate, coordinate and enhance agroforestry activities to meet the environmental, social and economic needs of land management within the state of Missouri, North America and the temperate zone worldwide.



Agroforestry

Agroforestry is a set of integrated land use practices. It combines trees, shrubs, forages, grasses, livestock and crops in innovative, flexible combinations tailored to the landowner's needs. The goal in agroforestry is to optimize production and conservation benefits.

Properly designed and implemented, agroforestry practices can

- ◆ Increase crop production
- ◆ Diversify products and farm income
- ◆ Improve soil quality and reduce erosion
- ◆ Improve water quality and reduce damage due to flooding
- ◆ Enhance wildlife habitat and improve biodiversity
- ◆ Reduce pest management inputs

In the temperate United States, agroforestry consists of five main practices:

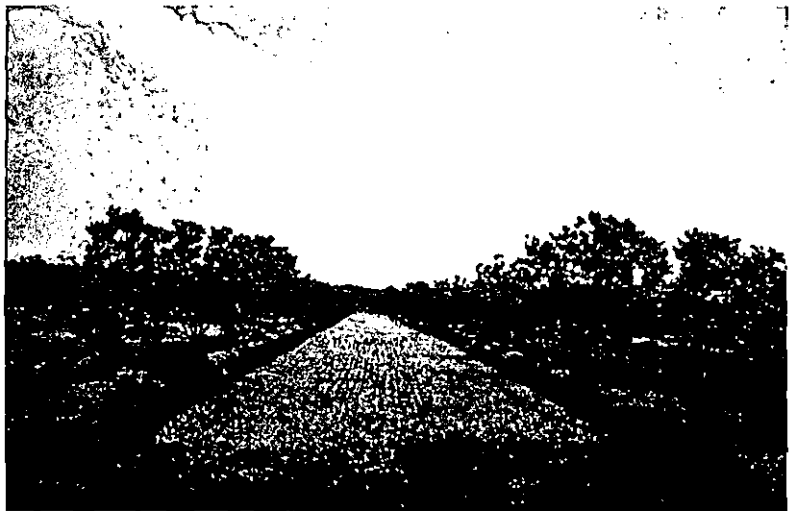
- (1) Alley Cropping
- (2) Silvopasture
- (3) Riparian Forest Buffers
- (4) Windbreaks and
- (5) Forest Farming.

When designing and implementing any of the five practices, it is important to consider the compatibility of the species with the site, the compatibility between species, the farm equipment available and the potential markets. Your local natural resource professionals in agriculture extension, the natural resources conservation service, and your local state forestry office can provide you with design and implementation assistance, as well as information regarding restrictions or requirements for stream-side protection or maintaining wildlife habitat.

Alley Cropping

Alley cropping is the planting of trees and/or shrubs in single or multiple tree rows at relatively wide spacing with a companion crop grown in the alleyways between the tree rows. The benefits realized in alley cropping practices include increased income diversity, biological diversity, improved aesthetics and reduced negative environmental impacts.

Alley cropping practices are designed according to the site characteristics, the tree products desired (e.g., nuts or timber), the growth requirements of the selected tree, the crop being grown in the alleyway, the farm equipment available and the landowner's objectives. For example, alleys can be arranged in



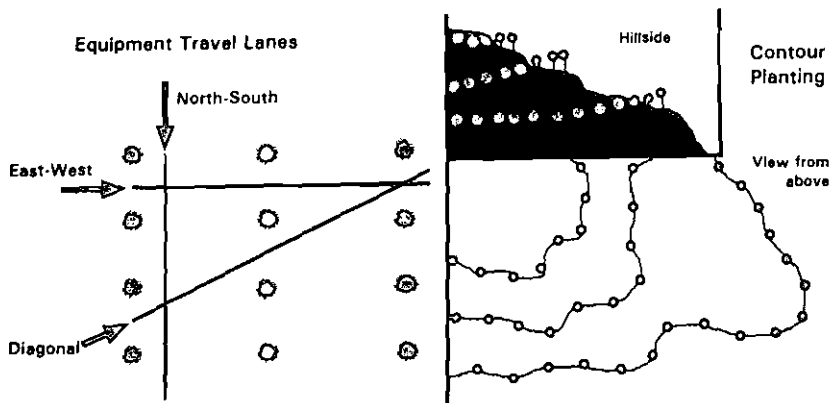


Figure 1 - Equipment travel lanes illustrated in a grid pattern planting design. Tree rows are planted on the contour on sloping sites.

straight rows and on diagonals to allow equipment to travel in various directions, reducing soil compaction (Figure 1). On sloping land, it may be necessary to plant the rows on the contour creating a terrace to reduce soil erosion due to water runoff.

While designs for an alley cropping practice will vary depending on landowner objectives, there are several basic considerations. Spacing between the trees within the row and between the rows of trees must be considered when designing an alley cropping practice. Distance between the rows is determined by (1) the growth requirements of the companion crop, (2) the width of the available farm equipment, (3) the type of tree(s) grown, (4) the desired product(s), and (5) the duration or length of time the landowner wishes to grow a light demanding crop in the alleyway. Selected trees should be deep rooted, create a light shade and produce one or more products (timber, nuts, fruit, pinestraw). Shrubs or



Harvesting wheat between walnut trees in an alley cropping practice.



Walnut and corn alley cropping practice.

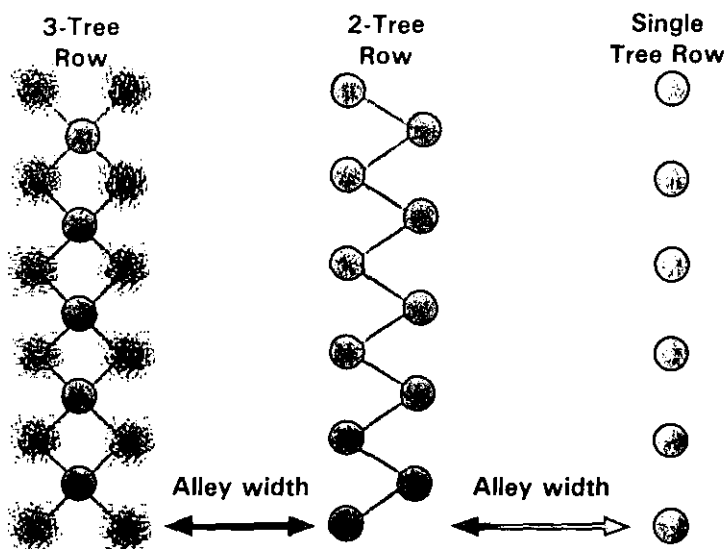


Figure 2 - Tree arrangement in triple (evergreen tree or shrub in the outer rows with a deciduous tree in the middle row), double and single rows.

coniferous trees can be used in multiple tree rows (Figure 2) to provide additional products and to train hardwood species to grow straight and tall, producing high value timber products. Growing trees for timber or nuts may require pruning of young trees. Pruning young nut trees to a height of eight (8) feet allows equipment to pass below the branches for mowing and harvesting of nuts while retaining much of the crown area. Greater pruning heights, to reduce defects in the wood caused by low branches, may be required for producing quality timber.



Traditional row crops as well as horticultural, medicinal or vegetable crops can be incorporated into an alley cropping practice. As the trees grow and produce more shade in the alleyways, companion crop selections may change. Over time, competition for water can limit the width of the area in the alley that can be cropped. Deep trenching with a ripper, trencher or chisel plow between the tree row and the crop to sever lateral tree roots (known as lateral root pruning) may be necessary to minimize production losses of the alley crops. Wider alleyways will accommodate crops that require full sun such as corn and soybeans. When shade becomes limiting, there will need to be a shift to a more shade tolerant crop such as shade tolerant forages or berry producing shrubs.



Cattle grazing in pecan silvopasture practice.

Rotationally grazing livestock, planting, pruning and protecting trees and monitoring forage quality are all part of managing a silvopasture practice. Proper design and planning, as well as a working knowledge of the silvopasture components, can reduce the time and labor involved.

Several benefits are realized by implementing a silvopasture practice. Trees protect livestock from temperature extremes by blocking cold wind and snow in winter and providing shade in summer. Livestock benefit from improved forage quality and reduce the need for chemical or mechanical vegetation control. Research at the University of Missouri Center for Agroforestry has shown that many forages, such as red clover and smooth brome grass, perform better, are more palatable, and produce higher levels of desired nutrients under some shade. Well-chosen and maintained forages control undesirable vegetation and fix nitrogen utilized by the trees.

Silvopasture practice design can be similar to design options for alley cropping with special consideration given to the interactions between trees and livestock (Figure 3). Trees can be planted in rows, individually throughout the pasture or in groups. Existing forest stands can be managed for grazing livestock as part of an *intentionally* designed silvopasture practice.

Silvopasture

Silvopasture deliberately combines trees with forage and livestock production in an *intensively* managed practice. Letting cows graze in a natural woodland area without any type of tree or forage management is **NOT** considered a silvopastoral practice.

Silvopasture Planting Designs



Trees in rows



Individual tree



Grouped trees

Figure 3 - Planting designs for silvopasture practices.



For optimal performance, select trees, forages and livestock that

1. are compatible with the site and each other,
2. produce marketable products,
3. meet landowner management objectives and,
4. if desired, provide wildlife or environmental benefits.



Year 1 - fast-growing riparian species are planted to establish buffer.



Year 2-3 - tree roots begin to stabilize stream banks and herbaceous vegetation grows in naturally.



Established buffer - some marketable trees have been removed and slower growing, higher value species are planted in the understory. Herbaceous vegetation is fully established in the understory.



Sheep grazing in a Christmas tree silvopasture practice.

Trees may produce nuts such as black walnut or pecan or be grown for timber alone. Livestock may include but are not limited to cattle, sheep, goats, horses, ostrich, emu, moose, fallow deer, poultry, bison and elk. During tree establishment stages, livestock should be excluded from the site or protection measures, such as electrified fencing, should be used to prevent damage to young trees. While livestock are excluded, forage can be produced for sale or feed for livestock.

Riparian Forest Buffers

Riparian forest buffers can have positive impacts on water quality. They are strips of planted or managed trees, shrubs and grasses along the banks of waterways. One popular design consists of three zones: Zone 1, undisturbed forest, is closest to the water; Zone 2, managed forest, is next to the undisturbed forest; and Zone 3, composed of grasses, is farthest from the water (Figure 4).

The roots of the undisturbed vegetation (trees and shrubs) in Zone 1 stabilize streambanks, hold soil in place and prevent channelization of the stream. Shade from the trees helps moderate the temperature of the water, benefiting aquatic life. Roots and woody debris provide food and habitat for aquatic life and slow the velocity of water.

Zone 2, the managed forest, can be planted with fast growing trees and/or shrubs that produce marketable products which can be harvested for profit. In this zone, nutrients in the runoff water are absorbed in the soil and used by trees and shrubs. When flooded,



Three-Zone Riparian Forest Buffer

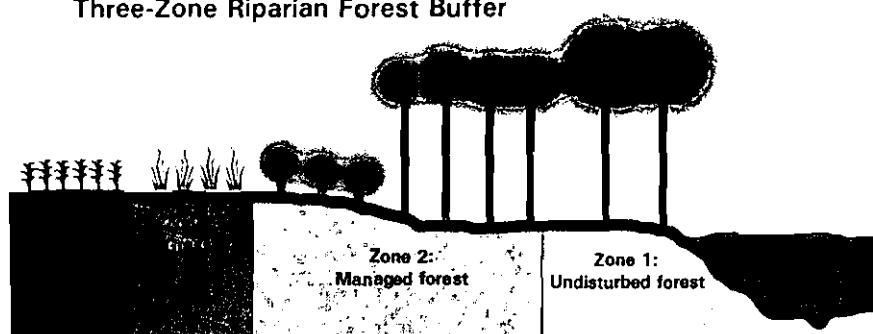


Figure 4 - Diagram of riparian forest buffer zones.

forested zones also serve as recharge areas for ground water aquifers.

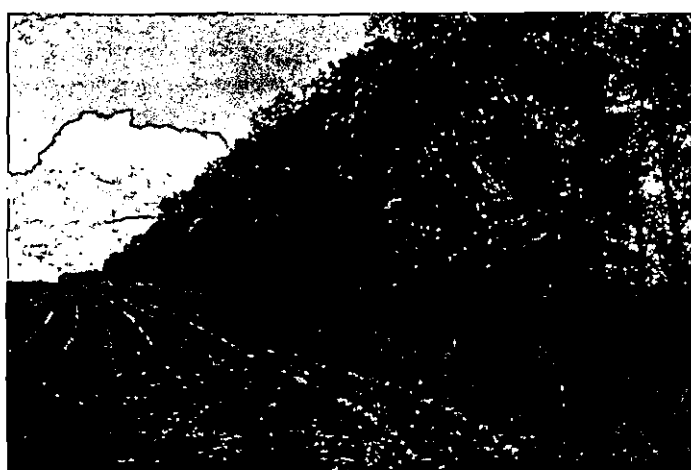
Grasses and other herbaceous vegetation in Zone 3 tend to increase soil porosity allowing greater infiltration and water storage potential. Dense grasses slow the flow of surface water and spread the flow more evenly over the landscape. Reducing the velocity of the water flow

allows sediment to settle out, allows time for pesticides to degrade and permits increased uptake of excess nutrients. Grasses can potentially be used for forage, hay or other products.

Keep in mind that not all areas will be wide enough to accommodate a three-zone buffer design. The width of the riparian forest buffer depends on the landowner's objectives, the condition of the waterway and the site characteristics (slope, soil type).

Windbreaks

Windbreaks protect crops and livestock from strong winds, reduce wind erosion, improve irrigation efficiency, expand wildlife habitat, improve aesthetics, manage snow and provide marketable products. Protection from cold wind and snow and hot, drying summer winds improves crop quality and yield despite the loss of cropping area due to the windbreak. Windbreaks provide shade and protection from temperature extremes in pastures and around feedlots improving livestock health,



Windbreak adjacent to crop field.

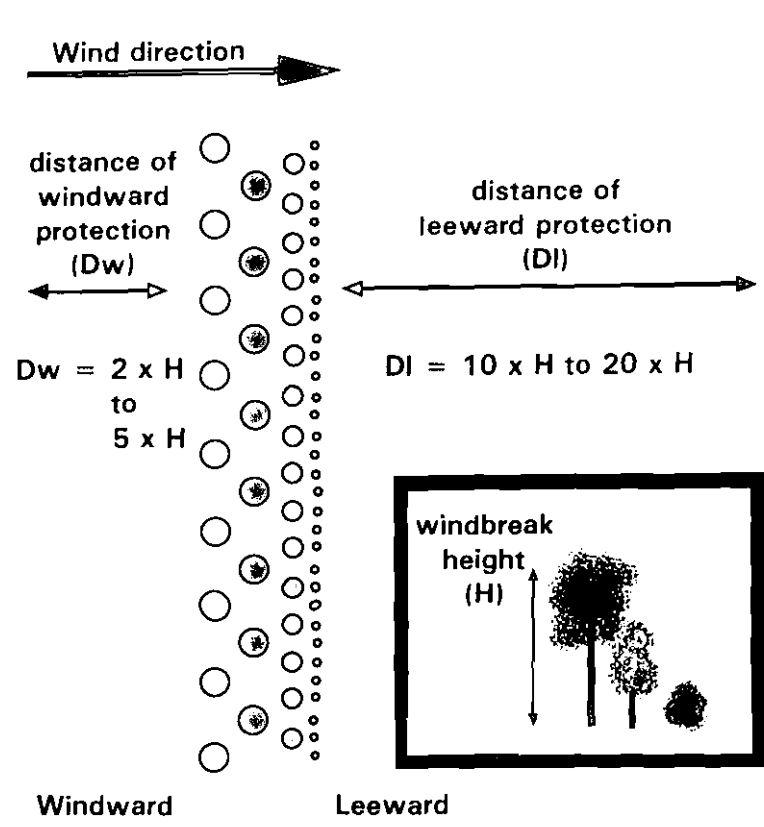
feeding efficiency and reproductive success. Increased plant and wildlife diversity have the potential to reduce fertilizer and pesticide inputs by capitalizing on natural pest predators and nutrient cycling.



Cattle sheltered by livestock windbreak.

Multiple row windbreaks allow harvesting of marketable trees and products without reducing the effectiveness of the windbreak. Trees, shrubs and/or herbaceous vegetation, selected for the products they produce (nuts, pulp for paper, botanicals) and their windbreak effectiveness, are planted perpendicular to the prevailing wind at wide spacing.





The area protected by, and the effectiveness of a windbreak, are determined by:

- Height
- Density
- Width
- Species composition
- Length
- Orientation
- Continuity

Wind speeds are reduced on the windward side of a windbreak to a distance two (2) to five (5) times the height of the tallest row. On the leeward side, wind speeds are reduced for a distance of ten (10) to 20 times the height of the trees (Figure 5). Windbreak density, the ratio of the solid portion to the total area, determines the amount of wind that flows through the windbreak. Densities of 40 to 60 percent provide the greatest leeward area of protection. Livestock windbreaks and crop windbreaks require different densities and orientation for optimal protection during sensitive seasons. Windbreaks are oriented perpendicular to: (1) hot,

Figure 5. Wind protection diagram with a multi-row windbreak.

dry summer winds to protect field crops during the growing season, (2) cold winter winds to protect livestock during calving season or (3) winter and early spring winds to reduce erosion when soil is exposed. The most effective length of a windbreak is ten (10) times the height to reduce the influence of end-turbulence (i.e. turbulent winds at either end). Gaps in the windbreak create areas of high-wind velocity reducing the effectiveness of the windbreak and should be avoided.

Management is the key to an effective windbreak. Gaps resulting from tree harvest, damage or mortality must be replanted. Pruning may be required if producing timber or for the general health of the trees and shrubs.



Ginseng in an intensively managed forest farming practice.

Forest Farming

Forest farming is a unique practice in which existing forest stands are managed to create an appropriate environment for growing potentially high value understory crops. Many medicinal and botanical plants that are currently wild-crafted (harvested from wild sources) from public and private lands are becoming scarce. Forest farming can mitigate over-harvesting by managing for these scarce, high value species.



Shiitake growing on logs in a forest farming practice.



Fruiting goldenseal in a forest farming practice.

When establishing a forest farming practice, the existing forest needs to be managed to open the canopy and create the appropriate light environment for the understory crop. The non-timber component or special forest products can be ginseng, goldenseal and other medicinal plants, floral greenery and/or food products like mushrooms and berries. Several crops can be grown in conjunction. Some existing practices combine growing ginseng, goldenseal and mushrooms as they have similar light requirements.

Anyone interested in undertaking forest farming or producing special forest products should thoroughly research the crop, including the growing requirements and the markets available or the potential for developing markets. Many herb and botanical dealers have certain requirements which must be met before establishing a planting contract with growers. The landowner needs to consider the labor involved and should start with small plots. As many of the crops associated with forest farming are high value, added protection measures may be required to deter theft.

Research in Agroforestry

The University of Missouri Center for Agroforestry (UMCA) conducts research in the five temperate agroforestry practices at the 650-acre University of Missouri Horticulture and Agroforestry Research Center (HARC) in New Franklin, Missouri.

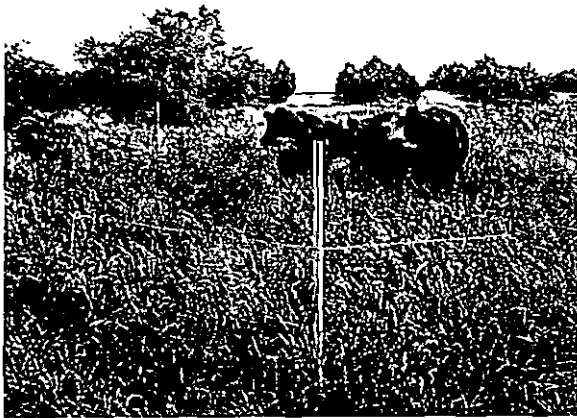
Alley cropping

Pitch pine (*Pinus rigida*)/loblolly pine (*P. taeda*) hybrids and black walnut (*Juglans nigra*) planted in single, double and triple rows are grown to examine the effects of row configuration on these species. Triple row spacing (walnut flanked on both sides with pine) is intended to produce a high quality sawlog by promoting natural pruning of the walnut's lower branches through shading of the trunk. Associated with this project are two progeny testing experiments which look at the suitability of pine hybrids and exotic pines for pine needle mulch production in Missouri.



