MODELLING NON-INDUSTRIAL PRIVATE FOREST MANAGEMENT IN GALICIA: A NEW APPROACH FOR FOREST RESEARCH

Verónica Rodríguez Vicente
Departamento de Enxeñería Agroforestal

TESIS DOCTORAL

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UNIVERSIDAD DE SANTIAGO DE COMPOSTELA
ESCUELA POLITÉCNICA SUPERIOR DE LUGO
DEPARTAMENTO DE ENXEÑARÍA AGROFORESTAL

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MEMORIA QUE PARA OPTAR AL GRADO DE DOCTOR PRESENTA LA INGENIERA VERÓNICA RODRÍGUEZ VICENTE.
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MOTIVACIÓN

En 1994 inicio la titulación de Ingeniería Técnica en Explotaciones Forestales por la Universidad de Santiago de Compostela en la Escuela Politécnica Superior de Lugo, para continuar, en el mismo centro, la titulación de Ingeniería de Montes en 1998.

Realizar el proyecto fin de carrera en el Departamento de Ingeniería Agroforestal de la Escuela Politécnica Superior de Lugo en el período de 2000-2001, me permitió completar mi formación académica como becaria de dicho departamento hasta el año 2005, determinando además el inicio de mis Estudios de Tercer Ciclo entre 2002-2003 con la presentación del Trabajo de Iniciación a la Investigación titulado *La propiedad forestal en Europa: situación y problemática actual.*

A finales del año 2005, inicio mi actividad profesional en la Asociación Sectorial Forestal Galega (ASEFOGA), sectorial de Unións Agrarias- UPA (Unión de Pequeños Agricultores), donde tuve y tengo la oportunidad de desarrollarme como ingeniera de montes.

El trabajo diario en esta asociación me ha permitido asesorar y ayudar en materia de gestión y planificación a un gran número de propietarios agroforestales asociados (cifra que casi asciende a 10.000), así como colaborar y participar, junto con otras entidades y asociaciones profesionales, con la administración pública en aquellos puntos de relevancia para este sector estratégico de Galicia.

Así, la actividad técnica desarrollada en la anterior asociación de propietarios forestales me ha permitido y me permite actualmente ser miembro de los siguientes órganos consultivos:

- Entidade Galega Solicitante da Certificación Forestal Rexional PEFC (presidencia)
- Asociación Galega Promotora da Certificación Forestal (vocal)
- Consello Forestal de Galicia (vocal)
- Consello Galego de Medio Ambiente e Desenvolvemento Sostible (vocal)
- Comisión Técnica de Prezos e Valores do Banco de Terras de Galicia- BANTEGAL (suplente)
- Xurado provincial de clasificación de montes veciñais en man común de A Coruña (vocal).

Mi labor como técnico de extensión forestal, junto con la representatividad que la propiedad privada individual tiene en Galicia, determinó que la línea de investigación, reflejada en la presente tesis doctoral, se centrara en el estudio empírico de la conducta de gestión forestal desempeñada por este tipo de propiedad en la región, generando un análisis socioeconómico pormenorizado de dicha actividad y articulando ejes clave de mejora.

El fin de la presente tesis doctoral es, en definitiva, desarrollar una línea de investigación estratégica para el medio agrario de Galicia, ser el modesto inicio de un ciclo de mejora continua.

Aportar paulatina e incrementalmente conocimientos y experiencia que permitan comprender las pautas de gestión forestal desempeñadas por este tipo de propiedad privada en la región a partir del conocimiento de sus objetivos y motivaciones para con la tierra.

Sólo así se podrá diseñar y trabajar en iniciativas públicas que promuevan una actividad forestal profesional acorde a los principios de gestión forestal sostenible.

A mi familia

ÍNDICE DE CONTENIDOS

ANEXOS

ARTÍCULOS I-V

La presente tesis se basa en los siguientes artículos científicos relacionados a continuación en números romanos:

I. Rodríguez-Vicente V., Marey-Pérez M.F., 2008. Sistemas de apoio á propiedade privada forestal e a súa aplicación en Galicia. *Revista Galega de Economía* 17(1), 111-130

II. Rodríguez-Vicente V., Marey-Pérez M.F., 2009. Characterization of nonindustrial private forest owners and their influence on forest management aims and practices in Northern Spain. *Small-Scale Forestry* 8 (4), 479-513

III. Rodríguez-Vicente V., Marey-Pérez M.F., 2008. Assessing the role of the family unit in individual private forestry in northern Spain. *Scandinavian Journal of Forest Research* 23 (1), 53-77.

IV. Rodríguez-Vicente V., Marey-Pérez M.F., 2009. Land-use and land-base patterns in non-industrial private forests: Factors affecting forest management in Northern Spain. *Forest Policy and Economics* 11 (7), 475-490.

V. Rodríguez-Vicente V., Marey-Pérez M.F., 2010. Analysis of individual private forestry in northern Spain according to economic factors related to management. *Journal of Forest Economics* 16 (4), 269-295.

RESUMEN

El sector forestal gallego ha experimentado en las últimas décadas una fuerte expansión en superficie sobre tierras antiguamente dedicadas a la agricultura y a la ganadería, incremento superficial que no ido acompañado de una repercusión económica y social similar. Partiendo de la importante representación de la propiedad privada de la tierra en la región, y en relación con el concepto de gestión forestal sostenible, se revisan en primer lugar diferentes metodologías de planificación y seguimiento forestal implementadas en otras regiones europeas atendiendo a su potencialidad como alternativas de avance y de desarrollo del sector forestal gallego. Estas líneas - redes de contabilidad, modelos de cooperación, programas de educación y asesoramiento y medidas públicas de apoyo económico - son analizadas con el fin último de generar criterios para su adaptación a la comunidad gallega. En segundo lugar, teniendo en cuenta el papel clave de la propiedad privada individual en la gestión de las tierras forestales de numerosas áreas rurales del mundo (non-industrial private forest ownership, NIPF ownership), los siguientes cuatro artículos de la presente tesis doctoral se centran particularmente en explicar y modelar la gestión NIPF - plantación, selvicultura y corta forestal- mediante el análisis empírico de atributos vinculados al perfil del propietario, unidad familiar, dinámica en los usos agroforestales de la tierra y características de la propiedad, y factores económicos. Así, un total de 103 NIPF de la región Mariña Oriental (noroeste de Galicia) fueron entrevistados personalmente en marzo de 2004 con el objetivo de conocer sus prácticas de gestión forestal durante el período 1999-2003. Los resultados sugieren que: (i) la ocupación profesional es el principal factor que, directa o indirectamente, influye en la conducta de gestión forestal, en concreto los antecedentes agrícolas del propietario; (ii) el patrón de adquisición de las tierras, los reempleos forestales, la disponibilidad de maquinaria agroforestal en la explotación, junto con la mano de obra familiar y el asesoramiento técnico en la actividad, son también factores significativos en las prácticas forestales analizadas; (iii) la gestión forestal responde principalmente al principio de capitalización e incremento de la productividad de la tierra como capital activo, siendo determinante el tamaño y grado de parcelación de la propiedad, así como el propio interés del propietario en la producción maderera; (iv) unos ingresos forestales atractivos y unas condiciones favorables para el mercado de madera son ítems clave en la iniciación y continuidad de la actividad forestal, siendo relevante en el tipo de gestión desarrollada las circunstancias personales y familiares. Los resultados pueden ser de interés para el diseño, planificación e implementación de medidas públicas de investigación y promoción que incentiven una gestión forestal sostenible al amparo del desarrollo rural entre la población NIPF.

En la región, la actividad forestal podría ser una actividad económica valiosa, si bien actualmente no es valorada como tal.

Palabras clave: agricultura; dinámica en los usos de la tierra; prácticas de plantación, selvicultura y corta forestal; propietario privado forestal no-industrial (propietario NIPF); rentabilidad forestal.

ABSTRACT

The Galician forestry sector has strongly expanded during the last few decades over lands formerly devoted to agrarian and livestock activities, increment in land which has not been accompanied by a similar socioeconomic repercussion. Given the important representation of the private land ownership in the region, and dealing with the concept of sustainable forest management, different potential methodologies for forest planning and monitoring implemented in other European regions are firstly reviewed as potential alternatives to advance and development of the Galician forestry sector. These guidelines - accountancy data network, co-operation models, education and advice programmes and public measures of economic support- are analysed with the final aim of proposing criteria for their adaptation to the Galician community. Secondly, taking into account non-industrial private forest (NIPF) ownership as a key component in most rural areas worldwide, the following four articles are specifically centred on explaining and predicting NIPF owner land management - planting, silvicultural and harvesting practices - by analysing attributes of landowner profile, family unit, dynamics in farming and forestry practices and landholding characteristics, and forest economics. In March 2004, 103 forest landowners were personally interviewed about their commitment to and involvement in land management during 1999-2003, considering a forest region in northern Galicia, the Mariña Oriental. Results suggest that: (i) professional occupation, particularly farming background, is the main factor affecting, either directly or indirectly, the forest management behaviour; (ii) pattern of land acquisition, household dependence on forest products for self-consumption, the availability of machinery, in addition to family labour force and technical guidance in forestry, are all significantly related to the ability to manage and use forestland; (iii) forest management mainly responds to investment and increasing the productivity of the land as a capital asset, which is directly influenced by the size and degree of parcellation of the holding, and directly or indirectly related to the owner's interest in timber production; (iv) attractive forest returns and favourable market conditions for timber production are significant factors for investment in and development of forestry, with personal and family conditions also being important factors in explaining the type of land management carried out. These findings may be of interest in designing, planning and implementing research and policy measures that allow NIPF landowners to promote sustainable forestry for rural development.

In the region, forestry could be a valuable economic activity but it is not considered as such today.

Keywords: farming; forest profitability; land-use change; non-industrial private forest (NIPF) owner; planting, silviculture and harvesting practices.

INTRODUCCIÓN

EL RECURSO MONTE

Se entiende por **monte** *todo terreno en el que vegetan especies forestales arbóreas, arbustivas, de matorral o herbáceas, sea espontáneamente o procedan de siembra o plantación, que cumplan o puedan cumplir funciones ambientales, protectoras, productoras, culturales, paisajísticas o recreativas.*

Concepto de *monte*, artículo 5 de la Ley 43/ 2003, de 21 de noviembre, *de montes*.

Se define **monte arbolado** *aquel monte poblado con especies forestales arbóreas como manifestación vegetal dominante y con una fracción de cabida cubierta (fcc) igual o superior al 20%. Este concepto incluiría las dehesas de base cultivo o pastizal con labores siempre que la fcc arbolada sea igual o superior al 20%. También comprendería los terrenos con plantaciones monoespecíficas o poco diversificadas de especies forestales arbóreas, sean autóctonas o alóctonas, siempre que la intervención humana sea débil y discontinua.*

Se entiende por **monte arbolado ralo** *el terreno de monte poblado con especies arbóreas como manifestación botánica dominante y con una fcc comprendida entre el 10- 20%; también el terreno con especies de matorral o pastizal natural como manifestación vegetal dominante, pero con una presencia de árboles forestales importante cuantificada por una fcc arbórea igual o superior al 10% e inferior al 20%, incluyéndose aquí las dehesas de base cultivo cuando la fcc forestal esté entre el 10- 20%. Por su parte, se define* **monte arbolado disperso** *como el terreno ocupado por especies arbóreas como presencia vegetal dominante y con una fcc entre el 5- 10%; igualmente espacio de tierra conteniendo matas, malezas y herbazales naturales como fenómeno botánico preponderante, pero con una manifestación de árboles forestales que cubran una fcc sobre el suelo igual o superior al 5% y menor del 10%. Las dehesas con base cultivo no se clasificarían dentro de este grupo aunque la fcc de los árboles esté entre el 5- 10%, pues la importancia del uso agrícola anularía prácticamente a los demás.*

Finalmente se entiende por **monte desarbolado** *el terreno poblado con especies de matorral o/y pastizal natural o con débil intervención humana como manifestación vegetal dominante con presencia o no de árboles forestales, pero en todo caso con la fcc inferior al 5%.*

Definiciones tomadas del Plan Forestal Español del MMA (2002), a partir del Inventario Forestal Nacional (IFN).

En torno al 69% del territorio de Galicia (Figura 1) es clasificado actualmente como monte (2.039.574,11 ha), siendo éste un recurso clave no sólo en el paisaje de la región, sino también en su economía e identidad cultural (MMA 1998). El monte gallego representa casi el 8% del monte estatal, cuando esta Comunidad Autónoma (CCAA) no llega a alcanzar el 6% de la superficie geográfica nacional; en 2001, la superficie forestal gallega ascendía a 688,1 ha por cada 1.000 habitantes, un 71,9% más que la media española (Xunta de Galicia 2005). Con esta superficie forestal, Galicia sería la sexta CCAA en contribuir al monte estatal, por detrás de Castilla y León (17,2% del monte estatal), Andalucía (16,5%), Castilla- La Mancha (13,2%), Aragón (9,4%) y Extremadura (8,7%).

Figura 1. Situación de la CCAA de Galicia, noroeste de España

Según los datos del III Inventario Forestal Nacional (IFN) del MMA (1998), los montes arbolados en Galicia abarcan 1.276.651,64 ha (62,6% del terreno forestal gallego y en torno al 11% de la superficie forestal arbolada de España). Mientras, las zonas de arbolado ralo y disperso se extienden por 82.140,92 y 23.864,22 ha, respectivamente, es decir, un 4,0 y 1,2%,

respectivamente, del uso forestal en Galicia. Con esta superficie forestal arbolada, Galicia sería la quinta CCAA en cuanto a contribución al monte arbolado estatal, por detrás de Andalucía (14,5% del monte estatal), Castilla y León (14,4%), Castilla- La Mancha (12,6%) y Extremadura (9,9%).

Por último, 21.075,87 ha y 596.590,73 ha se corresponden en la región con monte temporalmente desarbolado (talas e incendios, entre otros) y monte desarbolado, respectivamente (MMA 1998). Las anteriores cifras representan el 1,0 y 29,3%, respectivamente, del uso forestal de Galicia.

Comparando los datos del II y III IFN (1986-1987 y 1997-1998) para la CCAA, la superficie de monte arbolado ha aumentado en la región una media del 34% en los últimos once años; dicho incremento ha determinado, consecuentemente, un aumento de más del 44% en el número de pies y de más 133 millones de m^3 en las reservas totales de biomasa arbórea (MMA 1987; MMA 1998).

COMPOSICIÓN VEGETAL

La superficie arbolada en Galicia está dominada por especies de frondosas, representando este tipo de formaciones el 40% del monte arbolado gallego (562.417 ha). Las especies más importantes, tanto en extensión superficial como en importancia económica, serían el roble europeo (*Quercus robur* L.), rebollo (*Quercus pyrenaica* Willd.) y castaño europeo (*Castanea sativa* Mill.); dichas especies suponen el 13,4% (187.788,97 ha), 7,2% (100.503,78 ha) y 3,2% (45.518,25 ha), respectivamente, de la superficie forestal arbolada en Galicia (Xunta de Galicia 2001).

Sin embargo, por razones comerciales, y al igual que en otras comunidades españolas o regiones europeas, las distintas medidas o programas públicos en materia selvícola han determinado cambios en la composición de las masas forestales de Galicia, de forma que, muchas áreas con especies de frondosas autóctonas han sido transformadas hacia masas de coníferas.

Actualmente, la fracción de masas puras de coníferas o mixtas con frondosas suponen el 36% y 24%, respectivamente, del monte arbolado en Galicia (506.026 ha y 337.008 ha, respectivamente), siendo este cambio especialmente visible a partir de la década de 1985 con las iniciativas comunitarias de reforestación de tierras agrícolas mediante especies exóticas de crecimiento rápido.

Dentro de las coníferas, la especie más representativa es *Pinus pinaster* Ait. (pino del país), con una cabida de 383.631,78 ha, seguido en menor representatividad por *Pinus sylvestris* L. (pino silvestre) y *Pinus radiata* (D.) Don. (pino insigne), con 63.195,60 ha y 59.198,27 ha, respectivamente. Los valores anteriores suponen que el pino del país, el pino silvestre y el pino insigne representen el 27,3%, 4,5% y 4,2%, respectivamente, del monte arbolado en Galicia (Xunta de Galicia 2001).

Comparando los datos del II y III IFN (1986-1987 y 1997-1998) para la CCAA, la superficie de masas puras de coníferas y de frondosas ha incrementado en el período comprendido entre inventarios, en detrimento de las masas mixtas (coníferas y frondosas). En estos once años, el aumento más notable se ha manifestado en las formaciones de frondosas, en torno a un incremento del 443% en superficie con respecto al II IFN, mientras que dicho aumento se sitúa en un 34% para las masas de coníferas; por su parte, las masas mixtas han descendido en la región un porcentaje medio del 40% (MMA 1987; MMA 1998).