Single and double-row pine in alley cropping study





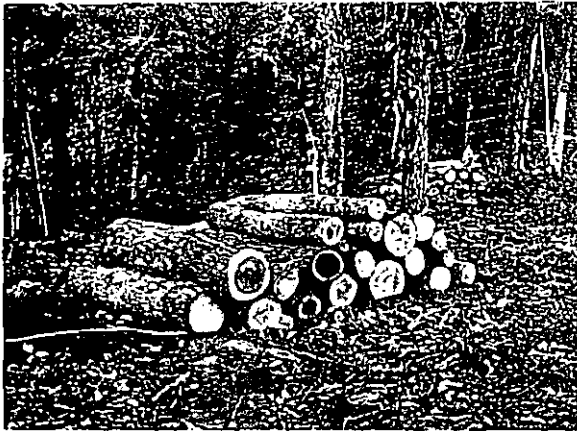
Cattle grazing near a row of young trees protected by an electric fence in the silvopasture study.

Silvopasture

Animal science researchers are testing methods to protect seedlings being established in cattle pastures. Two methods being examined are electrical fencing and unpalatable sprays.

Riparian Forest Buffers

For demonstration and water quality protection purposes, a riparian forest buffer has been established along the stream adjacent to the silvopasture experiment. This buffer will serve as an educational demonstration of a three-zone forested riparian buffer and to protect the stream from high nutrient content in the runoff water from the silvopasture practice.



Logs inoculated with mushroom spores in a forest farming setting

Windbreaks

Windbreaks serve to protect crops, livestock and soil from harsh seasonal winds. A recently established windbreak demonstrates windbreak effectiveness and a method of offsetting windbreak segments to minimize the wind tunneling effects of gaps in a windbreak created by roads or access to a field.

Forest Farming

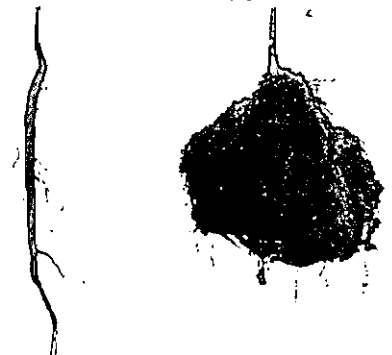
Mushroom production has the potential to add value to an existing forest or riparian forest buffer. Researchers are examining propagation methods for high value mushrooms, such as the European black truffle and shiitake, under the shade of a forest canopy.

Related Research

Root Production Method™, a method of air pruning tree roots as a means of improving growth rate and fruit production, is being compared to traditional bare root seedling growth and fruiting. Researchers are examining eleven species that have potential in agroforestry practices.

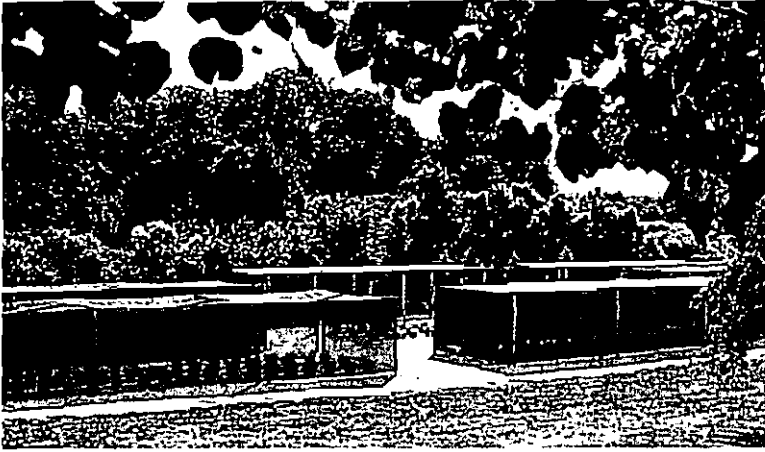


Cottonwood leaf beetle feeding.



Root mass of bare root seedling (left) versus RPM™ seedling (right)

Cottonwood and poplar hybrids are fast growing trees with potential for use in agroforestry practices. Several projects are being conducted on poplar to examine clonal variation in growth rate, carbon sequestration potential and susceptibility to insect damage.



Shade houses for shade tolerance evaluation.

A **shade tolerance evaluation** of grasses and other herbaceous plants is the first stage in an assessment of the suitability of these plants for use in agroforestry practices. After being evaluated for their tolerance to 50 percent and 80 percent shade, plants will be tested under various levels of shade in competition with trees for moisture and nutrients.

A recently constructed **flood tolerance** laboratory is used to test plant species and cultivars for tolerance to flooding. The effects of stagnant versus moving water and water depth are being examined.

Living mulches used in agroforestry practices may provide soil erosion protection and supplemental nutrition for trees. Researchers are examining the effectiveness of legumes and grasses as living mulches grown in conjunction with establishing trees.



Linear channels of the flood tolerance laboratory.

References:

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- Boehner, P., J.R. Brandle, S. Finch. Windbreak Series. Lincoln, NE, University of Nebraska Extension and Soil Conservation Service. EC 91-1764-B.
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- Garrett, H.E., W.J. Rietveld and R.F. Fisher (eds.). 2000. *North American Agroforestry: An Integrated Science and Practice*. American Society of Agronomy, Inc. Madison, Wisconsin. 402 p.
- U.S. Dept. of Agriculture Forest Service. *Agroforestry Notes*. Rocky Mountain Station, USDA-NRCS, Nov. 1997, AF Note-7 & AF Note-8.
- U.S. Dept of Agriculture Natural Resource Conservation Service. Conservation Practice Job Sheet. Washington, D.C., USDA-NRCS, April 1997, CPSJ 311 & 380.



Where can I get more information?

Local Information

Start by contacting natural resource professionals in your area for information specific to your site. This includes university agriculture extension, local or regional forestry professionals and the Natural Resources Conservation Service (NRCS).

General Information

For more general information on agroforestry and the five practices contact:

University of Missouri Center for Agroforestry (UMCA)
203 Anheuser-Busch Natural Resources Bldg. (ABNR)
Columbia, MO 65211
573/884-2874
email: umca@missouri.edu
<http://www.missouri.edu/~umca>

USDA National Agroforestry Center (NAC)
East Campus - UNL
Lincoln, NE 68583-0822
402/437-5178
<http://www.unl.edu/nac/>



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Economic Budgeting for Agroforestry Practices

by Larry D. Godsey

Evaluation of the economic aspects of agroforestry provides a basis for estimating financial needs and feasibility, highlights trade-offs between multiple benefits, and monitors economic efficiency. The main technique used in economic analysis is budgeting.

Economic budgeting is a very flexible process. However, effective application of budgets requires an understanding of the commodity, practice, or system to which it is being applied. Agroforestry poses some unique economic budgeting problems because it involves multiple enterprises with varying production cycles, such as trees, row crops, forages, and/or livestock.

Unique Characteristics of Agroforestry

1. Long planning horizons
2. Irregular cost and revenue occurrences
3. Fixed tree component with variable crop or livestock component

First, unlike most agricultural commodities, agroforestry has a "planning horizon" of greater than one season due to the tree component. A "planning horizon" is simply a time period in which all costs and revenues for a given practice are realized. For soybeans, a planning horizon may be six months to a year. For agroforestry, a simple planning horizon may be as long as sixty years when the trees are taken into consideration.

Second, because of the long planning horizon of agroforestry practices, many of the revenues and costs do not occur at regular or predictable intervals throughout the entire planning horizon, but are irregular in occurrence.

Finally, because agroforestry practices typically incorporate a fixed tree component with a crop or livestock component, the crop or livestock component may change over time. For example, an alley cropping practice may start out as soybeans grown between rows of eastern black walnut trees, but by the time the trees are producing nuts, hay may be the crop grown between the rows of trees because more of a mat is required to harvest the nuts.

These three characteristics of agroforestry practices require a specific type of budgeting method that will be flexible enough to allow for variable crop and/or livestock components, as well as comprehensive enough to show annual cash flows for the entire planning horizon.

Agroforestry Budgeting

Agroforestry budgeting is a two step process. The steps are 1) develop enterprise budgets, and 2) combine the enterprise budgets into a cash flow plan.

Two Steps to Agroforestry Budgeting

Step 1: Develop detailed enterprise budgets

Step 2: Combine all enterprise budgets into a cash flow plan.

An enterprise budget is simply a complete, detailed listing of all the costs and revenues expected for each single enterprise, such as corn, livestock, or trees. A cash flow plan combines the details from the different enterprise budgets in the agroforestry practice and adds a time dimension. The enterprise budget provides a framework for reporting and monitoring the profitability of each enterprise, and the cash flow plan provides the information necessary to assess and forecast the economic feasibility of the agroforestry practice over time.

Developing the Enterprise Budgets

Three steps for developing an Enterprise Budget

1. Revenues
2. Variable Costs (both cash and non-cash)
3. Fixed Costs (both cash and non-cash)

The development of an enterprise budget is a three-step process. The first step is to list all possible sources of revenue for an enterprise. For the tree component of an agroforestry practice, it is important to list not only the sources, but also list the timing of those revenues. For example, an alley cropping practice with eastern black walnut trees may receive CRP payments for the first ten years of the planning horizon but not after that period. Income from nut production

Examples of Agroforestry Revenues

- Cost share payments
- Nuts
- CRP Payments
- Biomass
- Grafted Seedlings
- Hunting rights
- Scionwood and cuttings
- Nature walks
- Timber (sawlogs, veneer logs, etc.)
- Seedlings

Examples of Agroforestry Variable Costs

Cash Costs

Establishment:

Site preparation (mechanical/chemical)
Seedlings
Planting (labor and equipment)
Watering
Staking

Maintenance:

Fertilization
Pest and Disease Control
Grafting
Thinning
Pruning

Harvesting:

Nut harvest
Timber harvest

Marketing:

Advertisement
Transportation

Non-Cash Costs

Family Labor

may start at year ten or twelve and continue until the tree is harvested for wood in year fifty-five or sixty.

The second step is to list, in detail, all possible sources of variable costs. Variable costs are those costs attributed to the productive use of resources. Variable costs can be grouped into cash and non-cash costs. Variable cash costs include payments for establishment, maintenance, harvesting, and marketing. Variable non-cash costs do not require a cash outlay, but reflect opportunity costs. Opportunity cost is simply the value of the next best alternative that is not chosen. For example, labor supplied by family members may not require a cash outlay, but could still be considered in the economic analysis.

Reporting variable costs should include the source of the cost, the amount of the cost, and the time interval in which that cost will be incurred. For example, thinning trees may cost \$50 per acre and occur in years twenty-one and twenty-five.

The third and final step to preparing an enterprise budget is to list all fixed costs. Fixed costs are typically those costs that are attributed to resource ownership. In other words, fixed costs occur regardless of any productive activity being attempted. Fixed cash costs usually include property taxes, insurance, interest on intermediate or long-term debt, and lease agreements. Fixed non-cash costs are important when developing an investment analysis, because these costs have significant influence on taxes. However, these costs are difficult to determine. Depreciation and land costs are the two main areas of fixed non-cash costs. Fixed costs may not change as often as the revenues and variable costs. In fact, any changes may be predictable, such as, a two-percent increase in property taxes every year. When reporting fixed costs, be sure and note the source, the amount, and the estimated changes that will occur in the original amount.

Appendix A is an example of an enterprise budget for an alley cropping practice using eastern black walnut (*Juglans nigra* L.). The enterprise budget reports all costs and revenues on a

Examples of Agroforestry Fixed Costs	
Cash Costs	
	Property Taxes
	Insurance
	Interest Payments (intermediate debt)
	Lease Agreements
	Land - Interest (Option 1)
Non-Cash Costs	
	Depreciation
	Land - Opportunity Cost (Option 2)

per acre basis. Species and spacing are clearly described so that this budget will not be confused with other types of agroforestry practices.

Characteristics of a Cash Flow Plan
1. Allows for analysis of multiple enterprises
2. Incorporates a time dimension

From Enterprise Budgets to Cash Flow Plans

Once enterprise budgets are developed, a cash flow plan for the agroforestry practice can be developed. It is important to understand that an agroforestry practice may include more than one enterprise. For example, a well established alley cropping practice may combine a tree enterprise with a hay and livestock enterprise. As mentioned earlier, often times the tree enterprise is fixed while the crop or livestock enterprises vary over time. Cash flow planning has two major characteristics that benefit agroforestry economic analysis; 1) a cash flow plan allows for multiple enterprises to be considered; and 2) a cash flow plan incorporates a time dimension.

Using a cash flow plan in conjunction with enterprise budgets can simplify the process of economic analysis by allowing the enterprise budgets to reflect the detailed information, and let the cash flow plans use minimal data to provide the analysis. Appendix B is an example of a cash flow plan for an alley cropping practice that uses eastern black walnut (*Juglans nigra* L.) along with bluegrass and white clover hay.

Common Indicators of Economic Performance

There are several common indicators used to analyze an agroforestry practice for economic performance. Supplementing these common economic indicators with some very basic indicators of economic performance can help both produc-

ers and economists understand the economic performance of agroforestry practices.

A common economic analysis technique known as net present value (NPV) analysis can be conducted given the information provided in a good cash flow plan. Net present value is simply all future net income streams from the practice discounted to reflect their current or present value. Appendix C shows the formula for the calculation of NPV. This indicator is useful only as a basis for comparison. The net present value of the agroforestry practice can be compared to the net present value of other alternatives, such as a soybean monoculture, to see which practice is the most economically profitable. Assuming each practice is discounted using the same period of time and the same discount rate, the highest NPV would indicate the best alternative.

Common Economic Indicators

- 1. Net Present Value (NPV)
- 2. Internal Rate of Return (IRR)
- 3. Annual Equivalent Value (AEV)

The internal rate of return (IRR) is another common indicator of economic performance. The internal rate of return is the rate at which an investment is expected to grow. For example, a savings account pays 3% per year, therefore, an investor who puts money in a savings account is expecting to earn 3% on that investment. If an agroforestry practice has an IRR of 6% then a rational investor would choose the agroforestry practice over the savings account earning 3%. However, the internal rate of return does not always capture the uncertainty of returns over time. Using the savings account example, an investor is assured that the money put into a savings account is relatively risk free, however, investment in agroforestry practices may face uncertainties that were not predicted or planned. Appendix C shows the calculations for deriving the IRR.

Another common indicator of economic performance that can be derived from a cash flow plan is the annual equivalent value (AEV). The annual equivalent value is an estimate of a level income stream that would have the same net present value as the actual income streams. Actual income streams for agroforestry practices may be positive one year and negative another, however, with the annual equivalent value, a level income estimate is established. The annual equivalent value can be used to compare alternative practices with the agroforestry practice to determine which practice has the highest expected income potential.

Supplemental Economic Indicators

All three of the common indicators can be used to evaluate the economic success of agroforestry practices. However, there are easier ways to help evaluate the economic feasibility of agroforestry practices without the complicated discounting equations. Using a cashflow budget, three supplemental economic indicators can be derived: 1) frequency of negative cashflow, 2) duration of negative cashflow, and 3) magnitude of positive and negative cashflows.

The frequency of negative cashflow is simply determining the number of years in a planning horizon in which a practice will have a net loss. For many landowners, a practice that appears to be economically profitable according to a NPV analysis in the long run, may not be feasible due to several periods of net loss.

Similar to frequency, duration of negative cashflow reflects the length of time that the practice

Supplemental Economic Indicators

- 1. Frequency of negative cashflow
- 2. Duration of negative cashflow
- 3. Magnitude of positive and negative cashflow

returns a negative cashflow, or net loss. While frequency would describe a practice as having negative cashflow 4 out of 15 years, duration may indicate that three of those four years occurred consecutively. A landowner may not be concerned about having a negative cashflow occasionally. However, a continuous net loss may make a practice undesirable and infeasible.

The magnitude of positive and negative cash-flow reflects the range of fluctuations that occur from year to year and throughout the planning horizon in net income. For example, one practice may have a very large net loss the first two years for startup costs, followed by several years of small net incomes. Over the long run, this practice may have a positive internal rate of return, but the periods of large net losses may make the practice infeasible. On the other hand, expected large net income in the future may make periods of small net losses tolerable.

The three supplemental indicators of frequency, duration, and magnitude require no special training in finance or math, and may have more influence on the decision process. The common indicators of net present value, internal rate of return, and annual equivalent value are still

important to help compare the agroforestry alternative to other possible alternatives. Using both types of economic indicators can help “fine tune” the economic analysis and aid in the decision process.

There are many other benefits to agroforestry besides those measured by economics. Environmental and social benefits may also have value to the decision-maker. These benefits are often difficult to quantify. With economic analysis, these benefits can be considered in light of financial considerations.

Reassessment

Economic analysis is not meant to be - nor is it designed to be a one-time activity. Economic analysis is designed to be a roadmap for a dynamic and living system. Reassessment takes the information gathered in the economic analysis and combines it with other information to change the original goals or fine tune the design so that it is more successful at meeting those goals. Reassessment is the continuous loop that helps redefine goals, adjust designs, and modify indicators. Economic analysis is just one part of the reassessment loop.