Se indica que el aumento significativo de la superficie de frondosas se asociaría mayoritariamente al aumento de los eucaliptales puesto que, este tipo de masas ha incrementado en más de un 400% entre inventarios en cuanto a superficie y un 123% en cuanto a existencias, así como a la progresión de los robledales por abandono de prácticas agrarias tradicionales, ausencia de selvicultura y éxodo rural (Xunta de Galicia 2005).

ESTRUCTURA DE LA PROPIEDAD

En torno a 1.994.418,87 ha de monte en Galicia, esto es, casi el 98% de la superficie de este recurso en la región, son gestionadas por propietarios forestales privados, siendo monte de titularidad pública 45.155,24 ha, el 2,2% de la superficie forestal gallega (MMA 1998). Esta última cifra contrastaría con lo que ocurre en los restantes países de la Unión Europa (UE), donde la propiedad pública del monte abarca en torno al 35% de la superficie total (FAO 2006).

Dentro de la propiedad pública del monte en Galicia, el III IFN del MMA (1998) indica que 22.900,43 ha están arboladas, cifra que representaría el 1,6% de la superficie forestal arbolada de la región. La anterior fuente muestra

además que 34.317,98 ha del monte público gallego presentan utilidad pública, es decir, el 76% del total de monte público gallego y el 1,7% de la superficie forestal total de la comunidad. Dentro del monte público de utilidad pública, casi el 48% sería monte arbolado (16.379,47), cifra que representa el 1,2% de las masas arboladas totales de Galicia.

Dentro de la propiedad privada, 1.382.550,78 ha se corresponden con monte arbolado, el 98,4% de las masas arboladas de Galicia. En concreto, 1.385.690,29 ha de monte privado está en manos de propietarios individuales, es decir, el 69,5% del total de monte privado gallego y el 67,9% de la superficie forestal total de la comunidad. Dentro del monte privado de titularidad individual, algo más del 77% es monte arbolado (1.069.595,99 ha), representando el 76,1% de las masas arboladas totales de Galicia (MMA 1998).

El número estimado de propietarios forestales individuales en la región oscila entre 600.000 y 700.000, por lo que resulta en una superficie forestal media de entre 1,5- 2,0 ha por propietario, mientras que el tamaño de parcela estaría en torno a 0,23 ha (MMA 2002).

El pequeño tamaño de las explotaciones agrarias y la elevada parcelación de su base territorial constituyen uno de los principales obstáculos para desempeñar una adecuada gestión y explotación del recurso territorio, siendo este hecho especialmente limitante en el recurso "monte".

La restante fracción de terreno forestal privado en Galicia (608.728,58 ha, el 30,5% del total de monte privado gallego y casi un 30% de la superficie forestal total de la comunidad) es *Monte Veciñal en Man Común*- MVMC (MMA 1998). Un total de 312.954,79 ha de monte comunal están arboladas, cifra que representa el 22,3% de las masas arboladas de Galicia. El número de comunidades gestoras de MVMC asciende a 2.835, por lo que resulta una superficie media de 237 ha por comunidad (Fernández *et al*. 2006).

Las mejores tierras de uso forestal, aportando además la mayor proporción de terreno arbolado, son de titularidad privada individual (Fernández *et al*. 2006), mientras que, por el contrario, los MVMC constan de una alta proporción de masas forestales desarboladas, dada su mayor descapitalización y estaciones de calidad inferior. Así, y atendiendo a las datos aportados anteriormente, se resume que más de las ¾ partes de la superficie forestal privada individual está arbolada, mientras que casi ½ de la superficie de monte público y MVMC está desarbolada.

Dado el papel relevante de los MVMC en el sistema territorial gallego, se requiere definir brevemente el concepto legal de este tipo de propiedad privada forestal en Galicia. En los MVMC, la tierra pertenece y es gestionada por una comunidad rural denominada *Asamblea de Comuneros*, formada por un grupo de vecinos que vive en una o más núcleos rurales, normalmente la parroquia. Bajo el régimen de gestión de los MVMC, la comunidad rural no tiene cargas de participación, el acceso es libre e igualitario para el grupo y es habitualmente determinado por el lugar de residencia en el núcleo rural o en la parroquia, estando excluidos del sistema de herencia, compra y venta. Cada miembro comunero representa a una familia o casa habitada de la comunidad rural, de tal forma que, existirán tantos comuneros como casas habitadas.

La Asamblea de Comuneros es responsable de revisar y actualizar anualmente el censo de comuneros, así como de elegir y aprobar la *Junta Rectora* para un período de cuatro años. Esta Junta Directiva estaría formada por un mínimo de tres miembros, presidente, secretario y tesorero, siendo responsable de las decisiones y actividades en materia a uso y gestión del MVMC. Todas las propuestas son votadas y sometidas a la mayoría relativa de la Asamblea de Comuneros durante las asambleas generales.

Por tipología de propiedad, la comparación entre el II y III IFN indica que la superficie arbolada ha crecido un 27,1% en el caso de los montes particulares y en un 64,8% en el caso de los montes públicos y MVMC (Xunta de Galicia 2005).

VALOR ECONÓMICO

El monte gallego consta de unas existencias totales de 133.092.754 m^3 de madera con corteza (cc) de pies con diámetro normal superior a 7,5 cm., siendo el número total de pies de dichas dimensiones 688.061.951. De las anteriores existencias, 61.237.010 m^3 cc se corresponderían con masas de coníferas y 71.237.010 m^3 cc a frondosas, es decir, el 46% y 53,5%, respectivamente. Por su parte, el volumen de leñas se estima en 7.433.109 m^3, es decir, el 5% del total de existencias arboladas de Galicia (Xunta de Galicia 2001).

Con el 11% de la superficie forestal arbolada de España, las masas forestales gallegas almacenan el 19,7% del volumen maderable y generan el 23% de la Producción Final Agraria (PFA) del subsector forestal estatal (Prada *et al*. 2005). Además, casi el 50% de la madera producida en España procede de esta comunidad (MMA 1998).

Entre el II y III IFN (1986-1987 y 1997-1998), las existencias totales de madera en Galicia pasaron de 90,4 a 133,1 millones de m^3 cc, correspondiéndose a un crecimiento relativo total del 47% y a una tasa de incremento anual del 4,3%; las existencias medias por unidad de superficie arbolada, entendida como tal aquella con una fcc superior al 5%, pasaron de 86,5 a 94,7 m^3/ ha entre inventarios (MMA 1987; MMA 1998).

Con el mayor crecimiento volumétrico anual en el conjunto estatal (casi 12 millones de m^3/ año), Galicia cuenta actualmente con un volumen maderable de 62,25 m^3/ ha y 337 pies/ ha (Xunta de Galicia 2001). Dado que el crecimiento corriente anual de media para las masas forestales de Galicia se presenta alrededor de diámetros normales de 13- 15 cm., se deduciría el predominio de especies de crecimiento rápido y ciclo productivo corto.

Sólo el 5,8 millones de m^3 cc son anualmente cortados en la región, es decir, el 52% de las existencias totales de madera, porcentaje claramente inferior a la posibilidad de corta que ofrece el monte gallego, así como inferior a la media europea, establecida en un 69% (Xunta de Galicia 2005).

Si bien Galicia se caracteriza por su riqueza forestal, el sector forestal juega un pequeño papel en el conjunto económico de la región, no siendo comparable con su importancia superficial ni volumétrica. El valor económico del sector forestal creció 28.253 millones de €, correspondiendo 16.404 millones de € al sector productivo, 9.285 millones de € al aspecto ambiental y 2.564 millones de € al aspecto recreativo (Xunta de Galicia 2005).

Las últimas estadísticas oficiales cifran que para el año 2002 (último dato disponible), las actividades del sector forestal generaron 856,8 millones de €, es decir, el 2,5% del Valor Añadido Bruto (VAB) de Galicia, siendo el subsector más importante en términos de VAB la industria de la madera (42,8% del VAB generado por el sector forestal); siguen en importancia, la selvicultura, explotación forestal y actividades de servicios relacionados con un 31,2% (Xunta de Galicia 2005).