Agroforestry Enterprise Budget

	Amount	Time Interval		Amount	Time Interval
Revenues:			Variable Cash Costs		
Cost Share Payments	\$ -		1. Establishment:		
CRP	\$ 62.00	Year 1-10	a. Site preparation		
Seedlings Sold	\$ -		Mechanical	\$ 36.00	Year 1
Grafted Seedlings Sold	\$ -		Chemical	\$ -	
Scionwood / Cuttings Sold	\$ -		b. Fertilizer		
Nuts (Yield will increase at 3% for 10 yrs)	\$ 255.00	Year 11-60	N-P-K	\$ 40.00	Year 1
Biomass	\$ -		Lime	\$ 18.00	Year 1
Hunting Rights	\$ -		c. Planting		
Nature Walks	\$ -		Seedlings (RPM Grafted)	\$ 312.00	Year 1
Timber (Thinnings)	\$ 1,200.00	Year 21	Labor	\$ 90.00	Year 1
Timber (Sawlogs, veneer logs, etc.)	\$ 1,000.00	Year 60	Equipment	\$ 6.00	Year 1
			d. Watering	\$ -	
			e. Staking	\$ 96.00	Year 1
Fixed Cash Costs			2. Maintenance		
Property Tax	\$ 0.40	Years 1-60	a. Fertilization (\$6.60 Yr2-3/ \$10.00 Yr4-6)	\$ 6.60	Year 2- 6
Insurance	\$ 0.20	Years 1-60	b. Pesticide/Fungicide	\$ 100.00	Year 11-60
Interest Payments	\$ -		c. Herbicide	\$ 12.50	Year 1-10
Leases	\$ 15.00	Years 11-60	d. Mowing	\$ -	
Management	\$ 1.40	Years 1-60	e. Thinning	\$ 50.00	Year 21
Fixed Non-Cash Costs			f. Pruning	\$ 4.00	Year 4-10
Depreciation	\$ -		3. Harvesting		
Land	\$ 9.00	Years 1-60	a. Nut harvest	\$ 74.00	Year 11-60
			b. Timber harvest		
			4. Marketing		
			a. Advertisement	\$ -	
			b. Transportation	\$ -	
			Variable Non-Cash Costs	\$ -	

Practice: Alley Cropping
Species: Black Walnut

Price Basis: \$/acre/year
Spacing: 30x30

Appendix B

Agroforestry Cash Flow Plan

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Revenues:											
Tree: Eastern Black Wa	\$ 62.00	\$ 62.00	\$ 62.00	\$ 62.00	\$ 62.00	\$ 62.00	\$ 62.00	\$ 62.00	\$ 62.00	\$ 62.00	\$ 255.00
Crop: Hay	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 120.00
Total revenues:	\$ 62.00	\$ 62.00	\$ 62.00	\$ 62.00	\$ 62.00	\$ 62.00	\$ 62.00	\$ 62.00	\$ 62.00	\$ 62.00	\$ 375.00
Variable Costs:											
Tree: Eastern Black Wa	\$ 650.50	\$ 19.10	\$ 19.10	\$ 26.70	\$ 26.70	\$ 26.70	\$ 44.50	\$ 44.50	\$ 44.50	\$ 44.50	\$ 202.00
Crop: Hay	\$ 34.50	\$ 30.00	\$ 30.00	\$ 44.50	\$ 30.00	\$ 30.00	\$ 30.00	\$ 44.50	\$ 30.00	\$ 30.00	\$ 60.00
Total Variable Cost	\$ 685.00	\$ 49.10	\$ 49.10	\$ 71.20	\$ 56.70	\$ 56.70	\$ 74.50	\$ 89.00	\$ 74.50	\$ 74.50	\$ 262.00
Fixed Costs:											
Tree: Eastern Black Wa	\$ 11.00	\$ 11.00	\$ 11.00	\$ 11.00	\$ 11.00	\$ 11.00	\$ 11.00	\$ 11.00	\$ 11.00	\$ 11.00	\$ 26.00
Crop: Hay	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00
Total Fixed Costs:	\$ 45.00	\$ 45.00	\$ 45.00	\$ 45.00	\$ 45.00	\$ 45.00	\$ 45.00	\$ 45.00	\$ 45.00	\$ 45.00	\$ 60.00
Net Income/(loss)	\$ (668.00)	\$ (32.10)	\$ (32.10)	\$ (54.20)	\$ (39.70)	\$ (39.70)	\$ (57.50)	\$ (72.00)	\$ (57.50)	\$ (57.50)	\$ 53.00
NPV @ 10%	(\$449.04)										
Internal Rate of Return	6.432%										
Annual Equivalent Valu	\$45.72										

Practice: Alley Crop
 Species: Black Walnut
 Crop: Hay

Price Basis: \$/Acre/Year
 Spacing: 30x30

Agroforestry Cash Flow Plan

	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21
Revenues:										
Tree: Eastern Black Wa	\$ 263.00	\$ 271.00	\$ 279.00	\$ 287.00	\$ 296.00	\$ 305.00	\$ 314.00	\$ 323.00	\$ 333.00	\$ 343.00
Crop: Hay	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00
Total revenues:	\$ 383.00	\$ 391.00	\$ 399.00	\$ 407.00	\$ 416.00	\$ 425.00	\$ 434.00	\$ 443.00	\$ 453.00	\$ 463.00
Variable Costs:										
Tree: Eastern Black Wa	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00
Crop: Hay	\$ 64.50	\$ 60.00	\$ 60.00	\$ 60.00	\$ 64.50	\$ 60.00	\$ 60.00	\$ 60.00	\$ 64.50	\$ 60.00
Total Variable Cost	\$ 266.50	\$ 262.00	\$ 262.00	\$ 262.00	\$ 266.50	\$ 262.00	\$ 262.00	\$ 262.00	\$ 266.50	\$ 262.00
Fixed Costs:										
Tree: Eastern Black Wa	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00
Crop: Hay	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00
Total Fixed Costs:	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00
Net Income/(loss)	\$ 56.50	\$ 69.00	\$ 77.00	\$ 85.00	\$ 89.50	\$ 103.00	\$ 112.00	\$ 121.00	\$ 126.50	\$ 141.00

Practice: Alley Crop
Species: Black Walnut
Crop: Hay

Price Basis: \$/Acre/Year
Spacing: 30x30

Agroforestry Cash Flow Plan

	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30	Year 31
Revenues:										
Tree: Eastern Black Walnut	\$ 343.00	\$ 343.00	\$ 343.00	\$ 343.00	\$ 343.00	\$ 343.00	\$ 343.00	\$ 343.00	\$ 343.00	\$ 343.00
Crop: Hay	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00
Total revenues:	\$ 463.00	\$ 463.00	\$ 463.00	\$ 463.00	\$ 463.00	\$ 463.00	\$ 463.00	\$ 463.00	\$ 463.00	\$ 463.00
Variable Costs:										
Tree: Eastern Black Walnut	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00
Crop: Hay	\$ 60.00	\$ 60.00	\$ 64.50	\$ 60.00	\$ 60.00	\$ 60.00	\$ 64.50	\$ 60.00	\$ 60.00	\$ 60.00
Total Variable Costs:	\$ 262.00	\$ 262.00	\$ 266.50	\$ 262.00	\$ 262.00	\$ 262.00	\$ 266.50	\$ 262.00	\$ 262.00	\$ 262.00
Fixed Costs:										
Tree: Eastern Black Walnut	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00
Crop: Hay	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00
Total Fixed Costs:	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00
Net Income/(loss)	\$ 141.00	\$ 141.00	\$ 136.50	\$ 141.00	\$ 141.00	\$ 141.00	\$ 136.50	\$ 141.00	\$ 141.00	\$ 141.00

Practice: Alley Crop
 Species: Black Walnut
 Crop: Hay

Price Basis: \$/Acre/Year
 Spacing: 30x30

Agroforestry Cash Flow Plan

	Year 32	Year 33	Year 34	Year 35	Year 36	Year 37	Year 38	Year 39	Year 40	Year 41	Year 42
Revenues:											
Tree: Eastern Black Walnut	\$ 343.00	\$ 343.00	\$ 343.00	\$ 343.00	\$ 343.00	\$ 343.00	\$ 343.00	\$ 343.00	\$ 343.00	\$ 343.00	\$ 343.00
Crop: Hay	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00
Total revenues:	\$ 463.00	\$ 463.00	\$ 463.00	\$ 463.00	\$ 463.00	\$ 463.00	\$ 463.00	\$ 463.00	\$ 463.00	\$ 463.00	\$ 463.00
Variable Costs:											
Tree: Eastern Black Walnut	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00
Crop: Hay	\$ 64.50	\$ 60.00	\$ 60.00	\$ 60.00	\$ 64.50	\$ 60.00	\$ 60.00	\$ 60.00	\$ 64.50	\$ 60.00	\$ 60.00
Total Variable Costs:	\$ 266.50	\$ 262.00	\$ 262.00	\$ 262.00	\$ 266.50	\$ 262.00	\$ 262.00	\$ 262.00	\$ 266.50	\$ 262.00	\$ 262.00
Fixed Costs:											
Tree: Eastern Black Walnut	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00
Crop: Hay	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00
Total Fixed Costs:	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00
Net Income/(loss)	\$ 136.50	\$ 141.00	\$ 141.00	\$ 141.00	\$ 136.50	\$ 141.00	\$ 141.00	\$ 141.00	\$ 136.50	\$ 141.00	\$ 141.00

Practice: Alley Crop
Species: Black Walnut
Crop: Hay

Price Basis: \$/Acre/Year
Spacing: 30x30

Agroforestry Cash Flow Plan

	Year 43	Year 44	Year 45	Year 46	Year 47	Year 48	Year 49	Year 50	Year 51	Year 52
Revenues:										
Tree: Eastern Black Walnut	\$ 343.00	\$ 343.00	\$ 343.00	\$ 343.00	\$ 343.00	\$ 343.00	\$ 343.00	\$ 343.00	\$ 343.00	\$ 343.00
Crop: Hay	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00
Total revenues:	\$ 463.00	\$ 463.00	\$ 463.00	\$ 463.00	\$ 463.00	\$ 463.00	\$ 463.00	\$ 463.00	\$ 463.00	\$ 463.00
Variable Costs:										
Tree: Eastern Black Walnut	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00
Crop: Hay	\$ 60.00	\$ 64.50	\$ 60.00	\$ 60.00	\$ 60.00	\$ 64.50	\$ 60.00	\$ 60.00	\$ 60.00	\$ 64.50
Total Variable Costs:	\$ 262.00	\$ 266.50	\$ 262.00	\$ 262.00	\$ 262.00	\$ 266.50	\$ 262.00	\$ 262.00	\$ 262.00	\$ 266.50
Fixed Costs:										
Tree: Eastern Black Walnut	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00
Crop: Hay	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00
Total Fixed Costs:	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00
Net Income/(loss)	\$ 141.00	\$ 136.50	\$ 141.00	\$ 141.00	\$ 141.00	\$ 136.50	\$ 141.00	\$ 141.00	\$ 141.00	\$ 136.50

Practice: Alley Crop
 Species: Black Walnut
 Crop: Hay

Price Basis: \$/Acre/Year
 Spacing: 30x30

Agroforestry Cash Flow Plan

	Year 53	Year 54	Year 55	Year 56	Year 57	Year 58	Year 59	Year 60
Revenues:								
Tree: Eastern Black Walnut	\$ 343.00	\$ 343.00	\$ 343.00	\$ 343.00	\$ 343.00	\$ 343.00	\$ 343.00	\$ 1,343.00
Crop: Hay	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00	\$ 120.00
Total revenues:	\$ 463.00	\$ 463.00	\$ 463.00	\$ 463.00	\$ 463.00	\$ 463.00	\$ 463.00	\$ 1,463.00
Variable Costs:								
Tree: Eastern Black Walnut	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00	\$ 202.00
Crop: Hay	\$ 60.00	\$ 60.00	\$ 60.00	\$ 64.50	\$ 60.00	\$ 60.00	\$ 60.00	\$ 64.50
Total Variable Costs:	\$ 262.00	\$ 262.00	\$ 262.00	\$ 266.50	\$ 262.00	\$ 262.00	\$ 262.00	\$ 266.50
Fixed Costs:								
Tree: Eastern Black Walnut	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00	\$ 26.00
Crop: Hay	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00	\$ 34.00
Total Fixed Costs:	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00	\$ 60.00
Net Income/(loss)	\$ 141.00	\$ 141.00	\$ 141.00	\$ 136.50	\$ 141.00	\$ 141.00	\$ 141.00	\$ 1,136.50

Practice: Alley Crop
Species: Black Walnut
Crop: Hay

Price Basis: \$/Acre/Year
Spacing: 30x30

Appendix C: Calculations

Net Present Value (NPV) is an estimate of the current value of all future incomes from an investment. To determine net present value, future net incomes or net losses, called cashflows, must be discounted to reflect the fact that a dollar today will purchase more than a dollar in the future.

$$NPV = cashflow_0 + cashflow_1 \left(\frac{1}{(1+i)^1} \right) + cashflow_2 \left(\frac{1}{(1+i)^2} \right) + \dots + cashflow_n \left(\frac{1}{(1+i)^n} \right)$$

Where:

NPV = Net Present Value

$cashflow_n$ = net income or net loss for the year "n", for example $cashflow_1$ is the net income from the first full year of production.

i = discount rate, or the opportunity cost of investing. For example, the dollars could have been invested in the stockmarket with an expected return of 14% instead of being invested in an agroforestry practice, therefore, the opportunity cost of the agroforestry practice would be 14%.

n = number of years included in the budget

Internal Rate of Return (IRR) uses the same equation as net present value, however, instead of solving for the NPV, an arbitrary NPV of \$0 is assumed. The discount rate becomes the unknown variable in the equation. The " i " now represents the rate at which all discounted cashflow will equal zero. Or, in other words, the rate at which future incomes will return the initial investment ($cashflow_0$).

$$0 = cashflow_0 + cashflow_1 \left(\frac{1}{(1+i)^1} \right) + cashflow_2 \left(\frac{1}{(1+i)^2} \right) + \dots + cashflow_n \left(\frac{1}{(1+i)^n} \right)$$

Since $cashflow_0$ is not affected by the variability of the discount factor, it is moved to the other side of the equation.

$$- cashflow_0 = cashflow_1 \left(\frac{1}{(1+i)^1} \right) + cashflow_2 \left(\frac{1}{(1+i)^2} \right) + \dots + cashflow_n \left(\frac{1}{(1+i)^n} \right)$$

Annual Equivalent Value (AEV) modifies the equation used in the other two indicators. The AEV calculates an annuity (or an annual set payment) that would give the equivalent net present value at the same discount rate. The equation used in the NPV calculation assumes varying cash flows for each year. The AEV equation assumes that the cashflow is the same each year, therefore, the equation can be modified as follows:

$$NPV = Cashflow \left(\sum_{t=1}^n \frac{1}{(1+i)^t} \right)$$

To calculate the AEV using this equation, the *NPV*, *n*, and *i* must be known. The *Cashflow* is the annual equivalent value that is being calculated. The above equation can be manipulated as follows:

$$Cashflow = \left(\frac{NPV}{\sum_{t=1}^n \frac{1}{(1+i)^t}} \right)$$

Although this looks like a difficult equation, the summation portion (annuity discount factor) of the equation can be simplified as follows:

$$\sum_{t=1}^n \frac{1}{(1+i)^t} = \frac{1}{i} - \frac{1}{i(1+i)^n}$$

To show how this equation works, let's assume that we have budgeted for an agroforestry practice using the enterprise and cash flow plans described in this paper. Assuming that the opportunity cost of investing in this practice is 8% and the planning horizon is 50 years, we calculated that the $NPV_{8\%, 50}$ is \$1200. To calculate the AEV, all we need to do is estimate the annuity discount factor shown above and divide that factor into the NPV.

$$\frac{1}{.08} - \frac{1}{.08(1+.08)^{50}} \Rightarrow 12.5 - \frac{1}{.08(46.902)} \Rightarrow 12.5 - \frac{1}{3.752} \Rightarrow 12.5 - 0.2665 \Rightarrow \underline{\underline{12.233}}$$

$$Cashflow = \frac{NPV}{12.233} \Rightarrow \frac{\$1200}{12.233} = \underline{\underline{\$98.00}}$$

This indicates that the series of cashflows expected with this practice have the same net present value as an annuity that pays \$98 per year. This does not, however, reflect the variability of those cashflows or the time it takes to start generating positive cashflows.

Most spreadsheet programs have these equations programmed in. However, it is good to understand what the equation is doing and what the indicator is telling you. Misinterpreted financial indicators can lead to bad decisions.



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AGROFORESTRY IN ACTION

Growing Chinese Chestnuts In Missouri

by Ken Hunt, Michael Gold and William Reid

Chinese chestnut is an emerging new tree crop for Missouri and the Midwest. The Chinese chestnut tree is a spreading, medium-sized tree with glossy dark leaves bearing large crops of nutritious nuts. Nuts are borne inside spiny burs that split open when nuts are ripe. Each bur contains one to three shiny, dark brown nuts. Nuts are baked or boiled to help remove the leathery shell and papery seed coat to reveal a creamy colored meat. Chestnuts are a healthy, low-fat food ingredient that can be incorporated into a wide range of dishes—from soups, to poultry stuffing, to pancakes, muffins and pastries (using chestnut flour). Historically, demand for chestnuts in the United States has been highest in ethnic markets (Italian and Asian) but as Americans search for novel and healthy food products, chestnut should find wider acceptance.

Chestnut Species

Three species of chestnut provide the basis for world-wide chestnut production—Chinese chestnut (*Castanea mollissima*), European chestnut (*C. sativa*) and Japanese chestnut (*C. crenata*). Chinese chestnuts are a medium-sized (40 ft.) tree often multi-branched and wide spreading. With both good cold hardiness (-20 °F) and adequate tolerance to chestnut blight, Chinese chestnut is the best adapted chestnut for Missouri and surrounding states. The European chestnut is a larger tree (65 ft.), wide spreading and generally too blight susceptible to grow east of the Rockies and is not as cold hardy as the Chinese chestnut. Most chestnuts seen in grocery store chains are imported European chestnuts, primarily imported from Italy. The Japanese chestnut is a small to medium-sized tree (35 ft.) but lacks the blight tolerance and winter hardiness of the Chinese chestnut. European and Japanese chestnuts are grown commercially in west coast states where chestnut blight is not as pervasive and the climate milder. Chestnut species

hybridize freely and many hybrids have been produced. Several Japanese x European hybrid cultivars are under test at the University of Missouri Horticulture and Agroforestry Research Center in New Franklin, MO, but long-term observation will be needed to determine if any have enough blight tolerance and climatic hardiness to be recommended for planting in Missouri.

Three *Castanea* species are native to the U.S., American chestnut (*C. dentata*), Allegheny chinkapin (*C. pumila* var. *pumila*), and Ozark chinkapin (*C. pumila* var. *ozarkensis*), but all three are very susceptible to chestnut blight attack. In fact, the devastation caused by chestnut blight (*Cryphonectria parasitica*) stem cankers has reduced American chestnut from a major timber species to a small understory



Chinese chestnut is a medium-sized tree with spreading habit and has attractive white catkins in late May and early June.

tree. The Allegheny and Ozark chinkapins are multi-stem shrubs to small trees that produce small tasty nuts and make interesting but blight susceptible landscape trees that are also useful for wildlife.

Site and Water Requirements

Chinese chestnut trees perform best in well-drained, loamy to sandy loam soils. Heavy poorly-drained soils or soils that perch a water table dur-

ing wet seasons promote *Phytophthora* root rot, a devastating disease of chestnuts. Soils should be slightly acid (pH 5.5-6.5). Most Chinese chestnuts can tolerate -20 °F temperatures when fully dormant, but it is strongly recommended that frost pockets be avoided as planting sites, to avoid injury to swelling buds in the spring. Site selection similar to the requirements for peaches, where summit and shoulder slopes are chosen to allow for good air drainage, would be the safest choice to safeguard from winter and late spring frost injury.

Chinese chestnut trees are rather drought tolerant once established, but ample water throughout the growing season promotes good tree growth and regular nut production. Maximum chestnut yields and nut size are obtained only under optimum soil water conditions, therefore irrigation is recommended. A lack of water during mid-August will result in small nut size, while a lack of water in September can prevent burrs from opening normally. Micro-irrigation techniques (drip and/or micro-sprinklers) are best suited for chestnut orchards.

Flowering, Pollination and Fruit Development

Flower buds are initiated during late summer on shoot growth that is located above the developing burrs. During the following spring, new shoots emerge from these buds with catkins appearing midway along the shoot (fig. 1). Chestnuts produce two types of catkins—catkins with only male, pollen-producing flowers (staminate catkins) and

catkins that contain both male and female inflorescences (bisexual catkins). The first few (basal) catkins are staminate catkins, producing pollen around 10 weeks after bud break. The last (most distal) catkins to develop along the current season's growth are bisexual, containing one to three pistillate inflorescences at the basal end of a catkin.

During the end of May to mid June, pollen is released from the most

basal staminate catkins. Pistillate flowers on bisexual catkins become receptive a few days later and are receptive for one to two weeks. Once pistillate flowers become receptive, the bisexual catkins begin to release pollen. Nearly all chestnut trees are self-incompatible and require another tree of a dif-

ferent cultivar for pollination. Flowering times of most Chinese chestnut cultivars are similar enough to ensure that any two cultivars will be able to pollinate each other.

Pollinator trees should be within 200 feet of each other to ensure adequate pollination. Numerous insects visit chestnut

catkins, feeding on the abundant amounts of pollen produced by this tree. However, chestnuts are primarily wind pollinated and do not require bees for adequate fruit set.

There are normally 3 pistils in each burr (involucre). If all three ovaries are pollinated, then three nuts develop in the burr. The middle nut is flattened on two sides, while the outside nuts are flattened on one side. If only one nut develops, then



Catkins of the 'Qing' cultivar releasing pollen. The upper catkin is bisexual with a receptive female inflorescence.