Entre los años 1995 y 2002, el VAB forestal creció un 31,3%, frente al 32,9% del empleo total y el 30,0% del empleo asalariado, acogiendo el monte gallego la cuarta parte de la valoración del aprovechamiento medio anual del sector forestal para el período 1996-2001.

Estas cifras se agravan si se considera que los ingresos procedentes de la selvicultura están continuamente descendiendo, si bien podrían compensarse con otras demandas de la sociedad para con respecto al monte y que, actualmente, no son compensadas económicamente a sus propietarios y gestores: protección de cauces, calidad hídrica, recreación, conservación de la naturaleza, protección frente a la erosión, regulación del clima, purificación del aire, sumideros de carbono atmosférico, etc. La mayoría de estas funciones vienen clasificándose como bienes públicos y economías externas a la selvicultura, pero muchos de ellos podrían clasificarse como bienes privados en cuanto tienen y pueden alcanzar un precio en el mercado.

OBJETIVO

La complejidad inherente a la propia actividad forestal, apreciada en la extensa literatura existente en la materia, ha determinado que esta práctica agraria haya ido progresivamente evolucionado desde una gestión forestal con marcado carácter industrial (producción de madera) hacia una gestión del ecosistema forestal, desde una gestión sostenida en producción y productividad maderera hacia una gestión forestal sostenible socioeconómica y ambientalmente y, por último, desde gestión forestal por exclusión hacia una gestión con inclusión de los grupos sociales implicados (Kant 2003). Las continuas demandas de la sociedad para con la gestión forestal sostenible, y el papel clave del monte en el archi-renombrado desarrollo rural, han comportado, y seguirán comportando continuos cambios en los patrones de trabajo forestal, y consecuentemente, adaptaciones del propio perfil del propietario, sus objetivos y sus metas de gestión forestal.

Como indican Karppinen (1998) y Kuuluvainen *et al.* (1996), la gestión forestal, como acción y decisión voluntaria, se dirige primariamente por las motivaciones de los propietarios, es decir, por sus valores y objetivos para con el monte. Por tanto, los propietarios difieren en su conducta de gestión forestal en base a diferencias subyacentes en cuanto a sus motivaciones; si el monte es gestionado principalmente para fines no-productivos o productivos dependerá claramente de los objetivos de la

propiedad (Arano y Munn 2006; Joshi y Arano 2009). Asimismo, las metas u objetivos de gestión forestal varían notablemente en función de la tipología de propiedad (Marey-Pérez *et al.* 2006), siendo indiscutible estudiar cómo diversos tipos de propietarios difieren en cuanto a uso, valorización y gestión del monte porque emplear un mismo rasero para la elaboración de estrategias y políticas de gestión no sería, entonces, ni productivo para la actividad en sí ni aportaría beneficios para la sociedad (Schelhas *et al*. 2003).

Consecuentemente, los patrones de gestión forestal no deben ser interpretados como las conductas aisladas de "individuos" (propietarios forestales), puesto que, las diferencias subyacentes en cuanto a motivaciones, además de responder a conocimientos y experiencias propias, es fruto también de compartir conocimientos y experiencias conjuntas, no individuales. Los valores y decisiones de los propietarios para con sus tierras son complejos, no son estáticos ni aislados, sino que son influenciables por y reflejan procesos sociales adyacentes y dinámicos (Schelhas *et al*. 2003; Bergseng y Vatn 2009; Vokoun *et al.* 2010). En definitiva, los propietarios son y serán los actores clave para comprender los usos de la tierra gracias a los derechos que éstos adquieren (Munton 2009), abarcando la complejidad de dichos sistemas de gestión tanto decisiones individuales como interacciones personales como efectos sobre el espacio, tiempo y escala (Parker *et al.* 2008).

Con el fin de desarrollar políticas de ordenación y planificación territorial sostenibles y coherentes a la realidad agraria existente es imprescindible incrementar progresivamente la literatura científica existente en cuanto a diferentes pautas de gestión forestal por parte de distintos tipos de propietarios. Dentro de este debate internacional para la sociedad, científicos y políticos, la pequeña propiedad privada individual (non-industrial private forest- NIPF owners) recibe una especial atención, dado que estos propietarios, como gestores casi exclusivos en numerosas regiones forestales del mundo, comienzan a jugar un papel clave a la hora de integrar de forma equilibrada la diversidad de usos y funciones del monte en las políticas de promoción y revitalización de áreas rurales, puesto que, desempeñan una importante labor de ordenación del territorio, manteniendo o incrementando el valor actual del subsector forestal.

Como se indicó previamente, el objetivo de la presente línea de investigación es aportar información estadística útil y detallada para comprender los patrones de gestión forestal desempeñados por propietarios privados individuales del noroeste de España, en la Comunidad Autónoma (CCAA) de Galicia, dada la representatividad de este tipo de propiedad de uso forestal en el conjunto del monte de la región. Dicha caracterización y cuantificación empírica de la conducta de gestión forestal desempeñada por propietarios NIPF permitiría diseñar iniciativas o programas públicos de forma coherente a sus necesidades, objetivos y expectativas para con la tierra. Consecuentemente, y dentro de la compleja estructura del desarrollo rural, se mejoraría la productividad de las explotaciones forestales y se potenciaría una gestión forestal sostenible compatible con otras alternativas de los usos del suelo.

La selvicultura a pequeña escala debe reconocerse como una actividad productiva con el fin revitalizar la economía, configurando un sector socialmente atractivo que mantenga la integridad medioambiental de las áreas rurales.

ARTÍCULO I. GENERALIDADES DE LA SELVICULTURA FAMILIAR

En base a los datos oficiales del sector forestal gallego apartados en secciones anteriores, el presente trabajo estructura la revisión de una serie de metodologías europeas para una explotación forestal eficiente, organizándose de acuerdo a criterios de gestión forestal sostenible que, desde la óptica de su posible aplicabilidad a la región gallega, permitan consolidar un sector estratégico en la región en viable.

ARTÍCULOS II- V. PERFIL DEL PROPIETARIO, UNIDAD FAMILIAR, EXPLOTACIÓN AGROFORESTAL Y ACTIVIDAD ECONÓMICA

Centrándose en una muestra de propietarios NIPF de un área forestal concreta de la región gallega, y con el fin de ayudar a comprender exhaustivamente los objetivos, motivaciones y perspectivas en materia de gestión forestal desarrollados por este tipo de propiedad privada, los artículos II- V se centran en el estudio empírico del patrón o conducta forestal de dichos propietarios analizando específicamente los siguientes atributos:

- Artículo II. Perfil del propietario: edad, nivel de educación formal, ocupación primaria, actividad agroganadera, participación en grupos o asociaciones, formación en materia forestal, disponibilidad de información sobre el

mercado de la madera, y conocimiento y puesta en práctica de criterios técnico-productivos de corta forestal

- Artículo III. Unidad familiar: patrón de adquisición de las tierras y futura transmisión a las generaciones futuras, ingresos anuales de la familia para el período 1999-2003, la fracción económica anual de reempleos forestales para el mismo período de estudio, la disponibilidad de maquinaria agroforestal en la explotación, y la mano de obra en selvicultura (trabajo propio, familiar y contratado anualmente en la práctica forestal) para el período 1999-2003
- Artículo IV. Explotación agroforestal: transformaciones de monte a prado y de prado a monte para el período 1999-2003, intenciones futuras de incrementar la superficie forestal productiva a corto/ medio plazo y de cambiar la actual especie forestal productora en el siguiente turno, extensión total (superficie forestal productiva en hectáreas) y grado de parcelación de la explotación agroforestal (número de parcelas por hectárea de superficie forestal productiva)
- Artículo V. Actividad económica: inversión en mejora de la explotación (infraestructuras y equipamientos), gastos de plantación y selvicultura, solicitud y cuantía de subvenciones en materia forestal, precio unitario e ingresos procedentes de la venta de madera, e ingresos no-madereros, todos ellos para el período 1999-2003.