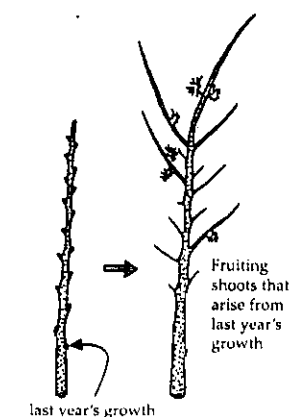
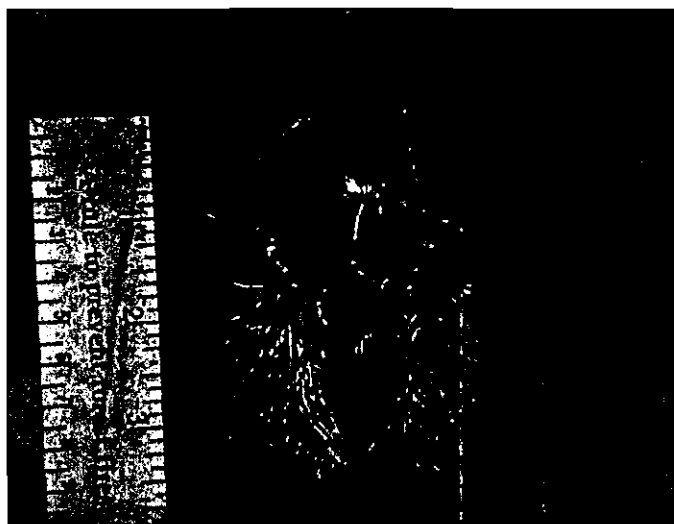


Figure 1: Fruiting shoots arise from previous year's growth.



A dehiscent burr of the 'Qing' cultivar. The nut in the middle position is flattened on two sides.

the nut is round in shape. Sometimes two involucre are fused together during development allowing four to six poorly shaped (flattened on three sides) nuts to develop. Certain cultivars tend to produce a low frequency of fused burrs.

Selecting Cultivars

Chinese chestnut seedlings are widely available in nurseries across the Midwest. Although these trees provide adequate nut production for home



Freshly harvested nuts of the 'Qing' cultivar are large and a shiny, medium-mahogany color.

quent years. Desired cultivars should be grafted to seedling trees one to two years after establishment. Nut production should begin one to three years after field grafting. Starting a chestnut planting with seedlings offers the advantages of low initial costs and the opportunity to establish cultivars not readily available from commercial nurseries. Disadvantages of establishing a chestnut orchard with seedlings include delaying the onset of profits from nut production and adding the expense of grafting your own trees.

Chinese chestnuts are easily grown from properly stratified nuts. Freshly harvested nuts can be stratified in moist sand by placing them in layers about three inches deep and holding them in a cool room or refrigerator (35 to 40 °F) for 60 to 90 days. The nuts can also be stored in resealable plastic bags with slightly moistened sphagnum moss and kept in the vegetable bin of a refrigerator. Stored chestnut seed can be quite prone to rotting so inspect the bag of nuts periodically and remove any spoiled nuts. The taproot (radicle) will slowly emerge during storage similar to acorns in the white oak family. Care must be taken not to injure the taproot when it is time to field plant the nuts in the spring after the danger of frost passes. Homegrown seedlings can be grown in a nursery row in your garden and transplanted the following year or planted directly in the final tree location. Soil drainage is critical so mound the soil into a small hill at each seed plant location to help prevent nuts from rotting.

Transplanting Trees

Transplant bareroot stock in March as soon as the soil can be easily worked. When planting bare root

seedlings, care should be taken to keep the roots moist. Prune the top of each tree to a single stem and prune off any broken or rotten roots. Dig your planting hole large and deep enough to fit the entire root system. Hold the tree in position and fill soil around the roots making sure the fibrous roots are spread out in their natural positions. Plant the tree at the same depth as it was in the nursery. Water in the tree after transplanting and do not place soil amendments or fertilizers in the planting hole.

Container-grown stock can be planted in early October or in late March. Dig your planting hole twice as wide as the container, but no deeper than the depth of the pot. After removing the tree from the container, gently tap or shake the rootball to remove some of the potting media, then inspect for encircling roots. Gently pull out the encircling



Containerized grafted 'Qing' trees ready to be fall field-planted.

roots and spread out into natural positions in the planting hole. Fill in the planting hole with topsoil making sure the tree is at the same depth as it was in the container. However, be sure to cover the rootball and potting soil with about an inch of soil to retard drying out of the rootball.

Care During Establishment

The trunks of young chestnut trees are susceptible to sunscald. To prevent injury, paint trunks white with 50/50 mixture of white latex interior paint and water or wrap the tree with a white, plastic, spiral tree wrap. Keep all vegetation controlled within a three-foot radius of the tree by using mulch or herbicides. If the tree makes several inches of new growth by early June, evenly spread a half-cup of ammonium nitrate fertilizer around the tree over the entire weed-free area. During the summer following tree establishment, it is especial-

Table 1: Recommended Chinese Chestnut Cultivars for Missouri.

Cultivar	Nut Fall	Nuts/lb	Growth Habit	Comments
Eaton	Sept 13-28	28-35	Spreading	The nuts have excellent flavor, and store well. Ornamental glossy leaves.
Mossbarger	Sept 13-28	28-34	Spreading	Nuts have very good flavor.
Sleeping Giant	Sept 14-28	25-35	Upright	Hybrid - Chinese x (Japanese x American). A larger sized tree with proven blight tolerance and excellent nut quality and flavor.
Peach	Sept 20-28	24-32	Upright	Good quality nut grown at Empire Chestnut Company, in Ohio.
Qing	Sept 20-28	20-24	Spreading	The tree is vigorous growing with good branch angles and easy to graft. A consistent bearer, nuts have excellent sweet flavor, store well and have a shiny medium-mahogany color.
Willamette	Sept 23- Oct 4	18-22	Upright	One of the Dunstan Chinese/American hybrids (mostly Chinese). Good nut quality but not as sweet as Qing.
Revival	Sept 27-Oct 10	24-32	Spreading	A Dunstan hybrid. The nut is very dense, stores well, and has a crunchy sweet flavor.

use, seedlings often produce small nuts of mediocre quality. Establishing an orchard of chestnuts with seedling trees will make nut harvest overly complicated. Each tree in the orchard will ripen at a different time making quick and efficient harvest difficult. Grafted trees of proven cultivars provide more uniform ripening, higher nut quality, larger nut size, and more consistent yields. The evaluation of chestnut cultivars for the Midwest is in its early stages. University trials in Missouri have been established and are providing preliminary data. Table 1 lists a few Chinese chestnut cultivars that have shown excellent potential for nut production in Missouri.

Methods for Establishing Chinese Chestnut Trees

Chinese chestnuts can be established by planting grafted trees, by planting seedling trees then field grafting one to two years later, or by planting nuts then field grafting two to three years later. Each of these methods has advantages and disadvantages. Prospective growers should choose the method

most suited to their skills and economic situation.

Transplanting grafted trees of desired cultivars is the simplest way to establish an orchard. Grafted trees come into bearing two or three years following establishment depending on tree growth rate. By providing optimum weed control and ample water, you will ensure vigorous tree growth and early fruiting. Grafted trees can be purchased as bareroot or container-grown trees. Bareroot trees are more widely available but suffer a greater degree of transplant shock. Transplant shock is a major contributing factor in graft failure following establishment. Fall planting of containerized grafted trees significantly reduces transplant shock but the availability of container-grown trees is severely limited. Currently, trees of all recommended cultivars are not widely available from commercial nurseries making it difficult to obtain grafted trees.

Seedling Chinese chestnut trees are widely available and are relatively inexpensive compared to grafted trees. Bare root seedling trees survive well but may grow slowly the first season. Growth is better the second growing season and in subse-



Sunscald injury to a chestnut trunk that has been pruned heavily. Painting the trunk after pruning with 50 percent interior white latex paint would have prevented the damage.

ly important to keep the soil around the tree moist (but not soggy) at all times. Installing a micro-irrigation system will help provide optimum soil water conditions both during the establishment phase and throughout the life of the orchard.

Chestnut Culture - Planning Your Orchard

Chinese chestnut is a very adaptable crop. Chinese chestnut can be grown as a backyard nut tree, a small-scale, low-input orchard tree, or an intensively managed,

high-density orchard crop. Tree spacing and pruning systems differ under each of these management regimes requiring the grower to choose a cultural system before setting out a single chestnut tree. The three basic cultural systems are described below.

Backyard Trees

Chinese chestnuts make an excellent nut tree for home production. Planting at least three trees (different cultivars if grafted trees) will ensure pollination and produce enough nuts for a family. Chinese chestnut trees naturally form wide spreading crowns that grow to a height of 35 to 40 feet. Spacing your trees at least 40 to 50 feet apart will allow ample room for tree growth and allow easy access to all sides of the tree at harvest time. Homeowners should plant their chestnut trees in a location where children and pets can be kept away from the spiny burrs that fall to the ground at harvest. Chestnuts require full sun for best nut production so they should not be planted adjacent to large shade trees.

Young trees should be trained to the central leader system in order to develop a strong framework of lateral branches along the main trunk. After the trees come into bearing, begin pruning off lower limbs—one or two each year until there is enough clearance for mowing and harvesting.

Once the trunk is developed, allow the tree to develop its natural spreading form. If branches with "narrow crotches" arise, prune them out. Branches with narrow crotch angles tend to form bark inclusions, which can lead to limb breakage under the weight of a heavy crop or ice storm. Mature trees require minimal pruning.



A strong crotch showing pronounced bark ridge for the upper right branch. The lower left branch does not show a pronounced bark ridge and is inherently weaker and should be removed.

Low-Input Orchard

Chestnut plantings of 50 to 500 trees are large enough to provide landowners with a reliable source of supplemental income but are small enough to manage with hand labor. For these growers minimizing capital expenditures for machinery is the key to profitability.

To maximize nut yield, initial tree spacing for the small-scale orchard should be 25 by 25 feet or roughly 70 trees per acre. As trees grow and limbs of adjacent trees start to touch, remove every other tree on the diagonal to leave trees on a 35 by 35-foot spacing. A second thinning would be necessary before chestnuts attain their final spacing of 50 by 50 feet (17 trees/ac). Thinning the orchard is crucial to provide optimal sunlight to the trees and ensure maximum nut production. Crowded trees create excessive shade on lower branches allowing flower and nut production only in the tops of the trees. Severe shading causes lower branches to die out and compromises general tree vigor.

Trees should be staked and pruned using the modified central leader pruning system. Many cultivars do not naturally grow vertical central leaders but must be staked to provide a structure for training the young trees. A strong stake should be

placed near each tree and a leader chosen and loosely tied to it. Central leaders grown vertically develop leaves and buds in a spiral fashion allowing good choices for scaffold branches growing in the proper directions. Central leaders allowed to bend over will develop buds on opposite sides of the shoot, not in a spiral fashion. The scaffold branches are selected during the second through sixth growing season, allowing for good spacing between branches in a spiral fashion along the main trunk. The height of the lowest scaffold branch depends on the individual growers equipment needs.

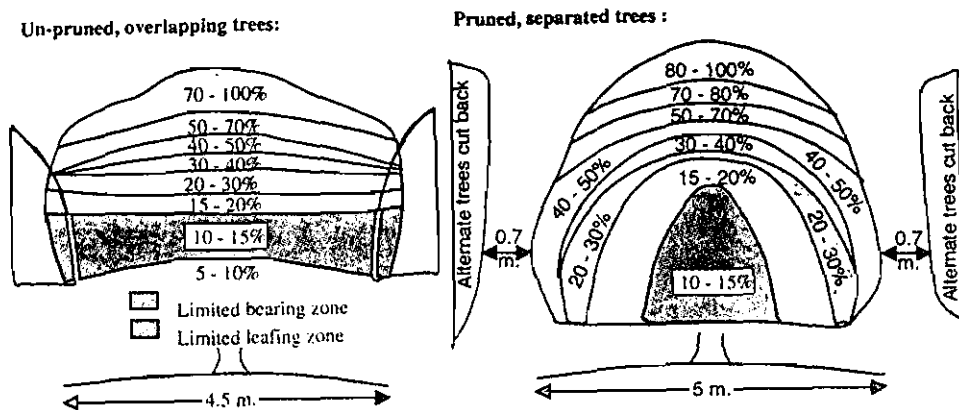


Figure 2: Measurements of relative solar radiation within the tree canopy.

Intensively-Managed Orchard

Large nut size is the key to profitable chestnut farming. Only the largest chestnuts command premium prices. To maximize the production of premium quality nuts, chestnut trees can be grown as a high-density, intensively managed orchard crop. This level of management requires a skilled grower that is willing to plant sufficient acres of chestnuts to justify investments in trees and the mechanization of orchard operations.

A hedgerow system of chestnut production has been developed in Japan by Dr. Hitoshi Araki and is currently practiced in New Zealand and Australia. Trees are planted 13 feet apart within rows spaced 26 feet apart. The trees are not thinned out over time but are pruned to contain tree size similar to what is done in peach orchard management. In a hedgerow orchard, a micro-irrigation system is critical for providing the optimum soil water conditions needed to maximize nut size.

Research in Japan has shown that chestnuts require a relatively high level of light intensity to be able to set and develop fruit. In addition, there is a direct relationship between the intensity of sunlight within the tree canopy and the number of female flowers per cubic foot of canopy (fig. 2). High light intensity stimulates nut-bearing shoot growth, which in turn promotes large fruit size. The hedgerow pruning system strives to maximize light penetration into the entire tree canopy. To

achieve these results, the Japanese pruning system limits tree height to 12 to 13 feet and restricts the distance from the edge of the canopy to the center of the tree. Trees are pruned to an elliptical tree shape (fig. 3)

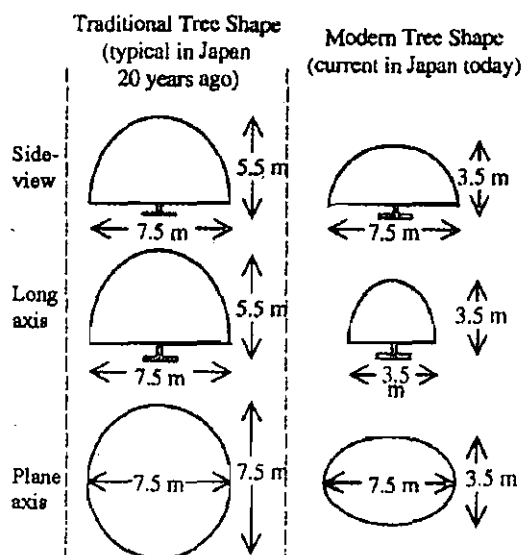


Figure 3: Re-shaping of chestnut trees in Japan.

To achieve needed tree structure, pruning should begin in the first year and continue regularly throughout the tree's life. The target initially should be to promote a leader and two main branches. The third year, the aim should be to encourage the tree to spread out (fig. 4). Thinning the inward growing branches is necessary to further encourage branch spreading into the alley. By approximately the fifth growing season, commercial cropping should begin. Cut out the central leader in the winter, leaving the two permanent structural branches that reach out into the alley-

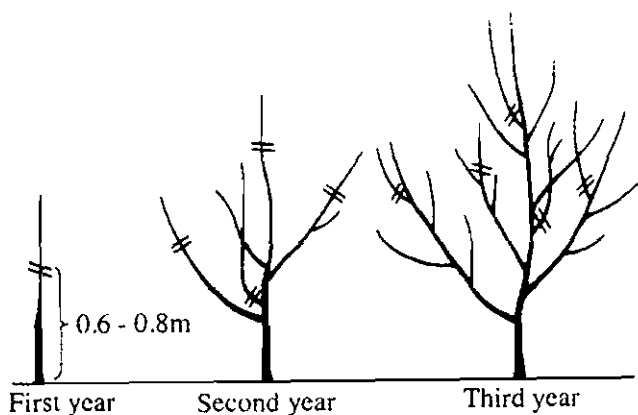


Figure 4: Pruning a young tree in three successive years.

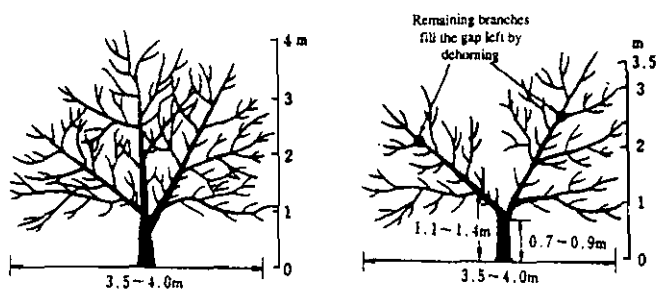


Figure 5: De-horning the central leader.

ways to become the tree's permanent framework. Removing the central leader also reduces tree height (fig. 5).

Subsequent tree growth will fill the gaps left by removal of the central leader. From this point on, thin out interior branches as they begin to crowd, and also remove branches to maintain a reduced tree height and elliptical tree shape. Depending on the cultivar and management inputs, time will determine whether the hedgerow system can be maintained in the Midwest. If not, every other tree will need to be removed within the hedgerow to allow the necessary light penetration into the canopy.

Fertilization

Fertilizer is required to keep trees actively growing and yielding consistent crops of large nuts. Before planting a new orchard test your soil for pH, phosphorus (P) and potassium (K). Chestnuts perform best in slightly acid soils (pH 5.5 to 6.5) so lime should be added only to extremely acid soils. Apply P and K fertilizers if soil tests reveal low levels of these essential plant nutrients. Nitrogen (N) fertilizers must be added to all soils to enhance tree growth. Mature orchards should receive 100 units of nitrogen per acre, spread over the entire orchard floor. To gain greatest efficiency

for N fertilization, spread your nitrogen applications over three application times. Apply 50 percent of total nitrogen before bud swell, 20 percent at the end of flowering and 30 percent after nut harvest. In young orchards, use the same N application rates but do not fertilize the entire orchard floor. Fertilize the tree row by spreading N fertilizer under the drip line of young trees.

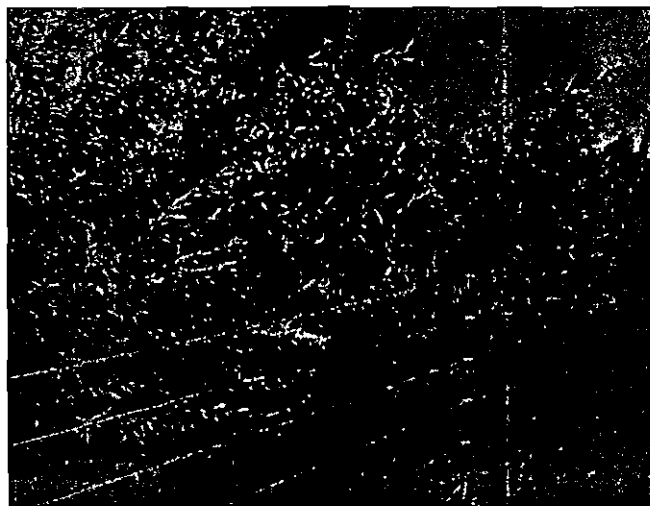
Pest Management

Chinese chestnut is a relatively pest free orchard crop. In small-scale plantings, chestnuts can be successfully grown without pesticides. However, no chestnut tree is safe from the browsing of deer, rabbits and voles.

Mammals

When trees are young, the smooth, thin bark of a chestnut tree is especially inviting to rabbits and voles. Place plastic tree guards around each tree, pressing the guard into the soil to prevent voles from digging under them. Remove all vegetation and mulch away from the tree during winter. Bare soil provides a beautiful backdrop for hawks and owls to spot daring rabbits and voles trying to attack your chestnut trees. Once chestnut trees develop rough bark, the threat from rabbits and voles diminishes.

Deer not only browse chestnuts, bucks often rub all the bark off of trees during late summer and early fall. In large chestnut plantings, electric deer fences are the most cost effective method for preventing deer damage. These electric fences require regular maintenance and vegetation must be controlled under all electric wires. In small chestnut plantings, a five-foot tall welded wire cage (two by four inch grid size) fashioned to form a two or



Electric fencing excludes deer from a Chinese chestnut planting.

three-foot circle around the tree will keep deer from browsing or rubbing. Anchor cages with a four-foot length of rebar driven into the ground. When trees become large enough to tolerate browse damage remove the cages and place two steel posts alongside the trunk to continue to minimize buck rub.

Insects

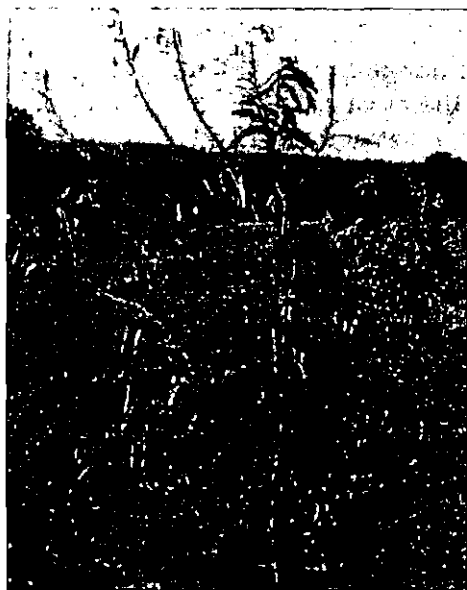
The yellow neck caterpillar (*Datana ministra*) is an occasional pest of chestnuts. These insects



Yellowneck caterpillars defoliating a chestnut branch.

feed in large colonies and can completely defoliate a young chestnut tree. Scout your orchard regularly starting in late June and look for newly hatching colonies. Although this pest is frequently kept under control by beneficial insects, an insecticide can be used to control outbreaks of yellow neck caterpillars.

Recommended insecticides include carbaryl and *Bacillus thuringiensis*.



A young chestnut tree defoliated by yellow neck caterpillars.

Two species of weevils pose the greatest risk of injury to a chestnut crop. These weevils lay eggs inside chestnuts starting in August and continuing until harvest. Larvae of the chestnut weevils are white, legless grubs, which can devour the entire contents of a nut. Because native chestnut

tree species have been killed by the chestnut blight fungus, chestnut weevils have become somewhat rare and are infrequently encountered in new chestnut plantings. It often takes 10 to 15 years before chestnut weevils find new chestnut plantings and build up to economically damaging populations.



Exit hole and larvae of the small chestnut weevil. (Photo courtesy of R. Bessin, University of Kentucky)

Small chestnut weevils (*Curculio sayi*) emerge from the soil in late May through July. Adults feed on chestnut foliage until nut kernels enter the dough stage in mid to late August. Although they can oviposit any time after kernel filling, most eggs are laid after the burr begins to open. The female weevil uses her long proboscis to drill a hole through the shell before turning around and placing her ovipositor into the nut and laying five to seven eggs. Eggs hatch in about 10 days and larval development is completed two to three weeks later. Mature larvae chew a small round hole through the shell, exit the nut, and then burrow into the ground under the chestnut tree. The insect remains in the soil for two to three years before re-emerging as an adult.

Large chestnut weevils (*C. caryatipes*) emerge from the soil in late July and August. Because of their larger size, large chestnut weevils are more successful in laying eggs in nuts before burrs open. The long proboscis of large chestnut weevils enable females to drill oviposition sites among the spines of the burr. Eggs hatch in five to seven days producing large, legless grubs. The life cycle of the large chestnut weevil is similar to that of its smaller cousin but the larger weevil spends only one to two years in the soil.

Nut Curculio (*Conotrachelus carinifer*) is a sporadic pest of chestnut. This curculio is primarily an acorn pest but has been observed to invade chestnut orchards when the acorn crop in nearby forests is low. The nut curculio is related to chestnut weevils and the damage inflicted to chestnut kernels is similar. Curculios have much shorter probosci and must wait until the burrs open to lay eggs inside the nut. The nut curculio has a one-year life cycle.

Good sanitation practices can help keep weevil damage under control. Prompt harvest followed by a hot water treatment (130 °F for 20 minutes,

then immediately cool to ~32 to 34 °F) will kill weevil eggs before they have a chance to hatch. In large orchards, control weevil populations by making three applications of carbaryl (Sevin®) at 10-day intervals starting in mid-August. The adult weevils can be scouted and monitored for their presence by jarring the tree and counting the fallen weevils.

Harvest, handling and processing

Harvest in the Midwest occurs during September and October, depending on cultivar and annual climatic variation. Prompt harvest of fallen nuts is necessary to prevent excessive predation by wildlife. Individual trees generally drop nuts for two to four weeks. Use heavy leather gloves when handling chestnuts in the burr. The prick of a chestnut burr can be very painful. In home plantings, roll the burr under your foot until the nuts pop free before picking up chestnuts. In large plantings, mechanical pecan harvesters have worked well for harvesting chestnuts.



Mechanized nut harvesting is essential in commercial-sized orchards. (Photo courtesy of Todd Leuty, Agroforestry Specialist, Ontario Ministry of Ag, Food and Rural Affairs)

Unlike most tree nuts that are high in oil content and low in water content, ripe chestnuts are high in carbohydrates (49 percent) and water (44 percent) making these nuts subject to molding and decay. Pick up nuts at least every other day to preserve nut quality. Promptly store nuts in a refrigerator (32 °F or slightly above) in sealed plastic bags (one to two gallon bags work well) to retard kernel molding. Ventilated plastic bags are needed for larger quantities to allow some air movement while still reducing excessive moisture loss.

Kernels of fully dry chestnuts (to less than eight percent moisture) are rock hard and inedible. However, dry chestnuts can be ground into chestnut flour and used as a substitute for corn meal. Dry chestnuts can also be rehydrated in boiling



Chestnuts in California are sorted to size and bagged in 25 pound "onion bags" and then stored at 27 °F until a full load is ready to be shipped to a wholesale broker in New York City.

water much like dry beans. Fully drying chestnuts provides chestnut enthusiasts a way to preserve the nuts if refrigerator space is limited. Although dry chestnuts are not susceptible to molding, they are subject to attack by stored grain pests such as Indian meal moth and confused flour beetle. Store dry chestnuts in tightly sealed containers to prevent insect attack.

Markets and marketing

Fresh, early-maturing, large-sized chestnuts command the highest market price. On a national scale, fresh chestnut prices are highest in September then gradually decline until demand for chestnuts falls off after January 1. New York terminal market prices have remained steady at ~\$1.00-\$3.00/lb. since 1995. Wholesale prices range from \$1.00/lb. to \$1.80/lb. Regardless of size, early maturing chestnuts are worth ~50-75 cents/lb. more than later maturing chestnuts. Missouri chestnut growers receive \$2-3/lb. for their product when marketing directly to the consumer.

Currently, chestnuts are graded into six industry recognized size classes of measured diameter:

- Small <1.00 in. (<25 mm, >45 nuts/lb)
- Medium 1.00-1.14 in. (25-29 mm, 40-45 nuts/lb)
- Standard 1.14-1.25 in. (29-31 mm, 30-40 nuts/lb)
- Large 1.26-1.38 in. (32-35 mm, 25-30 nuts/lb)
- Extra large 1.38-1.50 in. (35-38 mm, 20-25 nuts/lb)
- Special >1.50 in. (>38 mm, <20 nuts/lb)

For best value, fresh chestnuts marketed directly to consumers should be no less than 1¼ inches in diameter. Smaller chestnuts should be dried, peeled, and used to create value added products such as chestnut flour or chips.

Chestnut Grower's Calendar

Month	Non-bearing Trees	Bearing Trees	Pest Management
January	Plan grafting efforts	Maintain equipment	Maintain equipment
February	Collect scionwood Prune trees	Prune orchard	
March	Fertilize trees Plant bare-root trees	Prune orchard Fertilize trees	
April	Apply weed control	Apply weed control	
May	Graft trees to recommend- ed cultivars	Keep groundcover mowed	
June	Water newly-planted trees Stake new grafts	Keep groundcover mowed	Field survey for caterpillars
July	Prune off suckers below new grafts	Keep groundcover mowed	Field survey for caterpillars Install deer protection
August	Make sure newly planted trees have adequate water	Keep groundcover mowed Irrigate as needed	Scout for weevils Apply carbaryl as needed
September	Establish cool season cover crops	Harvest promptly Clean and market nuts Irrigate as needed	Refrigerate nuts to retard mold development Hot water treatment for weevil infestation
October	Plant container grown trees	Finish nut harvest	Install rabbit and vole protec- tion
November		Market crop	
December		Market crop	

Chestnut Resources

In the Library

- Aldrich, T.M., D.E. Ramos and A.D. Rizzi. 1982. Training Young Walnut Trees by the Modified Central-Leader System. UC Division of Ag. Sciences Leaflet No. 2471.
- Jaynes, R.A. 1979. Nut Tree Culture in North America. Northern Nut Growers Association.
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- Vossen, P. 2000. Chestnut Culture in California. University of California-Davis, Division of Ag. and Natural Resources, Publication 8010.

On the Web

University Sites

- Chestnut Fact Sheets (CT) <http://www.state.ct.us/caes/FactSheetFiles/IndexHeadingFiles/FSnut.htm>
- Chestnut Culture in California (CA) http://cesonoma.ucdavis.edu/HORTIC/chestnut_99.htm
- Growing chestnuts (MI) <http://www.msue.msu.edu/msue/imp/mod03/03900044.html>
- Chinese chestnut (MI) <http://www.msue.msu.edu/msue/imp/mod03/01701565.html>
- Nut weevils (KY) <http://www.uky.edu/Agriculture/Entomology/entfacts/fruit/ef206.htm>
- US Chestnut industry requirements (OR) <http://www.hort.perdue.edu/newcrop/proceedings1990/v1324.html>
- Online Publications (MO) <http://www.centerforagroforestry.org>
- The International Chestnut Marketing Situation (KY) <http://www.uky.edu/AG/AgEcon/publications/staff411.pdf>

Informative Grower Sites

- Chestnuts on Line (OR) <http://www.ChestnutsOnLine.com/>
- Empire Chestnut Company (OH) <http://www.empirechestnut.com/>
- Delmarvelous Chestnuts (DE) <http://www.delmarvelouschestnuts.com/grow.htm>

Retail Chestnut Nurseries

Burnt Ridge Nursery
432 Burnt Ridge Rd
Onalaska, WA 98570
360-985-2873
<http://landru.i-link-2.net/burntridge/>

England's Orchard & Nursery
316 SR 2004
McKee, KY 40447
606-965-2228
<http://www.nuttrees.net>

Chestnut Hill Nursery
15105 NW 94th Ave.
Alachua, FL 32615
800-669-2067
<http://www.chestnuthillnursery.com>

Nash Nursery
4975 Grand River Rd
Owosso, MI 48867
517-651-5278
E-mail: nashfarm@shianet.org

Empire Chestnut Company
3276 Empire Rd SW
Carrollton, OH 44615
330-627-3181
<http://www.empirechestnut.com/aboutus.htm>

Nolin River Nut Tree Nursery
797 Port Wooden Rd.
Upton, KY 42784
270-369-8551
<http://www.nolinnursery.com>

Acknowledgements

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Tax Considerations for The Establishment of Agroforestry Practices

by
Larry D. Godsey

Agroforestry is often promoted for its conservation benefits and potential income diversity. However, federal tax incentives may provide the greatest benefit to some landowners. Agroforestry is a mix of disciplines including forestry, agriculture and horticulture. Accordingly, agroforestry tax advantages can also be derived from three areas: reforestation, business investment and conservation tax laws. These three areas of the Internal Revenue Code (IRC) are reviewed in this document.

According to the Internal Revenue Service (IRS), a farm business is defined as

"...the trade or business of cultivating land or raising or harvesting any agricultural or horticultural commodity. This includes... raising or harvesting of trees bearing fruits, nuts, or other crops. ..."

In other areas of the IRC, the IRS specifically says "you are not farming if you are engaged only in forestry or the growing of timber." This seems to complicate the position of the taxpayer who has adopted agroforestry practices for the production of both agricultural commodities and timber. However, because agroforestry consists of raising trees and agricultural commodities, tax advantages for the agroforester can come from both forestry and farming incentives.

Reforestation Incentives

There are three possible tax incentives for landowners who choose to plant trees for timber production. These incentives are described in section 126, section 48 and section 194 of the IRC.

Section 126

Section 126 allows landowners to exclude from gross income all or a portion of cost-sharing payments received under the Forestry Incentive Program (FIP), Forest Stewardship Incentive Program (SIP), the Wetlands Reserve Program (WRP), the Environmental Quality Incentives Program (EQIP), the Wildlife Habitat Incentive Program (WHIP) and various state programs designed to improve forests. This exclusion **does not apply** to Conservation Reserve Program (CRP) cost-share payments.

Several programs that are excludable under section 126 support agroforestry practices. Programs such as EQIP, FIP and WHIP provide a flexible framework under which agroforestry practices can be incorporated on private lands. Agroforestry practices established or maintained with cost-share payments through programs like these three would benefit from the section 126 exclusion.

Figure 1: Excludable Programs Under Section 126

- Forestry Incentive Program (FIP)
- Forest Stewardship Incentive Program (SIP)
- Agricultural Conservation Program (ACP)
- Wetlands Reserve Program (WRP)
- Environmental Quality Incentives Program (EQIP)
- Wildlife Habitat Incentive Program (WHIP)
- Individual state programs designed at improving forests

Calculating the Section 126 Exclusions

In order to determine the exclusion amount eligible under section 126, a four-step procedure is used.

Step 1:

Calculate 10 percent of the average annual income from the affected acres during the past three years. According to the IRS, average annual income is considered to be the "average of the gross receipts from the affected acres for the three previous tax years prior to establishment of the practice on which cost-share payments are received." For example, suppose the gross receipts on a particular 20-acre tract of land were \$4,500 in 1998, \$5,280 in 1999, and \$4,500 in 2000. The average annual income would be \$4,760 $[(\$4,500 + \$5,280 + \$4,500)/3]$. Ten percent of the average annual income would be \$476 $(\$4,760 \times 0.10)$.

Step 2:

Multiply \$2.50 times the number of affected acres. This calculation establishes a minimum value for property that may not have had a positive income in the past three years. Using the 20-acre example started in step 1, this calculation would reflect a value of \$50 $(20 \text{ acres} \times \$2.50)$.

Step 3:

Calculate the present value of the larger number from steps 1 and 2. Using the 20-acre example, step 1 calculated a value of \$476 and step 2 calculated a value of \$50. The present value of the larger, or \$476 from step 1, will be calculated. The IRC does not specify how to calculate the present value or what discount rate to use. However, the most common method of calculating present value when no definite time frame is given would be to assume that the payment is a perpetual payment. To calculate the present value of a perpetual payment, simply divide the payment amount by the discount rate. The most common discount rate accepted by the IRS is the one posted by each regional Farm Credit Bank and published annually as an IRS Revenue Ruling. The regional office of the Farm Credit Bank for Missouri is located in St. Paul, Minn. The average interest rate for the year 2000, as indicated by the St. Paul office, is 8.26 percent. Calculating the present value of the \$476 would indicate a value of \$5,763 $(\$476/.0826)$.

Step 4:

Compare the number from step 3 with your cost-share payment; the smaller of the two is the

amount you can exclude from your gross income. In essence, if your cost-share payment is less than the amount calculated in step 3, you can exclude the entire amount. If the cost-share payment is greater than the amount calculated in step 3, you can exclude up to the amount calculated in step 3. From the example, if cost-share payments are less than \$5,763, they may be fully excluded from gross income. However, if cost-share payments are greater than \$5,763, they can only be excluded from gross income up to \$5,763. The remainder would be included in gross income.

Reporting Cost-Share Payments and the Section 126 Exclusion

Landowners who have received a conservation cost-share payment can expect to receive IRS Form 1099-G, which indicates the total amount of payment received. Regardless of whether this payment is going to be partially or completely excluded, it must be reported. In order to report the exclusion, the taxpayer must attach a plain sheet of paper to their tax return that states the following:

- amount of the cost-share payment;
- date it was received;
- amount of the payment that qualifies for exclusion from gross income;
- calculations showing how the exclusion amount was determined ;
- amount that will be excluded.

The method of reporting income from cost-share payments depends on the level of participation and type of activity claimed by the taxpayer. For landowners who file as "investors," the cost-share payment should be reported as "miscellaneous income" on the front of the Form 1040. Business owners who file as a sole proprietor should use Form 1040, Schedule C. Farmers who are reporting cost-share payments as part of their gross income should use Form 1040, Schedule F.

Section 194 and Section 48

Section 194 of the Internal Revenue Code describes the reforestation amortization deduction and provides guidelines for the reforestation investment tax credit of section 48. Both of these incentives are directed towards "commercial timber production" and are applicable to agroforestry.

Reforestation Amortization Deduction

The reforestation amortization deduction is an exception to the general rule, stated in section 263, that reforestation expenses must be capitalized. Section 194 allows the taxpayer the opportunity to amortize up to \$10,000 per year of reforestation expenditures over an 84-month period. Figure 2 details what the IRS considers "reforestation expenditures." This deduction does not apply to Christmas tree production, ornamental tree production, trees planted solely to produce nuts or fruits, shelterbelts or windbreaks. The reforested area must be at least once acre in size and located in the United States.

Establishment of trees under section 194 includes control of woody and herbaceous competition in order to support the survival of a plantation, and replanting of trees that do not survive. Many of these establishment expenses are not realized until the second or third year. The IRS allows the application of the reforestation amortization deduction and reforestation tax credit for these types of expenses incurred up to two years after the initial establishment.

The goal of this program is timber production. Growing trees for purposes other than timber production would not qualify for the amortization deduction. For example, eastern black walnut trees planted in an alley cropping practice can benefit from the reforestation amortization deduction if the trees are maintained in such a way that 1) a marketable butt log will be harvested in the future, and 2) timber production is the primary purpose of the plantation. Any nut crop would be an incidental enterprise that would be taxed as ordinary farm income. Expenses that are incurred in the harvesting and marketing of the nut crop would be deducted as ordinary farm expenses.

As mentioned earlier, "commercial timber production" would have to be the focus of the agroforestry practice in order for it to qualify for the reforestation amortization deduction. The IRS recognizes a written forest management plan as one way of indicating a focus on "commercial timber production."

Reforestation Investment Tax Credit

Reforestation expenses that are amortizable under section 194 are also eligible for the reforestation investment tax credit described in section 48. The tax credit program allows the taxpayer to claim a credit up to 10 percent of the first \$10,000 spent on reforestation each year. If the investment tax credit is used, the amortization deduction amount must be reduced by half of the investment tax credit

Figure 2. Reforestation Expenditures

"Direct costs incurred in connection with forestation or reforestation by planting or artificial or natural seeding, including costs

- (i) for the preparation of the sites;
- (ii) of seed or seedlings; and
- (iii) for labor and tools, including depreciation of equipment such as tractors, trucks, tree planters, and similar machines used in planting or seeding.

(Internal Revenue Code: Title 26, Subtitle A, Chapter 1, Subchapter B, Part VI, Section 194)

percentage. For example, if a 10 percent investment tax credit is taken, the reforestation amortization deduction must be reduced by half of this percentage, or 5 percent.

Since the reforestation investment tax credit applies to the same expenses as the amortization deduction, similar rules of eligibility apply. If a taxpayer has investment tax credit from other sources, these credits can be carried back or forward. The taxpayer must carry credits back using amended returns before carrying the credits forward. For tax years prior to 1998, the credits could be carried back three years and forward 15 years. However, for tax years beginning after 1997, the credits can only be carried back one year and then forward 20 years.

Credits from passive activities can only be applied to income from passive investments. However, if the credits are from sources where the taxpayer is considered a material, or active, participant in the business, then the credits may be applied against all sources of income.

Calculating the Reforestation Amortization Deduction and Reforestation Investment Tax Credit

As mentioned earlier, the amount of the reforestation amortization deduction depends on the percentage of

reforestation investment tax credit taken. The following steps will provide an example for calculating both the tax credit and the annual amortization deduction allowed for reforestation expenses incurred in a given year.

Step 1.

Identify the total qualifying reforestation expenditures. As an example, assume that a landowner has spent \$8,000 on seedlings, labor and site preparation for a given year. The landowner's intent is to establish 15 acres of trees that will be marketable timber in the future. According to the rules of section 194, all \$8,000 qualifies as reforestation expenses.

Step 2.