Los anteriores atributos son completados con el análisis empírico de las tres prácticas de gestión forestal habitualmente recogidas en la literatura científica para predecir y modelizar la conductas o patrones de los propietarios NIPF, plantación y mejora forestal-selvicultura (Doolittle y Straka 1987; Straka y Doolittle 1988; Hyberg y Holthausen 1989; Löyland *et al.* 1995; Hardie y Parks 1996; Gunter *et al.* 2001; Zhang y Flick 2001; Zhang y Mehmood 2001; Kline *et al.* 2002; Arano *et al*. 2004; Potter-Witter 2005; Ross-Davis *et al.* 2005) y corta de madera (Hyberg y Holthausen 1989; Dennis 1990; Kuuluvainen y Salo 1991; Löyland *et al.* 1995; Kuuluvainen *et al.* 1996; Prestemon y Wear 2000; Zhang y Mehmood 2001; Bolkesjø y Baardsen 2002; Conway *et al.* 2003; Potter-Witter 2005; Bolkesjø *et al.* 2007; Størdal *et al.* 2008).

MATERIAL Y MÉTODOS

Tras la caracterización y descripción del objetivo de la presente línea de investigación, el siguiente apartado indica la metodología empleada para cada uno de los cinco artículos científicos incluidos.

ARTÍCULO I. GENERALIDADES DE LA SELVICULTURA FAMILIAR

El análisis de las estadísticas oficiales indica que el sector forestal en Galicia tiene que retomar y completar su crecimiento con modelos de gestión selvícola adoptados en países que, con ciertas similitudes, tienen un mayor desarrollo en investigación y en innovación forestal. Para eso, se seleccionaron cuatro puntos básicos de estudio y de revisión en distintos ámbitos europeos para su posible adaptación a Galicia:

- Redes de contabilidad forestal: análisis de la rentabilidad económica forestal
- Modelos de cooperación: participación y gestión en comunidades forestales
- Programas de educación y asesoramiento: extensión forestal
- Medidas públicas de apoyo económico: dimensión política de la gestión forestal.

Todos ellos fueron analizados en tres fases: la descripción de las experiencias que de esta materia se dispone actualmente en Galicia, base para la posible aplicación o adaptación de modelos europeos; un posterior análisis de los principales programas o medidas desarrollados en diferentes regiones europeas y, por último, la generación de criterios para su adaptación a la comunidad.

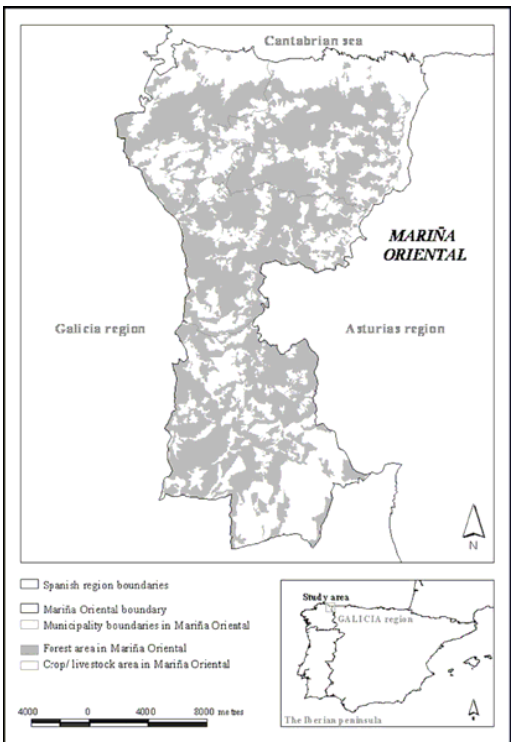
ARTÍCULOS II- V. PERFIL DEL PROPIETARIO, UNIDAD FAMILIAR, EXPLOTACIÓN AGROFORESTAL Y ACTIVIDAD ECONÓMICA

Área de estudio

Los artículos II-V actualizan y desarrollan la investigación previamente realizada por Marey-Pérez (2003), en materia de propiedad y gestión forestal privada en Galicia. La información de estudio partió de los datos recogidos mediante entrevistas personales a propietarios NIPF aleatoriamente seleccionados en A Mariña Oriental, región situada al noroeste de Galicia (Figura 2).

Figura 2. Localización del área de estudio, A Mariña Oriental, en Galicia (noroeste de España)

Esta región gallega es claramente representativa de las numerosas regiones forestales del norte de España, donde el monte cubre la mayoría del territorio (53%) y la selvicultura es una actividad en crecimiento (en torno al 46% del terreno forestal es monte arbolado). En cuanto al régimen de tenencia de la tierra, más del 90% del terreno forestal arbolado del área es propiedad de 3.043 propietarios NIPF.



En la actualidad, el eucalipto blanco o azul (*Eucalyptus globulus* Labill.), junto con el pino marítimo o del país (*Pinus pinaster* Ait.), son las principales especies forestales productivas en A Mariña Oriental, cubriendo más del 71% del terreno forestal de la región para una producción de madera media de 26,4 m^3/ ha y año, y un turno medio de 12 y 25 años, respectivamente.

Selección de la población y diseño de la muestra

De acuerdo al Reglamento (CEE) 571/1988, del Consejo, de 29 de febrero, *relativo a la organización de encuestas comunitarias sobre la estructura de las explotaciones agrícolas,* la población de estudio en A Mariña Oriental estaría formada por propietarios NIPF con una superficie mínima de monte productivo de 1 ha, añadiéndose la condición de ser residentes en la región. Estas dos premisas asegurarían que los propietarios a analizar eran gestores de cierta base territorial y con información necesaria en cuanto a metas y pautas de gestión forestal, dado el contacto más o menos directo para con la tierra. Las fuentes públicas empleadas para dicha selección fueron el Catastro y el Censo de Población (Ministerio de Economía y Hacienda).

Del total de 3.043 propietarios NIPF de la región, 333 cumplían las dos premisas de partida, gestionando en su conjunto, 1.154 ha de terreno forestal productivo, es decir, el 42% de la superficie forestal arbolada de A Mariña Oriental, incluyendo parcelas de superficie inferior a 1 ha.

El análisis del importante número de variables incluidas en el Catastro indicó el notable grado de heterogeneidad en la población de estudio, hecho que determinó la necesidad de su estratificación con el fin de mejorar la caracterización y posterior validación de los resultados a obtener, así como también para determinar el sesgo en la selección de la muestra. De acuerdo con la anterior fuente oficial, se consideró que la variable denominada *área forestal productiva por propietario* era la variable catastral más adecuada para fijar el número mínimo de propietarios a entrevistar y posteriormente estratificar, dado el nivel de información asociado. La determinación del número de estratos y puntos de corte requeridos se basó en datos oficiales de corta de madera en A Mariña Oriental. Así, la estratificación de los propietarios se definiría atendiendo al tamaño del terreno forestal productivo que permitiese al propietario NIPF cortar el equivalente medio anual de corta en la región (Marey-Pérez 2003).

En lo que se refiere al diseño del tamaño muestral, dentro de las opciones que ofrece el muestreo estratificado se optó por seguir la metodología de la afijación de mínima varianza de Neyman (Sukhatme 1953), para un error muestral del 5% y un nivel de confianza del 95%.

Del total de 333 propietarios NIPF, cada uno responsable de más de 1 ha de superficie forestal productiva y

residentes permanentemente en A Mariña Oriental, el tamaño muestral se diseñó finalmente con un total de 103 propietarios, organizados en cuatro estratos, a contactar y entrevistar en persona. Dicha muestra de propietarios NIPF gestionaba el 12% del monte y el 13% del monte arbolado productivo en el área de estudio.

Diseño del cuestionario y realización de encuestas

Con el objetivo de obtener la mayor calidad y cantidad posible de información al menor coste fue necesario ensayar previamente varios cuestionarios personales antes de decidir una versión final y definitiva que recopilase toda aquella información de interés relacionada con las prácticas de gestión forestal (plantación, selvicultura y corta), el perfil del propietario, su unidad familiar, explotación y usos de la tierra, y economía para el período de 1999 a 2003.

Las entrevistas fueron realizadas en dos fases en el mes de marzo de 2004. La primera fase consistía en una entrevista telefónica entre las 20:00 y 22:00 horas, preguntando por la posibilidad de participar en el estudio. Si el propietario accedía, el entrevistador fijaba la realización de la entrevista personal entre 1- 2 días después (segunda fase). Cada entrevista personal supuso una duración media de 36 minutos.

Las variables de estudio para la presente investigación se basaron en la información obtenida en las entrevistas personales, añadiéndose datos complementarios del Catastro. Mediante software SAS/ STAT™ (versión 9.1), dicha información fue redefinida y codificada en variables nominales, ordinales y binarias con el fin de resumir los datos del estudio y cumplir posteriormente las premisas de los análisis estadísticos a emplear.