Determine the reforestation investment tax credit percentage. Generally speaking, most taxpayers will choose to take the full 10 percent reforestation investment tax credit. However, there are limits to the amount of tax credit that can be taken. The discussion of those tax credit limits is beyond the scope of this publication. The instructions for Form 3800 detail how to calculate the tax credit limits. Following the example started in step 1, the taxpayer may take a reforestation investment tax credit of \$800 ($\$8,000 \times 0.10$).

Step 3.

Reduce the reforestation expenses by one-half of the percentage used for the investment tax credit. Based on the rules of section 194, the amortizable amount must be reduced by one-half of the percentage used for the reforestation tax credit. In the example from step 2 above, a 10 percent reforestation tax credit is taken. In this case, the reforestation expenses must be reduced by one-half, or 5 percent, before they are amortized. The reforestation expenses of \$8,000 must be reduced by 5 percent. The amortizable amount of reforestation expenses will be \$7,600 ($\$8,000 \times 0.05 = \400 , $\$8,000 - \400).

Step 4.

Calculate the annual amortization deduction amount. Table 1 lists the amortization percentages for each tax year. Based on the amortizable amount calculated in Step 3, the amortization deduction for the first year of the reforestation project would be \$542 ($\$7,600 \times 0.0714$). In years two through seven, \$1,086 ($\$7,600 \times 0.1429$) can be deducted each year. Finally, in the eighth year, \$542 ($\$7,600 \times 0.0714$) can be deducted.

Reporting the Reforestation Amortization Deduction and Reforestation Tax Credit

The reforestation investment tax credit should be reported on Form 3468, Part I, Line 3. If you have a carryback or carryforward of any credits, an investment credit from a passive activity, general credits from an electing large partnership (Schedule K-1, Form 1065-B), or more than one general business credit, you must complete a Form 3800 to figure the tax liability limit.

A taxpayer that chooses to amortize qualifying reforestation costs under section 194, can do so with Form 4562. The deduction amount will be entered in Part VI of Form 4562. A separate sheet of paper should be attached for each property with the following information:

- a description of the costs and the dates they were incurred;
- a description of the type of timber being grown and the purpose for which it is being grown.

This form needs to be filed on a timely basis, including extensions, in the year in which the expenses are incurred. However, if the taxpayer did not choose to take the deduction on a timely filed return, but decides to take the deduction later, it is still possible. The taxpayer may file an amended return within six

Table 1: Annual Reforestation Amortization Deduction Percentage

Year of Deduction	Percentage of Amortizable Reforestation Expenses Deducted
Year 1	1/14 or 7.14%
Years 2 - 7	1/7 each year or 14.29% each year
Year 8	1/14 or 7.14%



months of the due date of the original return, not including extensions.

Business Investment Incentives

As a landowner engaged in an active farming or forestry business, section 179 of the IRC provides a special deduction for personal property. Personal property that is used more than 50 percent in a farming or forestry business qualifies for the deduction.

Section 179

Section 179 of the Internal Revenue Code provides a taxpayer with the option of deducting the cost of certain qualifying property in the year it was placed in service instead of taking the annual depreciation deductions. Under the rules of the section 179 deduction, a taxpayer may elect to deduct costs up to \$20,000 for personal property that is used in an active trade or business. Since agroforestry often involves active participation in the business of growing crops, livestock, or timber, the section 179 deduction should be considered. The deduction cannot exceed total taxable income from all sources in the year that the qualifying property is put into service. Therefore, the deduction is the smaller of total taxable income or \$20,000. If total taxable income is less than \$20,000, then the difference between \$20,000 and total taxable income can be carried forward to the next year.

The property must qualify based on the rules described by section 1245. Basically, the rules state that qualifying property must be depreciable personal property that is used as an integral part of an active trade or business. This does not include investment property or other property that is purchased solely for the production of income. Figure 3 has a partial list of qualifying property for section 179.

Section 179 deduction amounts are in the process of being increased. Figure 4 (page 6) shows the maximum amounts deductible, by year. For the year 2000, the deduction was increased to \$20,000. The deduction amount will increase to \$24,000 for the tax years 2001 and 2002.

Calculating the Section 179

Deduction

Calculation of the section 179 deduction is relatively straightforward. However, it is subject to three limits:

- the maximum dollar limit;
- the investment limit;
- taxable income limit.

Along with these three limits, it is also important to note that the section 179 deduction must be figured before determining the depreciation deduction. This prevents the taxpayer from taking both the section 179 deduction and a depreciation deduction on the same dollar value of property.

As an example of the maximum dollar limit, suppose a taxpayer purchases qualifying property in the year 2000 that totals \$22,000. Based on the maximum dollar limits listed in Figure 4, only \$20,000 of that purchase can be considered for the section 179 deduction. The remaining \$2,000 becomes the unadjusted basis for the purchased property and can be depreciated. It is important to understand that section 179 does not specify how the maximum dollar limit is met by the taxpayer. In other words, suppose in the year 2000 a taxpayer purchases a tractor for \$15,000, a walnut harvester for \$5,000, and a huller for \$2,000. Each of these purchases qualifies for the section 179 deduction, but it is up to the taxpayer to determine how to meet the \$20,000 maximum dollar limit. For example, the taxpayer may choose to deduct the purchase prices for the tractor and the harvester ($\$15,000 + \$5,000 = \$20,000$) and depreciate the huller (\$2,000). Or, the taxpayer may choose to deduct the cost of the huller, harvester and part of the tractor ($\$2,000 + \$5,000 + \$13,000 = \$20,000$) and depreciate the remaining tractor cost

Figure 3: Qualifying Property Under Section 179

- **Tangible personal property** (e.g. agricultural fences, machinery and equipment)
- **Business property** (all business property, other than structural components, contained in or attached to a building e.g. office equipment)
- **Livestock**
- **Single purpose agricultural (livestock) or horticultural structures**

(IRS Publication 225, Farmer's Tax Guide: 2000)

(\$2,000).

The second limit placed on the section 179 deduction is the investment limit. The maximum dollar limit will be reduced if the taxpayer exceeds the maximum investment limits of \$200,000. If a taxpayer has more than \$200,000 of qualified property for a given year, then the \$20,000 deduction limit is reduced one dollar for every dollar of qualified property over \$200,000. For example, if a taxpayer purchases \$212,000 of qualified property in a given year, the \$20,000 maximum dollar limit must be reduced by \$12,000. In this case, the maximum deduction would be \$8,000.

The final limit on the section 179 deduction is the taxable income limit. As an example, suppose a \$12,000 tractor is purchased that will be used to plant, prune or harvest crops and timber in an alley cropping practice. If the taxpayer's total taxable income for the year in which the tractor was purchased is \$20,000, the taxpayer may deduct \$12,000 from that amount. However, if the taxpayer's total taxable income in the year the tractor was purchased is only \$10,000, then \$10,000 of the tractor cost may be deducted. The remaining \$2,000 must be carried forward for deduction in the following year.

For many landowners, there may be more than one type of deduction that is based on taxable income, such as a charitable contribution. The IRS suggests the following eight-step method to determine the amount of deductions to take:

Step 1.

Figure taxable income without the section 179 deduction or the other deduction. For example, suppose that the taxable income before the section 179 deduction or the charitable contribution deduction was calculated at \$15,000.

Step 2.

Figure a hypothetical section 179 deduction using the taxable income figured in step 1. Suppose a taxpayer had \$13,000 worth of qualifying property. Based on the limits determined by section 179, this taxpayer's maximum section 179 deduction can only be \$13,000.

Step 3.

Subtract the hypothetical section 179 deduction figured in step 2 from the taxable income figured in step 1. This equals \$2,000 (\$15,000 - \$13,000).

**Figure 4: Maximum Amounts
Deductible Under Section 179, by year**

Year	Maximum Amount
Prior to 1997	\$17,500
1997	18,000
1998	18,500
1999	19,000
2000	20,000
2001	24,000
2002	24,000
After 2002	25,000

Step 4.

Figure a hypothetical amount for the other deduction using the amount figured in step 3 as taxable income. Using the \$2,000 from step 3 as taxable income and applying the 50 percent rule for charitable contributions, the taxpayer may hypothetically deduct up to \$1,000 for charitable contributions.

Step 5.

Subtract the hypothetical other deduction figured in step 4 from the taxable income figured in step 1. This equals \$14,000 (\$15,000 - \$1,000).

Step 6.

Now figure the actual section 179 deduction using the taxable income figured in step 5. Using the \$14,000 figured in step 5, the taxpayer would still be able to deduct \$13,000.

Step 7.

Subtract the actual section 179 deduction figured in step 6 from the taxable income figured in step 1. This equals \$2,000 (\$15,000 - \$13,000).

Step 8.

Figure the actual other deduction using the taxable income figured in step 7. The taxable income figured in step 7 was \$2,000. The actual deduction for charitable contributions would be \$1,000.

Because of the numerous assumptions and exceptions to taxable income deductions, it would be to the advantage of the taxpayer to seek professional guidance when more than one deduction is available.

Reporting the Section 179 Deduction

The section 179 deduction is reported on Form 4562. It can be filed with either an original tax return filed in the year the property was placed in service or with a “timely filed” amended return. If the taxpayer is filing IRS Form 4562 with an original tax return, the return does not have to be filed on time. However, if the taxpayer is filing IRS Form 4562 with an amended return, it will not be accepted if it is not filed on time. This includes any extensions.

Conservation Incentives

As a general rule, any improvements made to land are considered capital improvements and must be added to the basis of the land. However, landowners who make improvements for conservation or erosion control may choose to deduct a portion of those expenses under section 175.

Section 175

According to Internal Revenue Code, section 175, if a taxpayer is in the business of farming, as defined earlier, then some soil and water conservation practices may qualify for deduction in the year that they occur. Typically, these expenditures would be considered capital expenses and would be added to the basis for the land. However, under section 175, conservation expenses, totalling up to 25 percent of the gross farm income, can be deducted. This deduction is possible as long as the taxpayer is a material, or active, participant in the farm business. The list of acceptable conservation practices includes, but is not limited to the following:

- treatment or movement of earth (such as leveling, conditioning, grading, terracing, contour furrowing and restoration of soil fertility);
- construction, control and protection of diversion channels; drainage ditches; irrigation ditches; earthen dams; and watercourses, outlets and ponds;
- eradication of brush;
- planting of windbreaks.

The last two items on the list above are key elements

that apply to agroforestry.

For soil and water conservation expenses to qualify for this deduction, they must be consistent with a plan approved by the U.S. Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS), such as:

- NRCS individual site plans;
- NRCS county plans;
- Comparable state agency plans.

Since the Conservation Reserve Program (CRP) does not qualify for the section 126 exclusion, section 175 provides the taxpayer a deduction to offset the income from soil rental payments and cost-share payments. Agroforestry practices that are established under a CRP practice such as the riparian forest buffer practice (CP22), the alley cropping practice (CP19), or the field windbreak practice (CP5A) may qualify for this deduction. It is important to remember that section 175 only applies to **capital expenses on productive farmland** for soil or water conservation and erosion control.

Calculating the Section 175 Deduction

The section 175 deduction is limited to 25 percent of gross income in a given year. Gross income is the sum of all income earned from the farming business, such as the sale of crops, livestock, fruits, vegetables and other farm products. Gross income does not include the sale of capital assets such as equipment or land. Any conservation expenses that exceed 25 percent of gross income for a given year may be carried over to the next year. However, the deduction in any given year may not exceed 25 percent of gross income for that year.

Reporting the Section 175 Deduction

Conservation expenses that are deductible under section 175 must be deducted in the year that they are incurred using Form 1040, Schedule F, line 14. Expenses that are not deducted must be capitalized. If the taxpayer wishes to change methods of treating soil and water conservation expenses or capitalize some conservation expenses and deduct others, the IRS must approve the change of methods. To get approval from the IRS, a written request must be submitted before the due date of the return for the first tax year the new method will apply. The written request must include the following:

- name and address of the taxpayer;
- first tax year the method or change of method is to apply;
- whether the method or change of method applies to all soil and water conservation expenses or only to those for a particular farm or project. If the method or change of method does not apply to all expenses, identify the project or farm to which the expenses apply;
- total expenses paid or incurred in the first tax year the method or change of method is to apply;
- a statement that indicates the intention of the taxpayer to maintain separate accounting records for the expenses to which this method or change of method relates.

Conclusion

It becomes apparent that in order for an agroforestry practice to benefit from the current tax codes, the taxpayer must be aware of the requirements of each tax incentive. For the cost-share exclusion of section 126, it is important to work with natural resource professionals to identify excludable cost-share programs that are currently funded and support agroforestry practices.

For the reforestation amortization deduction and investment tax credit of sections 48 and 194, tree species that have timber value must be incorporated into the agroforestry practice. Ornamental trees, Christmas trees or fruit trees would not qualify. Trees planted solely for nut production would also be disqualified. The Internal Revenue Code does not specify a planting density or provide an acceptable species list. Therefore, the taxpayer's planting intent will most likely be the determining factor as to whether or not the practice qualifies for the section 48 and section 194 incentives. Remember, the reforestation amortization deduction and the reforestation investment tax credit are for "commercial timber production;" any intent other than that will not qualify for these incentives.

Under section 179, a deduction of up to \$20,000 can be taken in a given year to recover the cost of personal property used in an active trade or business. Farm fences, livestock, machinery and equipment qualify for this deduction. Structures specifically used for the growing of mushrooms or commercial plants would also qualify. The maximum deduction amount of \$20,000 will continue to increase over the next three years until it reaches a \$25,000 deduction limit in 2003. The key to this deduction is that the

taxpayer must have an active trade or business enterprise from the agroforestry practice, whether it be crops, livestock, timber, nuts or some other product.

Finally, capital expenses for soil and water conservation on productive farm land, including the establishment of windbreaks that are designed based on USDA/NRCS approved plans, are deductible for up to 25 percent of gross farm income. Section 175 of the IRC specifically identifies planting windbreaks and the eradication of brush as deductible soil and water conservation expenses.

Income exclusions, tax deductions, and tax credits can provide financial incentives above and beyond the expected revenues from agroforestry practices. As stated before, the key to all tax benefits is good record keeping. Most university extension services have publications describing the best method of record keeping for both timber production and agricultural production, such as "Maintaining Woodland Tax Records" which is published by University Extension, University of Missouri-Columbia.

A great resource for more forestry and agroforestry tax considerations is the National Timber Tax website at www.timbertax.org. For more information about whether or not a practice will qualify for an available tax incentive, contact your local IRS office or consult your personal tax advisor.

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- Haney, Harry L. Jr., William L. Hoover, William C. Siegel and John L. Greene. 2001. *Forest Landowners' Guide to the Federal Income Tax*. U.S. Department of Agriculture Forest Service, Agriculture Handbook #718 .
- U.S. Department of the Treasury, Internal Revenue Service. 2000. *Internal Revenue Code , Title 26 (26 USC)*.
- U.S. Department of the Treasury, Internal Revenue Service. 2000. *Publication 225: Farmer's Tax Guide*. Cat. No. 11049L.

Summary of Tax Incentives for Agroforestry Establishment

Internal Revenue Code	Subject of Code	Limits	Reporting	References
Section 48	Reforestation Investment Tax Credit	✓ Cannot exceed 10% of qualifying reforestation expenses under section 194 ✓ \$1,000 maximum credit ✓ Subject to general business credit limits	✓ Form 3468, Part I, Line 3 ✓ Form 3800	✓ Form 3468, Instructions ✓ Form 3800, Instructions ✓ Publication 334, Tax Guide for Small Businesses ✓ Publication 535, Business Expenses ✓ Publication 225, Farmer's Tax Guide
Section 126	Cost-Share Payment Exclusions	✓ Applies only to a limited number of programs ✓ Eligible amount depends on a Four-step calculation based on income received during the three prior years from affected land.	Attach a plain sheet of paper to the return with the following information: ✓ amount of the cost-share payment ✓ date received ✓ amount that qualifies for exclusion ✓ calculations showing the excludable amount ✓ amount that will be excluded	✓ Form 1040, Schedule F, Instructions ✓ Form 1040, Schedule C, Instructions ✓ Form 1040, Instructions ✓ Publication 225, Farmer's Tax Guide ✓ USDA/FS Ag handbook #718, Forest Landowner's Guide to the Federal Income Tax
Section 175	Conservation Deduction	✓ Cannot exceed 25% of gross income from farming ✓ Capital expenses must be from a plan approved by NRCS or similar state agency	Form 1040, Schedule F, Line 14	✓ Form 1040, Schedule F, Instructions ✓ Publication 225, Farmer's Tax Guide
Section 179	Qualifying Business Property Deduction	✓ \$20,000 maximum dollar limit ✓ \$200,000 maximum investment limit ✓ Taxable income limit	Form 4562	✓ Form 4562, Instructions ✓ Publication 225, Farmer's Tax Guide ✓ USDA/FS Ag handbook #718, Forest Landowner's Guide to the Federal Income Tax
Section 194	Reforestation Amortization Deduction	✓ \$10,000 maximum ✓ reduced by one-half of the percentage used for the tax credit of section 48 ✓ must be amortized over 84 months	Form 4562, Part VI with separate sheet of paper stating: ✓ description of costs and date incurred ✓ description of the type of timber and purpose for which it is grown	✓ Form 4562, Instructions ✓ Publication 225, Farmer's Tax Guide ✓ USDA/FS Ag handbook #718, Forest Landowner's Guide to the Federal Income Tax

Definitions:

Active Trade - See "Business."

Adjusted Basis - Adjustments to original basis including the cost of any improvements made to the original property. For timber property, this could include additional seedlings and associated costs of planting.

Amortization - The periodic subtraction of an allowed annual amount to recover qualifying capital costs over a specified period of time.

Basis - The basis of an asset is how much it actually costs (*Section 1012 of the Internal Revenue Code*). For timber acquired by purchase, the basis is the amount paid for the timber. (*See Section 1016 Internal Revenue Code and Department of the Treasury, Internal Revenue Service, Publication 551, Basis of Assets.*) Basis for property acquired by other means is determined based on the method of acquisition. For example, basis for inherited property is equal to its fair market value as of the date of death or some alternate valuation date. Similarly, the basis for property acquired as a gift is equal to the donor's basis at the time of transfer. Also see "Adjusted Basis" and "Stepped-up Basis."

Business - An activity that is established for the purpose of earning profit, which involves regular transactions. There are many factors determining whether or not an activity is an active business. However, the two most important factors are the "presumption of profit" and regular transactions. Also see "For Profit," "Investment," "Material Participation," "Passive Participation," and "Profit."

Capital Costs - Expenditures for the acquisition or improvement of real estate, machinery or other equipment that has a useful life of more than one year. These expenditures may be added to the original cost of the property in order to calculate adjusted basis. Tree planting costs are an example of a capital expenditure.

Capitalization - The process of adding the cost of acquiring a capital asset to a capital account. Depending on the nature of the asset, the capitalized amount may be recoverable through

depreciation, depletion, amortization, or only through sale or exchange.

Carry Back (Carry Forward) - An accounting technique that allows a taxpayer to get full benefit of available excess annual tax credits and deductions by applying them to previous tax returns (carry back) or future tax returns (carry forward).

Depletion - The using up or wasting away of a natural resource. In the case of timber, depletion is the recovery of an owner's basis in timber. It applies when timber is harvested and the cut logs are sold or used in the owner's business.

Depreciation - The process by which the basis of a capital asset with a determinable useful life is recovered as the asset is used for the production of income. Capital assets associated with forest ownership whose basis is recoverable through depreciation include equipment, buildings, fences, temporary roads and the surfaces of permanent roads.

Expensing - The recovery of an expense by subtracting it from taxable income in the year it is paid or incurred. This is also called deducting.

For Profit - A profit motive is presumed if the activity produced a profit in at least three of the last five tax years, including the current tax year. There are special cases where this profit requirement is modified. For example, certain activities involving the breeding, showing, training and racing of horses need to show profit in at least two of the last seven tax years. (*See USDA/FS Agriculture Handbook 718, Forest Landowner's Guide to the Federal Income Tax.*) Also see "Profit."

Intangible Property - Property that cannot be seen or touched. Examples of intangible property include lease rights, goodwill, patents, copyrights, etc.

Investment -- An activity engaged in for the purpose of realizing a profit, that does not require the regular transaction necessary to be considered a trade of business. The least active level of participation in an income-producing activity. Also see "Business," "For Profit," "Material Participation," "Passive Participation," and "Profit."

Material Participation - "Regular, continuous, and

substantial" participation in a business. A material participant in a business must meet at least one of the following seven tests.

1. You participated in the activity more than 500 hours.
2. Your participation was substantially all the participation in the activity of all individuals.
3. You participated at least 100 hours during the tax year, and no other individual participated more.
4. The activity is a significant participation activity, and you participated in all significant participation activities for a total of more than 500 hours. A significant participation activity is a trade or business in which you participated more than 100 hours and you did not materially participate based on all of the other tests for material participation.
5. You materially participated in the activity for any five of the 10 immediately preceding tax years.
6. The activity is a personal service activity in which you materially participated for any three preceding tax years. A personal service activity involves the performance of personal services including the fields of health, law, engineering, architecture, accounting, actuarial science, performing arts, consulting, or any other trade or business in which capital is not a material income-producing factor.
7. Based on all the facts and circumstances, you participated in the activity on a regular, continuous, and substantial basis.

(See Department of the Treasury, Internal Revenue Service, Publication 925, *Passive Activity and At-Risk Rules*.)

Ordinary Expenses - Currently deductible operating expenditures including management, taxes and interest. These expenses are generally deductible in the year they occur. Pruning costs, noncommercial thinning costs and harvesting costs

of annual crops are examples of ordinary expenses.

Passive Participation - A person is a passive participant in a trade or business if they do not meet any of the rules required for material participation. (See Department of the Treasury, Internal Revenue Service, Publication 925, *Passive Activity and At-Risk Rules*.) Also see "Material Participation."

Personal Property - Personal property is property that is not permanent in nature and is not a permanent fixture on land. For example, machinery, equipment and livestock are considered personal property.

Profit - Profit is calculated by subtracting expenses from gross income for a trade or business activity in a given tax year. Appreciation in the value of assets is also considered profit. Profit from timber will most likely be realized from appreciation in value through physical growth and enhanced quality until it is harvested. (See USDA/FS *Agriculture Handbook 718, Forest Landowner's Guide to the Federal Income Tax*.) Also see "Active Trade," "Business," and "For Profit."

Real Property - For taxation purposes, real property refers to land and permanent fixtures on the land, such as buildings, ponds, roads and standing timber. A fixture is permanent if it is "...erected on, growing on, or attached to land ..." and cannot be removed from the land without destroying its original use, purpose or function. (See Department of the Treasury, Internal Revenue Service, Publication 551, *Basis of Assets*.)

Stepped-up Basis - If property is acquired through inheritance, the basis may be "stepped-up" or increased. The stepped-up basis is determined by the fair market value of the property on the deceased's date of death or some other alternative valuation date. (See Department of the Treasury, Internal Revenue Service, Publication 551, *Basis of Assets*.)

Tangible Property - Property that can be seen or touched. This would include trees, machinery, equipment, etc.

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Productive Conservation:

Growing Specialty Forest Products in Agroforestry Plantings

Discovering profits in unlikely places

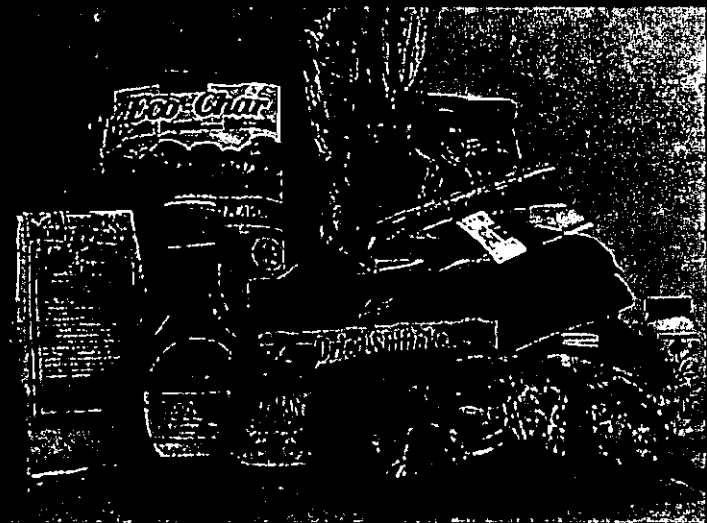
Whether you own a small acreage just outside of town, or a 5,000-acre farm, you may be able to earn supplemental income, save money, and improve and protect your environment by producing commercially valuable specialty products from tree and shrub plantings. There are many opportunities for producing, selling, or personally enjoying specialty forest products in rural, suburban or even in urban settings. For example, is your country home, farmstead, livestock area, or acreage battered by the wind or buried by winter snows? Tired of mowing acres of lawn on your acreage every weekend? Do you have fencelines, woodlots, marginally-productive upland fields, streamside areas, pivot irrigation corners, or just hard-to-farm small parcels? Any of these areas could be better utilized by planting woody crops in windbreaks, living snow fences, or streamside buffers that produce specialty forest products (SFPs).

Unsheltered acreage or farmstead Well-protected acreage or farmstead



Eroding streambank

Productive stable streambank



What are specialty forest products?

Specialty forest products generally fall into one of four categories; 1) medicinals and botanicals, 2) forest-based food products, 3) woody decorative florals, and 4) handicraft products and specialty woods.

1. Medicinals and Botanicals

Medicinals and botanicals are plant-derived substances that are used in a variety of food supplements, herbal health items, cosmetics or other products. Products are made from nearly all parts of trees, shrubs or herbaceous plants, including wood (cedar), bark (smooth sumac, slippery elm), buds (cottonwood), leaves (catnip, ginseng, ginkgo), roots (sassafras, ginseng, goldenseal), fruit and flowers (echinacea, partridgeberry, skullcap, St. John's Wort, elderberry), nuts (black walnut, pecan), sap (maples), and even pollen (ash, oak, cottonwood, maples, pines and many others).



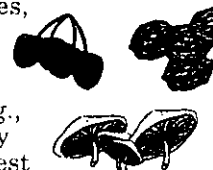
Ginseng

2. Woody-Based Food Products

Tree and shrub-based food products include nuts, fruit and some mushrooms. Nuts include black walnut, Chinese chestnut, pecan (and northern pecan), hickory, butternut, hybrid hazelnut and ginkgo. Superior nut cultivars exist for all of these species. Commercial nut markets include in-shell products, whole and crushed kernels, oils and confections. High prices for fresh kernels are often paid by high-end restaurants, bakeries, etc.

Commonly harvested fruits include chokecherry, highbush cranberry, sand cherry, currants, Cornelian cherry, dogwood, elderberry, saskatoon (serviceberry or Juneberry), jostaberry, Nanking cherry, chokeberry, buffaloberry, pawpaw and persimmon, among many others. All are harvested for home consumption, but many are also gathered for commercial use as fresh fruit, jams, jellies, syrups, juices, concentrates, confections and wines. Berries usually sell for \$0.65 to \$1.50 or more per pound.

High value gourmet mushrooms (e.g., Shiitake and oyster) can be intentionally cultivated on logs or wood chips in a forest setting. These are marketed in supermarkets and ethnic or high-end restaurants.



Food products

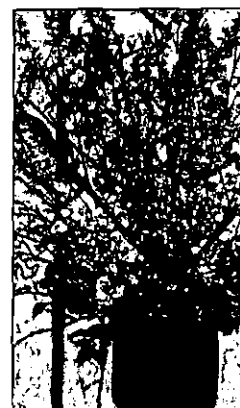
Productive Conservation with

Woody Decorative Florals

Any woody plant species that has a colorful or unusually shaped stem, bud, flower, fruit or even leaf can become a decorative floral product. Examples include cultivars of red yellow-stemmed dogwoods; curly, pussy, flame and basket willows; red (sweet) birch; holly and bittersweet vines (for fruit); flowering branches of forsythia, apple, cherry, witchhazel, and many others. Floral designers increasingly use these materials fresh and dried in creative floral arrangements.

Good opportunities exist for garnering substantial returns producing and marketing decorative woody stems. Retail florists generally pay around \$0.50-\$0.80 per 4'-5' stem for curly or pussy willow. Decorative florals can be sold directly to retail floral shops, large retailers and wholesalers throughout the US. For example, nearly 200,000 woody stems are sold each year in Nebraska alone (Lambe, D. 2000).

Woody stems are sold fresh or dried, depending on the end use. Flowering stem material is generally cut dormant, and is forced to flower by either the grower or florist. Some plant materials with showy leaves are preserved by soaking in glycerin and enhanced with various dyes, increasing their value. "Floral greens" are cuttings from coniferous trees (firs, spruces and pines) for use in wreaths and seasonal decorations. Produced in native northern forests, they are a multimillion dollar industry in a number of northern states.



Willows creatively used in floral arrangements

Specialty Forest Products With Commercial Markets

Species	Scientific Name	Cultivars for SFP Production	Products/Characteristics
Walnut, Black	Juglans cinerea	"Kenworthy", "Mitchell"	fresh nuts
Castanet, Chinese	Castanea mollissima	Many	fresh nuts
Ginkgo	Ginkgo biloba	"Salem Dandy", "Salem Lady", "Mother Load"	canned nuts, medicinal
Alnut, Hybrid	Corylus hybrid	"Farris 88-BS", "G-17", "G-14", "Gellatly # 502", "Grimo 188P", "Skinner", "Grand Traverse"	fresh nuts, oils, syrups, nutmeat, confections
Walnut, Northern	Carya illinoensis	"Winkler", "Rutter/Badgersett Hybrids"	
Nut, Black	Juglans nigra	many	fresh nuts, nutmeat, confections
		many	fresh nuts, oil, nutmeat, nutshells
Cherry, Nanking	Prunus armeniaca	"Moongold", "Sungold", others	fresh and dried fruit, jam
Cherry, Sand or Bush	Shepherdia argentea	None	fresh fruit, jelly, wine
Cherry, Black	Prunus tomentosa	"White", standard red variety	fresh fruit, jelly
Cherry, Red	Prunus besseyi	"Hansen", "Sioux"	fresh fruit, jelly
Cherry, Black	Prunus serotina	None	fresh fruit, jelly, wine, juice
Cherry, Red	Aronia melanocarpa	"Nero", "Viking"	jelly, juice, persistent winter fruit
Cherry, Red	Prunus virginiana	"Boughens Chokeless", "Robert", "Pickup's Pride", "Goertz", "Garrington"	fresh fruit, jelly, wine, syrup, juice
Cherrybush, American (Highbush)	Viburnum trilobum	"Schubert" or "Canada Red"	
Cherrybush, American (Highbush)	Ribes odoratum	"Wentworth", "Hahs"	fresh fruit, jelly, wine, syrup, juice
Cherrybush, European Black	Ribes nigrum	"Crandall", "Deseret"	fresh fruit, jelly, wine, juice, syrup, medicinal
Cherrybush, Red	Ribes rubrum	"Consort", "Blacksmith", "Brodtorp"	fresh fruit, jelly, wine, juice, syrup, medicinal
Cherrybush, White	Ribes sativum	"Ben Sarak", "Laxton's Giant", others	
Cherrybush, Corneliancherry	Cornus mas	Many	fresh fruit, jelly, wine
Cherrybush, Red	Sambucus canadensis	"Elegant", "Redstar", "Yellow", "Redstone"	fresh fruit, jam, sparkling wine
Cherrybush, Red	Ribes hirtellum or R. uva-crispa	"York"	fresh fruit, jelly, wine, juice, tea, medicinal
Cherrybush, Red	Ribes nigridoloria	"Adams"	fresh fruit, jelly, wine, juice, tea, medicinal
Cherrybush, Red	Actinidia arguta	"Pixwell", "Welcome", "Clark"	fresh fruit, jelly, wine, juice, tea, medicinal
Cherrybush, Red	Morus rubra	"Jostagrande", "Jostina", "Red Josta"	fresh fruit, jelly, wine, juice, tea, medicinal
Cherrybush, Red	Ceanothus americanus	Many	fresh fruit
Cherrybush, Red	Asimina triloba	"Johnson", "Weisman", "Cooke", "Wellington"	fresh fruit, jelly, wine
Cherrybush, Red	Diospyros virginiana	None	tea
Cherrybush, Red	Rosa arkansana	Many	fresh fruit
Cherrybush, Red	Amelanchier alnifolia	"Hicks", "Meader", "Pieper", "Runkwitz"	fresh fruit, jam, wine
Cherrybush, Red		Unknown	tea, syrup, jelly
Cherrybush, Red		"Smoky", "Northline", "Pembina", "Thiessen"	fresh fruit, jelly, syrup, juice
Cherrybush, Red		"Martin", "Honeywood", "Nelson"	

WOODY DECORATIVE FLORALS

Species	Scientific Name	Cultivars for SFP Production	Products/Characteristics
Crabapple	Malus spp	Many	flowers, forced
Red (Sweet)	Betula lenta	None	speckled burgundy stems
Sweet, American	Celastrus scandens	None	branches with orange berries
Bloodtwig	Cornus sanguinea	"Atrosanguinea"	dark, blood red or burgundy stems, suckers freely
Redosier	Cornus sericea	"Cardinal"	bright red-orange stems, suckers freely
	Cornus sericea var. coloradensis	"Cheyenne"	red stems, suckers freely
	Cornus sericea	"Bailey's Red"	red stems, suckers freely
	Cornus sericea	"Colorado Red Osier"	red stems, suckers freely
	Cornus alba	"Allemaans Compact"	red stems, suckers freely, few lateral branches
	Cornus alba	"Sibirica"	bright coral-red stems, suckers freely
	Cornus alba	"Kesselringii"	brownish purple stems, suckers freely

Aircraft products can be derived from forest-grown trees, shrubs, vines, pine needles, etc. Most of these products are not produced commercially, but are instead harvested from existing forests. Markets can be small and easily overwhelmed with excess supply.

Specialty Forest Products

Marketing conservation pay: producing specialty forest products in agroforestry settings

Specialty forest products come from woody plants that can be planted in settings that provide many environmental and conservation benefits. They can be planted in a field or farmstead windbreak, in a large community windbreak that protects an entire rural town or village, or as a living snow fence. Wind protection increases crop yields by up to 50% and reduces energy costs around the home and farmstead, and trims removal costs. Woody plants can also be used in streamside buffer strips to intercept pollutants. SFP-producing plants used in conservation settings can reduce soil erosion, improve water quality, enhance wildlife habitat, and improve your own quality of life. They also can be arranged in mass groupings or "orchards" to maximize production efficiencies.

Even a backyard can be transformed into a low-maintenance "edible landscape" for both people and wildlife, filled with species that produce high quality nuts, berries, and mushrooms. Kids want a snack? Take them into the backyard to "graze" for fruits and nuts. And if you have time to harvest the "fruits" of your yard, the local wildlife will only benefit from the available food and

as with any crop, changes abound. The timing of harvest, availability of the product, available labor, economic pressure, insect diseases, year-to-year production variability, and lack of subsidized subsidy or insurance programs require planning and management.



Produce red-stemmed dogwoods in your windbreak

Marketing specialty forest products for supplemental income

Most SFPs can be sold in the marketplace. Some markets are quite established and well-structured with both wholesale and retail outlets (native florals, some fruits and nuts). Other markets are more informal (a local jelly company, winery, floral shop, craftsperson, the farmers' market, or a roadside stand), and are better suited for the producer. Large or small, all specialty forest product markets are competitive, requiring far greater marketing efforts than do traditional

smaller niche markets may be easily overwhelmed by excessive competition. Prices can be volatile, depending on product supply and quality. Specialty products have seasonal markets (pussy willow in the spring, holly in the holiday season, berries when ripe), others are more year-round (mulch, willows). It definitely pays to line up markets *before* production commitments are made. Solid marketing and quality production can earn higher prices and consistently greater profits.

Summary

Specialty forest products produced in woodlands or in agroforestry settings can provide important supplemental income to rural and semi-rural residents, and at the same time improve the environment. Successful producers clearly need to be skilled growers and effective marketers of products.

Selected Resources

- Agroforestry information:
<http://www.agroforester.com>
- *Conservation Trees*. National Arbor Day Foundation. www.arborday.org
- *Farming the Forest for Specialty Products: Proceedings of the North American Conference on Enterprise Development Through Agroforestry*, Minneapolis MN, October 4-7 1998. 1999. S. Josiah, Editor. University of Minnesota: 800-876-8636, or www.extension.umn.edu.
- *Income Opportunities in Special Forest Products: Self-help Suggestions for Rural Entrepreneurs*. 1993. M.G. Thomas. USDA Forest Service, Ag. Info. Bulletin 666.
- The National Agroforestry Center produces a number of SFP-related publications:
<http://www.libfind.unl.edu/nac/pubs/>
- Non-Wood News
FAO: <http://www.fao.org/forestry/FOP/FOPW/NWFP/NWFP/newsle-e.stm>
- North American Fruit Explorers:
<http://www.nafex.org>
- International SFP:
<http://www.fao.org/forestry/FOP/FOPW/NWFP/nwfp-e.stm>
- SFP use and markets:
http://www.sfp.forprod.vt.edu/special_fp.htm
- SFP information by species:
<http://www.hort.purdue.edu/newcrop/default.html>
- SFP reference info.:
<http://www.ifcae.org/ntfp/>
- *Woody Decorative Floral Assessment for Nebraska*. 2000. D. Lambe. University of Nebraska-Lincoln.

Photo and Graphic credits: The National Arbor Day Foundation; Nebraska Forest Service; Scott Josiah; Agroforestry graphics courtesy of University of Minnesota

Productive Conservation

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School of Natural Resource Sciences and
Cooperative Extension

Funded by



UNIVERSITY OF
Nebraska
Lincoln

USDA National
Agroforestry
Center



**The National
Arbor Day Foundation**

arborday.org

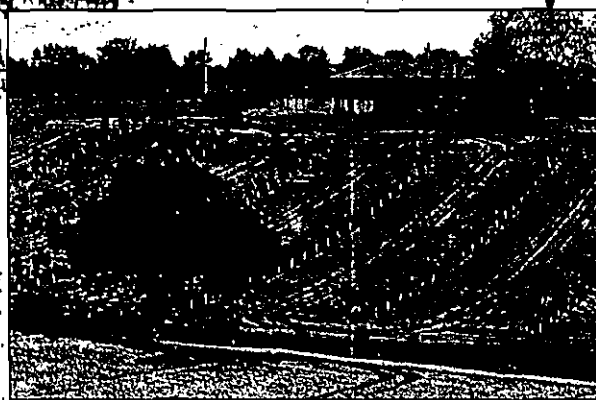
Diversifiez votre exploitation avec...

L'AGROFORESTERIE

Peupliers et blé, Gard



Cormiers et pois, Haute-Garonne



► associer des arbres espacés
aux cultures dans des parcelles agricoles

► planter des cultures dans
des parcelles boisées/éclaircies

Noyers et blé dur, Hérault



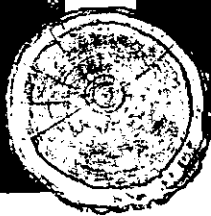
Peupliers et bovins, Lot



Noyers et lavande, Drôme



7 atouts pour votre



Noyers et blé, Hérault



Merisiers et bovins, Pas-de-Calais

1

Gagner de l'argent avec des arbres de qualité

... récoltés au bout de 20 à 50 ans. Les arbres poussent beaucoup plus vite en présence des cultures. Bien entretenus, ils donnent un bois sans noeud valorisé en tranchage et déroulage.