Análisis estadísticos

Puesto que la población de estudio no atendía las premisas establecidas por los tests de bondad-de-ajuste de Kolmogorov- Smirnov ni de normalidad K-S o de homogeneidad de varianzas de Levene, los artículos II- V incluyen análisis estadísticos no-paramétricos en función del tipo de variable analizada (continua, nominal u ordinal y binaria) con el objetivo de explicar estadísticamente, de forma completa y fiable, la conducta de gestión forestal realizada por los propietarios NIPF de estudio en A Mariña Oriental en base a cuatro puntos clave: el perfil del propietario, la unidad familiar, la explotación y usos de la tierra, y la economía.

En primer, se comprobaba la fuerza y significación de correlación lineal entre variables para, a continuación, testar la existencia de diferencias significativas para un nivel de confianza del 95% y un nivel mínimo de significación estadística del 5%.

Mediante el uso de tablas de contingencia, la relación estadística entre variables nominales, ordinales y/ o binarias se fundamentó en el coeficiente D de Somers, comprobar posteriormente la existencia de diferencias significativas en la distribución de frecuencias entre variables mediante tabulación cruzada chi-cuadrado χ^2de Pearson. Para los análisis estadísticos entre variables continuas con respecto a variables nominales, ordinales y/ o binarias, se usó el coeficiente ρ de Spearman para niveles de significación estadística del 1% y 5%. La existencia de diferencias significativas en la distribución de medias entre variables se basó en el test H de Kruskal-Wallis, realizando además comparaciones-por-iguales mediante el test T3 de Dunnett; tras chequear la existencia de diferencias significativas, el estudio se completaba con análisis post-hoc del test HSD de Tukey, el cual permitiría definir subgrupos homogéneos de variables nominales/ ordinales que mostrasen una conducta estadística similar con respecto a la variable continua.

Otros métodos

El artículo nº II de la presente investigación completó el estudio ajustando estadísticamente la participación del propietario NIPF en un grupo profesional de asesoramiento (asociación, cooperativa o sindicato, entre otros) con respecto a una combinación de variables explicativas (otros atributos del perfil del propietario, unidad familiar, explotación y usos de la tierra, y economía) para un nivel de significación estadística del 5%. Del mismo modo, el artículo nº IV modeliza la relación entre la transformación pasada de prado a monte arbolado entre 1999-2003, e intenciones futuras de incrementar el terreno forestal productivo a corto/ medio plazo y de cambiar la actual especie forestal arbolada en el próximo ciclo.

Dada la naturaleza binaria de las variables dependientes, se usó regresión logística mediante selección por pasos hacia adelante, método basado en una función de probabilidad acumulativa cuyo principal objetivo es modelizar cómo la presencia de diversos factores y el valor o nivel de los mismos, afecta la probabilidad de ocurrencia (Ryan 1997).

Finalmente, el artículo nº V de la presente investigación incluyó una ecuación de regresión para el ratio anual de plantación entre 1999-2003 con respecto a una combinación lineal de variables continuas de explicación relacionadas con factores del perfil del propietario, unidad familiar, explotación y usos de la tierra, y economía.

Atendiendo a la naturaleza cuantitativa continua de la variable dependiente, se optó por la regresión lineal múltiple por pasos, modelo predictivo cuyo principal objetivo es modelizar cómo la presencia de diversos factores y el valor o nivel de los mismos, afecta la proporción de la variable dependiente, de acuerdo con los criterios de selección estadística de minimización del sesgo y maximización del ajuste R2-ajustado (Neter *et al.* 1996).

Al igual que en los análisis no-paramétricos, se empleó software SAS/ STAT™ (versión 9.1).

RESULTADOS Y DISCUSIÓN

ARTÍCULO I. GENERALIDADES DE LA SELVICULTURA FAMILIAR

Como principales resultados se citan:

- A pesar de la relativa importancia en el conjunto económico de la región y de su interrelación con otros sectores, la actividad forestal en Galicia ha sido sistemáticamente marginada de las reflexiones y negociaciones políticas en materia económica, presentando un desfase temporal en contabilidad forestal con respecto a otros países más dinámicos en la materia.

Así, los estudios realizados hasta el momento en la región se han limitado al campo de la economía aplicada o bien se han resumido en estadísticas de diferentes anuarios e informes de la administración pública, sin desarrollar un plan contable que permita determinar la progresión socioeconómica de una muestra de explotaciones forestales tipo agrupadas a partir de factores productivos. Dado que la selvicultura computa una pequeña parte de todas las actividades agrícolas y no-agrícolas de una explotación, sería una tarea complicada establecer una red pura de contabilidad y rentabilidad forestal, citándose la posible adaptación y proyección de las estadísticas económicas agrícolas ya existentes.

- A los problemas económicos citados anteriormente se unen los inconvenientes asociados a la parcelación territorial de Galicia, obstáculo de vital importancia para desarrollar una actividad competitiva y rentable. En este sentido, los modelos de gestión forestal conjunta han demostrado ser motores de dinamización socioeconómica en numerosas áreas rurales, incentivando la interacción y cooperación entre propietarios forestales cara un fin común viable.

La aplicación a Galicia de este modelo de gestión forestal en común ya existe y se lleva a cabo en los denominados Montes Veciñais en Man Común, descritos anteriormente. Sin embargo, la mayoría de estas comunidades son deficitarias en capital humano, estando principalmente integradas por miembros de edad avanzada, retirados de la actividad agroganadera o profesionales activos no-agrarios, sin información ni formación forestal, que participarían en tales colectivos sin percibir contraprestaciones económicas individuales. Todos estos factores pueden determinar y determinan que, no depender de los recursos colectivos y no obtener beneficios de la participación, desencadene en absentismo o ausencia de acción para la gestión común.

- Otro factor de relevancia que es necesario estudiar en la eficiencia forestal es el capital humano, esto es, las habilidades, cualidades y saber-hacer (experiencia) de los propietarios forestales. A diferencia de otras regiones con amplia tradición forestal, los propietarios forestales gallegos no disponen servicios de extensión forestal como tal, modelos de asistencia técnica que han demostrado ser claramente efectivos a la hora de dinamizar y profesionalizar la actividad.

Las principales fuentes públicas de información y asesoramiento forestal actualmente existentes en la región son los servicios administrativos de la Xunta de Galicia a través de las cámaras de extensión agraria y los distritos forestales. Estos últimos (distritos forestales) conformarían la unidad pública básica de asesoramiento, gestión y ejecución forestal más directa y práctica. Con todo, la extensión forestal en la comunidad es asumida y desempeñada principalmente por asociaciones privadas sin ánimo de lucro de propietarios de montes, grupos

profesionales que trabajan y cooperan estrechamente con sus asociados en todas aquellas materias relacionadas con el monte.

- En la región gallega, la dimensión política del monte se ha venido centrando, de forma generalizada, en líneas de apoyo a la producción y en la innovación tecnológica de plantaciones monocultivo de escasas especies comerciales de crecimiento rápido, así como en la actuación directa en materia de incendios forestales, dejándose la inversión forestal a la iniciativa privada mediante incentivos económicos.

El contexto forestal actual demanda, sin embargo, nuevos enfoques económicos en el diseño de programas o de medidas públicas para el sector en un intento de abarcar o de cubrir la multiplicidad de objetivos relacionados con el desarrollo rural en general y con la gestión forestal sostenible en particular. Así, se está asistiendo a un cambio en la valoración de los recursos naturales, especialmente de los espacios rurales, donde los valores y las actividades tradicionales deben y deberán combinarse con los ambientales y con los culturales, buscando la profesionalización y viabilidad en la actividad forestal.

ARTÍCULO II. PERFIL DEL PROPIETARIO

Como principales resultados se citan:

- El nivel de educación reglada del propietario NIPF y su participación en grupos profesionales se asociaban significativamente con el ratio anual de plantación. Este grupo de propietarios NIPF se correspondía principalmente con profesionales activos fuera de la agricultura, de mediana edad e ingresos familiares altos, gestores además de grandes superficies de monte arbolado productor.
- La ocupación primaria del propietario NIPF, en concreto su condición como agricultor activo, y su participación en grupos profesionales de asesoramiento se relacionaban significativamente con el ratio anual de tratamientos selvícolas. Nuevamente, estos propietarios NIPF eran mayoritariamente profesionales activos no-agrarios que apostarían por la selvicultura mediante la contratación de asistencia técnica profesionalizada.

Fuera de las ocupaciones no-agrarias, otro perfil de propietario NIPF a destacar en cuanto a su contribución a las actividades de plantación y selvicultura en el área de estudio fueron los agricultores retirados y activos, respectivamente. En este caso, la gestión forestal se basaba en la propia formación del propietario en la materia, su participación en grupos profesionales y la disponibilidad de maquinaria agroforestal en la explotación, además de apoyarse en importantes fracciones de trabajo propio y familiar.

- El ratio anual de corta se relacionaba significativamente con la edad del propietario NIPF, la disponibilidad de información sobre el mercado forestal (madera) y el conocimiento y aplicación de criterios técnico- productivos en materia de corta. Estos propietarios de mediana edad eran profesionales fuera de la agricultura o agricultores en activo que, posiblemente gracias a sus conocimientos y experiencia en la materia, habían fijado los mejores precios de madera en cortas previas, además de obtener los mayores ingresos en dichas transacciones.

El modelo de regresión logística desarrollado para la participación del propietario NIPF en grupos profesionales de asesoramiento (asociaciones) reveló que dicho atributo estaba significativa y positivamente vinculado a aspectos propios de la actividad agrícola (el estatus del propietario como agricultor en activo y la disponibilidad de maquinaria agroforestal), así como con la intención futura de aumentar la superficie forestal productora a corto/ medio plazo en la explotación.

ARTÍCULO III. UNIDAD FAMILIAR

Como principales resultados se citan:

- El patrón de adquisición de las tierras y la fracción anual de trabajo familiar en la explotación eran factores positiva y significativamente relacionados con el ratio anual de plantación.
- El ratio anual de tratamientos selvícolas se vinculaba positiva y significativamente con la disponibilidad de maquinaria agroforestal en la explotación.

- La fracción anual de reempleos forestales dentro de la unidad familiar se asociaba positiva y significativamente con el ratio anual de corta.

Además, un factor clave en la conducta de gestión forestal de los propietarios NIPF del área de estudio fue la fracción anual de trabajo contratado, variable positiva y significativamente relacionada con los ratios anuales de plantación, selvicultura y corta.

Los propietarios NIPF que gestionaban bases territoriales adquiridas mediante herencia y compra eran significativamente más proclives a plantar sus terrenos de monte que los restantes propietarios analizados, identificándose como agricultores retirados que habían transformado anteriormente terrenos agroganaderos abandonados en monte arbolado mediante incentivos públicos. Dichos propietarios se caracterizaban por dedicar una importante fracción de trabajo propio a la actividad forestal, apoyándose en su formación y saber-hacer en la materia, así como en ayuda y dedicación familiar. La inversión y gestión forestal respondería básicamente a valores emocionales, esto es, capitalizar la tierra heredada para ser transmitida.

Por su parte, aquellos propietarios NIPF con maquinaria agroforestal disponible en la explotación y aquellos con una importante tasa de reempleo forestal en la unidad familiar eran significativamente más proclives a realizar tratamientos selvícolas y cortas de madera, respectivamente, que la restante población de estudio. Dichos propietarios se perfilaban principalmente como agricultores activos con formación forestal miembros de grupos profesionales de asesoramiento (asociaciones). El mayor vínculo con la tierra, asociado a su ocupación primaria en la agricultura, determinaba que estos propietarios dedicasen una importante fracción de trabajo propio a la actividad forestal, uniéndose además una importante ayuda familiar.

Sin embargo, es necesario distinguir un grupo de propietarios NIPF claramente diferenciado de los anteriores perfiles. Esta tipología de propietarios se ajustaba a profesionales activos no-agrarios que, del mismo modo que los agricultores retirados, capitalizarían las tierras mediante la inversión y gestión forestal. Estos propietarios eran gestores de grandes y poco parceladas superficies de monte arbolado que, no dedicando importantes fracciones de trabajo propio y familiar en la explotación, trabajaban estrechamente con técnicos profesionales. Mediante esta contratación de trabajo forestal, este grupo de propietarios NIPF contribuía significativamente a la actividad forestal desarrollada en A Mariña Oriental.

ARTÍCULO IV. EXPLOTACIÓN AGROFORESTAL

Como principales resultados se citan:

- La transformación pasada de terreno forestal a prado respondía a la demanda de superficie agroganadera en la base territorial de la explotación, estando positiva y significativamente vinculada con el estatus del propietario NIPF como agricultor activo.

Así, en contraste con otras ocupaciones profesionales, los propietarios NIPF vinculados activamente en la agricultura se caracterizaban, de forma generalizada, por gestionar menores áreas de uso forestal, posiblemente por su completa dedicación o implicación en la agricultura, así como más parceladas, probablemente para mejorar e incrementar la productividad de la tierra.

- Tanto la transformación pasada de terreno agrícola abandonado a monte arbolado como la intención futura de incrementar el terreno forestal productivo a corto/ medio plazo dependían claramente de experiencias previas en materia de corta y venta de madera.

Los propietarios NIPF con mayores beneficios económicos de la actividad forestal (mejores precios unitarios y mayores ingresos por cortas previas de madera) se caracterizaban por haber aumentando recientemente el monte arbolado en su explotación o por pretender incrementarlo en un futuro cercano. El perfil de este tipo de propietario NIPF se correspondía con el de agricultor jubilado o profesional no-agrario en activo, propietarios que capitalizarían sus tierras mediante el cultivo forestal.

Los resultados del modelo de regresión logística para estimación de la transformación pasada de terrenos agroganaderos abandonados a monte arbolado indicaron que el perfil del propietario NIPF, representado por su condición de agricultor en activo y su participación en organizaciones profesionales, junto con la actividad anual en tratamientos selvícolas, eran los factores

determinantes de haber practicado dicho cambio de uso en la explotación.

Por su parte, el modelo de regresión logística ajustado para la intención futura de incrementar el terreno forestal productivo a corto/ medio plazo dentro de la explotación atendió nuevamente a la participación del propietario NIPF en asociaciones profesionales, añadiéndose la fracción anual de trabajo contratado en la actividad forestal y los ingresos anuales por venta de madera.

- La intención futura de cambiar la especie forestal productiva en el siguiente turno o ciclo se asociaba positiva y significativamente con las fracciones anuales de trabajo propio y contratado en la explotación, así como con los gastos anuales en plantación y selvicultura. Este perfil de propietario NIPF se correspondía principalmente con un agricultor activo que, no disponiendo de más base territorial para la actividad forestal, dada la necesidad de terrenos para la actividad agroganadera, pretendía mejorar la rentabilidad del monte arbolado mediante dicho cambio.

El modelo de regresión logística desarrollado para esta intención futura fue el más complejo en cuanto a variables explicativas incluidas. Así, además de vincularse con el ratio anual en tratamientos selvícolas, este propósito se completaba nuevamente con la participación del propietario NIPF en asociaciones profesionales, el conocimiento en y aplicación de criterios técnico- productivos en materia de corta forestal, la fracción anual de trabajo propio en la explotación, la superficie forestal productiva y, finalmente, el ingreso anual por venta de madera.

- Finalmente, los análisis de correlación y dependencia mostraron que los propietarios NIPF más eficientes y dinámicos en materia de gestión forestal, esto es, aquellos con los mayores ratios anuales de plantación, selvicultura y corta en el área de estudio, eran los propietarios y gestores de mayores superficies de monte arbolado dentro sus explotaciones, siendo además, terrenos forestales menos parcelados (menor número de parcelas por unidad de superficie de monte arbolado).

ARTÍCULO V. ACTIVIDAD ECONÓMICA

Como principales resultados se citan:

- El ratio anual de plantación forestal se relacionaba positiva y significativamente con la inversión anual en mejora de la explotación (equipamientos e infraestructuras), los gastos anuales en plantación y selvicultura, la solicitud de subvenciones públicas, la cuantía anual de ayuda finalmente concedida, y el ingreso anual y precio unitario por venta de madera.
- El ratio anual de tratamientos selvícolas se asociaba positiva y significativamente con la inversión anual en mejora de la explotación, los gastos anuales en plantación y selvicultura, y la solicitud de subvención pública.
- El ratio anual de corta de madera se vinculaba positiva y significativamente con los gastos anuales en plantación y selvicultura, el ingreso anual y precio unitario por venta de madera, y los ingresos anuales no-madereros (venta de tierras).