Roitiers et pâture, Orne

Semis de colza entre des



Protection des jeunes arbres

Paysage agroforestier, Hérault



Merisiers et ovins, Pyrénées-Orientales



Noyers et maraîchage, Dordogne



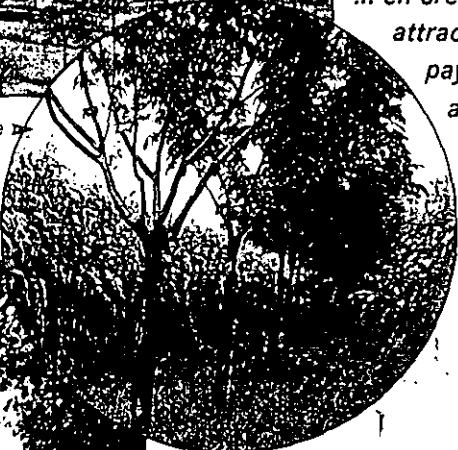
Mer

4

Offrir une image différente du métier d'agriculteur

... en créant des paysages originaux, attractifs et sécurisants. Ces nouveaux paysages répondent aux attentes de la société et correspondent aux orientations actuelles de la politique agricole de l'Union européenne.

s et maïs, Isère



Noyers et tritiale, Charente-Maritime



Prendre plaisir à élever des arbres

Apprenez à connaître les arbres, à les entretenir, et regardez les grandir.

6

Projet agroforestier

Poiriers et bovins, Orne

2

Maintenir votre revenu agricole

... avec les cultures entre les lignes d'arbres.
Le rendement des cultures intercalaires reste stable longtemps (10 à 15 ans sur 90 % de la parcelle) et diminue ensuite lentement. L'écartement entre les lignes d'arbres est choisi pour tenir compte de la culture associée et des contraintes de la mécanisation.



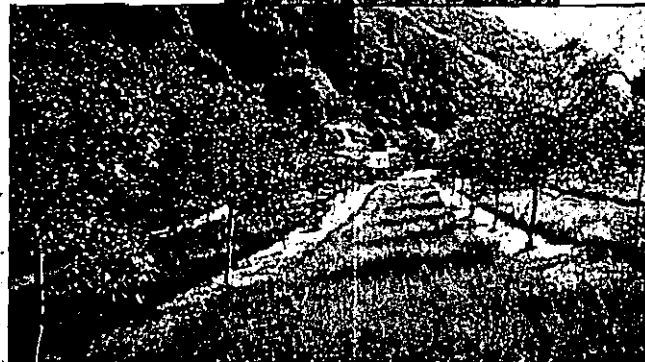
Merisiers et colza, Gard

Préserver la qualité de l'environnement

Arbres et cultures bien gérés ensemble sont complémentaires. Les arbres limitent les risques de pollution par lessivage des éléments fertilisants, freinent l'érosion, enrichissent le sol en matière organique.

Ils peuvent favoriser les populations d'auxiliaires pour la protection intégrée des cultures intercalaires.

3



Noyers et luzerne, Drôme

5

Diversifier les activités de votre exploitation

... en cultivant des arbres. Sur une portion limitée de votre SAU (10 à 20 %), des plantations agroforestières introduites progressivement augmentent la valeur de votre exploitation, sans diminution notable de son revenu agricole.

s, Allier

Noyers et blé dur, Hérault



Transmettre un patrimoine vivant

Les agroforestiers traditionnels du Dauphiné vous le diront : les arbres transmis de père en fils sont respectés. Chaque arbre récolté pour financer un investissement professionnel ou familial est aussitôt replanté pour les enfants.



7



Projet agroforestier

Poiriers et bovins, Orne

2

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Merisiers et colza, Gard

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3



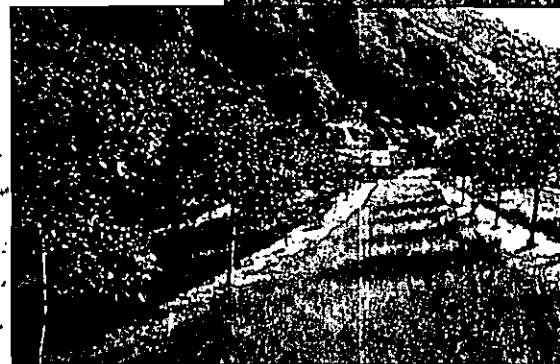
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Châtaignes, Allier



Noyers et luzerne, Drôme

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7



Noyers et blé dur, Hérault



Une plantation agroforestière est : rentable



Les études de rentabilité menées par l'Inra montrent que les projets agroforestiers présentent des résultats égaux voire supérieurs, à la situation agricole d'origine ou à un boisement en plein.



réversible

Après la récolte des arbres, le dessouchage de la parcelle demande peu de travail et n'abîme pas le sol. La parcelle peut facilement retrouver sa fonction agricole d'origine.



facile à réaliser

Planter et entretenir les arbres est une activité qui s'apprend. Cultiver entre les arbres demande une nouvelle technicité à votre portée. Des ouvrages existent. Faites appel à un technicien.



compatible avec le statut du fermage

L'agroforesterie permet au propriétaire de planter tout en laissant le fermier exploiter la terre. Un contrat précise les modalités de l'accord et les responsabilités respectives, et peut prévoir une rémunération du fermier pour l'entretien des arbres.



encouragée par les pouvoirs publics

Les cultures intercalaires ont droit aux mêmes aides que les cultures en plein (primes PAC). Des aides à l'investissement existent pour la plantation d'arbres espacés.

créative

Un projet agroforestier laisse place à votre imagination : mélangez les essences d'arbres, diversifiez les plantes associées, osez des formes et des couleurs originales.



DRAF-AUVERGNE

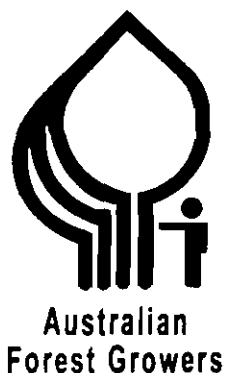
CEMAGREF

LYCÉE AGRICOLE BRIOUDE-BONNE

ESSAIS AGROFORESTIER

Plantation de feuillus précieux et résineux en prairie pâturée à différentes densités (50-100-200 / ha) Installation Préalable





Australian Forest Growers Branches



AFG has been in existence since 1969. Its members include forest growers engaged in farm forestry, private native forestry, and several corporate members, most of whom are managed investment scheme (MIS) or prospectus companies. AFG has a national special interest branch called Treefarm Investment Managers Australia, which represents those MIS companies.

AFG represents over 1200 growers directly as well as the interests of over 30,000 growers who invest through MIS companies. AFG provides a range of services to its members including the quarterly magazine Australian Forest Grower and other publications, as well as certification of pruned stands for clearwood production. AFG can be contacted at national.office@afg.asn.au or visit our website www.afg.asn.au

AFG also manages the Farm Forest Line website (<http://www.farmforestline.com.au/>). Farm Forest Line is a free information service managed by Australian Forest Growers in association with Melbourne University School of Resource Management and Energy Strategies. Farm Forest Line provides reliable information and advice about farm forestry practice, opportunities and developments.





An Australian Government Initiative

Joint Venture Agroforestry Program



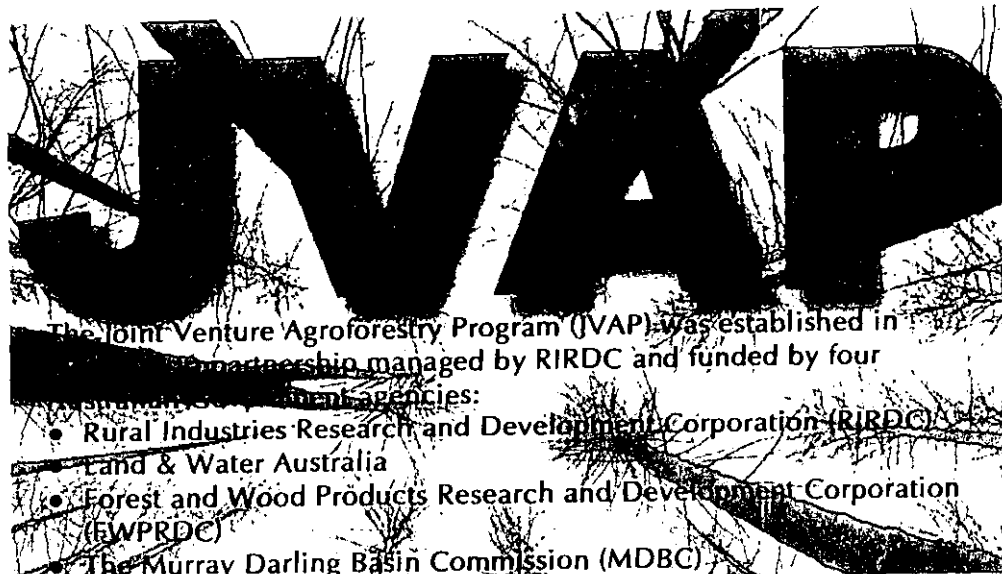
Rural Industries
Research & Development Corporation
Forest & Wood Products
Research & Development Corporation
Land & Water Australia
Murray-Darling
Basin Commission

Australia's Forest Industry



This map was sourced from the National Forest Inventory, Bureau of Rural Sciences (BRS). BRS is a research group within the Australian Government Department of Agriculture, Fisheries and Forestry. JVAP and AGO funded BRS to establish the Bioenergy Atlas website (see www.brs.gov.au/mapserv/biomass/).

The JVAP publishes its research reports and design guidelines. Most publications are available for free download from www.rirdc.gov.au and can also be purchased by visiting our bookshop at www.rirdc.gov.au/eshop



The Joint Venture Agroforestry Program (JVAP) was established in 2001 as a partnership managed by RIRDC and funded by four Australian Government agencies:

- Rural Industries Research and Development Corporation (RIRDC)
- Land & Water Australia
- Forest and Wood Products Research and Development Corporation (FWPRDC)
- The Murray Darling Basin Commission (MDBC)

The Australian Forest Growers also contribute to the partnership and provide a valuable industry perspective. Additional support is provided by the Natural Heritage Trust, Grains R&D Corporation (GRDC) and the Australian Greenhouse Office.

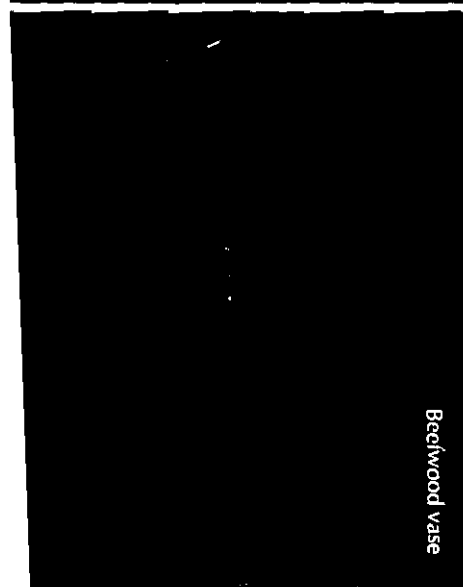
The Joint Venture Agroforestry Program works to develop practical agroforestry systems and strategies for the combined purposes of commercial production of tree products, increased agricultural productivity, and sustainable natural resource management within the agricultural environment. The JVAP is helping to provide the knowledge base that landholders need to invest with confidence in agroforestry.

JVAP has funded over ten years of research into a broad range of aspects of farm forestry and agroforestry. Groups conducting the research include universities and the Commonwealth Scientific and Industrial Research Organisation (CSIRO). Topics include:

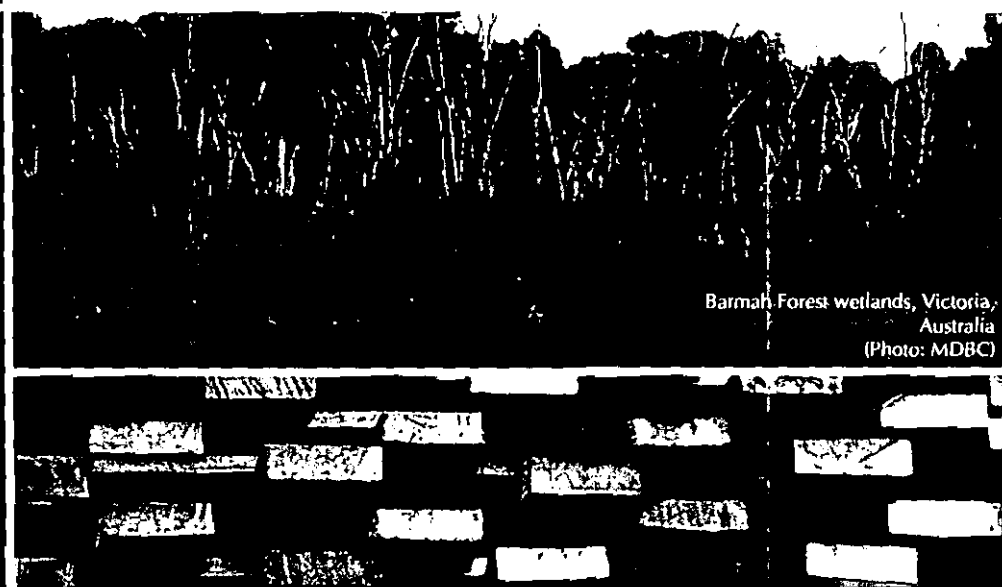
- bioenergy and short rotation woody crops
- new woody perennial species and products for low rainfall regions
- silviculture, tree breeding, social and economic impacts and impediments to farm forestry
- biodiversity within native forest and plantations
- farm forestry design at the farm and catchment level
- the role of farm forestry and agroforestry in achieving natural resource solutions

Three particularly important current issues for Australia are:

- dryland salinity in south-western Western Australia and the Murray Darling Basin
- the impact of trees on catchment water yield for agriculture and urban uses
- managing remnant and planted forests for biodiversity and ecosystem services in agricultural landscapes.



Beckwood Vase



Barmah Forest wetlands, Victoria, Australia
(Photo: MDBC)

Developing *Prosopis* as a valuable resource for dry zones

The Forestry Research Programme of the UK Government's Department for International Development (DFID) has supported HDRA in running a series of research and development projects since 1992, on *Prosopis* trees for drylands and the people who live there. This is a synthesis of the work and its impacts.

Mesquite or algarrobo (*Prosopis* species) are now probably the most common trees in the dry tropics of the world. Many species were widely introduced from their native Americas in the past two centuries, and today, epitomise the problems of, and failures in, promoting new dryland tree crops; a number of which are now invasive weeds.

Over twelve years, researchers at HDRA and their collaborators have played a valuable role in identifying and overcoming some constraints to the development of these trees as a resource, adapting activities to meet changing demands. In so doing, support continues to be offered for the provision of much-needed resources to improve livelihoods of some of the poorest people in the world's drylands.

Finding the right species

Early HDRA trials indicated that for the most arid areas with no post-planting care, *Prosopis* species are able to survive and grow better than trees of any other genus. DFID supported two projects from 1992 to 1995, assessing the field performance of over 100 accessions of 12 *Prosopis* species under very arid conditions in Cape Verde, studying physiological aspects of drought-tolerance in Oman, and investigating techniques for selection and vegetative propagation. Parallel to this was a demonstration and extension project in India, which also involved *Prosopis* species, and field-tested some of the same accessions and techniques.

As results were presented to international audiences, it became increasingly evident that much work on *Prosopis* was being duplicated around the world, and there was no single knowledge base on these widespread tropical species. Furthermore, there were some obvious taxonomic problems that required resolution.

Gathering global knowledge

In 1998, work began on a programme to gather the global knowledge on the most important and widespread tropical species, *Prosopis juliflora* and

related tropical species. By 2001, a comprehensive monograph and reference database were produced which are still in high demand, and a technical extension manual, aimed specifically at India, was also published, in English and Hindi.

Four principal constraints to the development and promotion of *Prosopis* were identified, centred on: problems in species identification, tree and stand management, processing of tree products, and their commercialisation. Some or all of these are reasons for lack of success in developing many dry zone trees, indicating common lessons to be learnt.

Making an impact

Aiming at management and utilisation of *Prosopis*, workshops and a series of training courses were organised in India in 2001. These proved popular, with demonstrations of saw milling, pod processing, feed mixing and making human foods. Participants at all levels noted a problem in policy and attitude towards these trees as a resource. Three policy briefs were then produced in 2002 and widely distributed; one aimed at India, one for a global audience, and one for where *Prosopis* is a problem weed. A further six country-specific briefs are to follow in 2004, for Ethiopia, Sudan, Kenya, South Africa, Sri Lanka and Brazil.



Converting weedy *P. juliflora* stands to productive agroforestry, high-pruning scrub trees to single stems. A novel approach promoted by HDRA - demonstrated during a training course in Tamil Nadu, India, 2001.

Aiming at overcoming the taxonomic problems, HDRA also began work on identifying the main species, using hypotheses based on the global literature review as well as leaf and seed samples collected worldwide. Detailed leaf measurements, chromosome numbers and molecular markers were used to separate the two most common tropical species, *P. juliflora* and *P. pallida* that were previously treated together. From this work, a field identification guide was published in 2004.

Spreading the knowledge

These publications and this wealth of experience, are, thanks to DFID, now available to all individuals and organizations with an interest in seeing this 'tree of the poor' becoming one which helps lift the poor to a better and sustainable life.

Identifying Tropical *Prosopis* Species: A Field Guide. Pasiecznik NM, Harris PJC, Smith SJ, 2004. HDRA, Coventry, UK. 31pp.

The *Prosopis juliflora* - *Prosopis pallida* Complex: A Monograph. Pasiecznik NM, Felker P, Harris PJC, Harsh LN, Cruz G, Tewari JC, Cadoret K, Maldonado LJ, 2001. HDRA, Coventry, UK. 162pp.

Managing *Prosopis juliflora* (Vilayati Babul): A Technical Manual. Tewari JC, Harris PJC, Harsh LN, Cadoret K, Pasiecznik NM, 2000. CAZRI, Jodhpur, India and HDRA, Coventry, UK. 94pp. (English and Hindi language versions). Available to download at www.hdra.org.uk/int_res.

The Genus *Prosopis*: A Reference Database. Cadoret K, Pasiecznik NM, Harris PJC, 2000. (Version 1.0): CD-ROM. HDRA, Coventry, UK.

Policy briefs. Pasiecznik N, 2002. HDRA, UK.

1. *Prosopis* (mesquite, algarrobo): Invasive weed or valuable forest resource?
2. Exploiting the value of *Prosopis* for dryland forestry and agroforestry systems.
3. *Prosopis juliflora* (vilayati babul) in the drylands of India: develop this valuable resource - don't eradicate it.

Selected additional dissemination

Management and Utilisation of *Prosopis juliflora* - Training Manual Neelakantan KS, Dasthagir MG *et al* (eds.), 2001. Forest College and Research Institute, Tamil Nadu Agricultural University, Mettupalayam, India.

***Prosopis juliflora*; Part 1 - Don't see it as a disaster; Part 2 - Unexplored multiple uses.** Countrywide Classroom Network educational video films, 2000. University Grants Commission Distance Learning Programme, India.

***Prosopis* Species in the Arid and Semi-Arid Zones of India.** Tewari JC, Pasiecznik NM, Harsh LN, Harris PJC (eds.), 1998. Proceedings of a Conference, 21-23 November 1993, CAZRI, Jodhpur, India. The *Prosopis* Society of India and HDRA, Coventry, UK. 128pp.

***Prosopis* genetic improvement trials in Cape Verde.** Harris PJC, Pasiecznik NM, Bradbury M, Vera Cruz MT, 1997. In: Felker P, Moss J (eds.), *Prosopis: Semi-Arid Fuelwood and Forage Tree. Building Consensus for the Disenfranchised.* Center for Semi-Arid Forest Resources, Kingsville, USA.

Problems and potential of *Prosopis*. Harris PJC, Pasiecznik NM, Bradbury M, Ramírez L, 1998. In: Prendergast HDV *et al.* (eds.), *Plants for Food and Medicine.* Royal Botanic Gardens, Kew, UK.



For copies of the publications mentioned, contact HDRA (enquiry@hdra.org.uk) or see the HDRA website (www.hdra.org.uk/int_res) where they are becoming available online. For more information on these projects and on-going work, contact Phil Harris (pharris@hdra.org.uk) or Nick Pasiecznik (npasiecznik@hdra.org.uk)