El modelo de regresión múltiple ajustado para el ratio anual de plantación indicaba que dicha práctica en la región se explicaba casi exclusivamente por atributos de carácter económico (inversión anual en mejoras de la explotación, gastos anuales en plantación y selvicultura, e ingresos anuales por venta de madera), añadiéndose la superficie forestal productora dentro de la explotación como otra variable de importancia en el ajuste.

Sin restar importancia a la situación personal y familiar del propietario NIPF, así como a las propias características de la explotación agroforestal, a la hora describir y explicar el patrón de gestión forestal en el área, los principales resultados obtenidos sugirieron que unos ingresos forestales atractivos y unas condiciones de mercado favorables para la producción de madera parecían influenciar, directa o indirectamente, la inversión en el monte y la continuidad de su manejo como capital activo. Así, los gestores forestales más dinámicos de A Mariña Oriental se caracterizaban por beneficiarse ampliamente de la actividad forestal en cuanto a ingresos económicos, pero igualmente invertían cumplidamente en mejoras de la explotación, y en la plantación y mejora

selvícola de sus terrenos forestales con el fin de mantener su productividad y aumentar su rentabilidad.

CONCLUSIONES

Analizar el crecimiento del sector forestal en Galicia mediante indicadores de superficie puede apuntar, en primer término, hacia una apuesta decidida por parte de los propietarios de tierras por este subsector agrario. Sin embargo, estos índices no reflejan realmente la situación del monte gallego, puesto que este incremento se asienta principalmente en la crisis de los subsectores agrícola y ganadero, así como en la falta de alternativas para la tierra que no pasen en muchos casos por su forestación. En la actualidad, casi un 70% de la superficie de la comunidad gallega es terreno forestal, lo que supone un enorme potencial socioeconómico que aún no se ha visto refrendado por las características productivas de este sector, principalmente por sus deficiencias estructurales y por la falta de definición de objetivos y de modelos de desarrollo forestal. La selvicultura, como práctica de la tierra claramente diferente con respecto a otros usos del territorio, parecer estar en una fase de iniciación en la economía rural, compartiendo numerosos objetivos y prácticas de gestión con la agricultura, pero no al mismo nivel económico ni formativo.

El punto de partida para el desarrollo del sector forestal en Galicia estará en ajustar e implementar procedimientos o metodologías de rigor científico, testados exitosamente en otras áreas europeas con amplia tradición forestal, que permitan caracterizar exhaustivamente su situación actual y estudiar su progresión espacio- temporal. No se trata de romper la lógica existente en el medio rural gallego, sino de complementarlo mediante su adaptación y modernización a las nuevas condiciones y demandas en materia de producción y organización forestal: aprovechar la oportunidad productiva del monte en Galicia sin abandonarlo ante el atraso en formación y en gestión.

Los resultados de la presente investigación indican que los distintos programas o líneas públicas de apoyo a la gestión forestal de propietarios NIPF deben ser afines y coherentes a la existencia de diferentes perfiles de propietarios y unidades familiares y, por tanto, a la existencia de diferentes explotaciones y prácticas de gestión de la tierra. En este sentido, es particularmente importante diferenciar los objetivos y motivaciones de gestión forestal de los agricultores, que muestran un fuerte vínculo emocional con la tierra y que dedican una importante fuerza de trabajo a la actividad, de los propietarios no-agrarios, que estarían menos arraigados a la propiedad de la tierra, pero que también contribuirían al subsector forestal mediante la contratación de trabajo profesional.

Independientemente del perfil de propietario NIPF, los terrenos forestales muestran ser, indiscutiblemente, una importante parte de la base territorial de las explotaciones rurales, considerando la selvicultura como una opción al abandono de terrenos agroganaderos descapitalizados y un complemento económico en la unidad familiar. Respondiendo a señales atractivas en cuanto al mercado de la madera, los propietarios NIPF atienden a la responsabilidad moral de cuidar y mantener la productividad de sus tierras. Como resultado, el interés de los propietarios NIPF en la selvicultura no podría expresarse explícitamente en términos económicos (recurso monte como medio para generar ingresos económicos a partir de la producción de madera) o en términos sociológicos (recurso monte como capital a transmitir en herencia a las generaciones futuras), sino en una combinación de ambos.

Sin embargo, y sin desestimar el peso de factores de índole social, geográfico o político, los atributos económicos son claves y determinantes del desarrollo e intensidad de la gestión forestal desarrollada por propietarios NIPF, indicando que promover una selvicultura social y ambientalmente sostenibles implicará primeramente promover una selvicultura rentable económicamente. Así, unas prácticas forestales responsables, dentro del contexto de desarrollo rural y de protección ambiental, dependerán de la existencia de una red social de propietarios que perciban ingresos y contraprestaciones económicas por conservar, mejorar y gestionar monte como fuente de bienes y servicios para la sociedad.

Considerando la actual dirección de las políticas forestales, los programas e incentivos públicos relacionados con la certificación forestal serán particularmente importantes, puesto que, dicha herramienta permite combinar las opciones *rentabilidad* y *utilidad* aportadas por el monte. Por tanto, será esencial motivar y compensar a los propietarios NIPF por gestionar recursos forestales que, entre otros múltiples puntos, mejoran y mantienen la riqueza natural y vitalidad rural, contribuyen al ciclo global del carbono, proporcionan numerosos productos y servicios, e incrementan el producto doméstico bruto y ratio de empleo de la región.

Los recursos forestales son la esperanza social, económica y ambiental para la recuperación y renovación de las áreas rurales, reorientándose las prácticas y valores tradicionales para con el monte hacia los principios y criterios de gestión forestal sostenible mediante un proceso participativo de toma de decisiones de todos los actores implicados.

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ANEXOS

SISTEMAS DE APOIO Á PROPIEDADE PRIVADA FORESTAL E A SÚA APLICACIÓN EN GALICIA[1]

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Resumo: *O sector forestal galego experimentou nas últimas décadas unha forte expansión en superficie sobre terras antigamente dedicadas á agricultura e á gandería, incremento superficial que non foi acompañado por unha repercusión económica e social similar. As razóns atópanse nas carencias estruturais que o propio sector presenta e que non foron corrixidas pola política forestal desenvolvida ata o momento na Comunidade. Tendo en conta a representatividade da propiedade privada de uso forestal en Galicia, este traballo examina as actuais condicións, necesidades e criterios de xestión forestal para este tipo de propiedade na Comunidade. Para iso, e en relación co concepto de xestión forestal sostible, revísanse diferentes metodoloxías de planificación e seguimento forestal implementadas noutras rexións europeas atendendo á súa potencialidade como alternativas de avance e de desenvolvemento do sector forestal galego. Así, dados os problemas actuais da actividade forestal, seleccionáronse catro puntos clave de estudo para a súa posible adaptación a Galicia: redes de contabilidade, modelos de cooperación, programas de educación e asesoramento e medidas públicas de apoio económico. Estas liñas son analizadas en tres niveis: descrición das actuais experiencias na materia en Galicia, base para a posible aplicación ou adaptación de modelos europeos; análise posterior dos principais programas ou medidas desenvolvidos en diferentes rexións europeas e, por último, xeración de criterios para a súa adaptación á Comunidade.*
Palabras clave: *Eficiencia económica / Innovación forestal / Rendibilidade forestal / Silvicultura familiar.*

EUROPEAN SUPPORT SYSTEMS TO PRIVATE FOREST OWNERSHIP AND THEIR APPLICATION IN GALICIA

Abstract: *The Galician forestry sector has strongly expanded during the last few decades over lands formerly devoted to agrarian and livestock activities, increment in land which has not been accompanied by a similar socioeconomic repercussion. The reasons are the structural deficiencies of the forestry sector, which have not been corrected by the forest policy developed up to now in the region. The present survey analyses the current conditions, needs of, and criteria for private forest management in Galicia, given the important representation of this type of land regime tenure in the region. In order to achieve this, dealing with the concept of sustainable forest management, different potential methodologies for forest planning and monitoring implemented in other European regions are reviewed, taking their potentiality into account as alternatives to advance and development of the Galician forestry sector. Therefore, given the current forestry problems, four key issues have been selected for their possible adaptation to Galicia: accountancy data network, co-operation models, education and advice programmes and public measures of economic support. These guidelines are analysed at three levels: description of the current experiences on the subject in Galicia, the basis for the possible application and adaptation of European models; later analysis of the main programmes and measures carried out in different European regions and finally, a proposal of criteria for their adaptation to the community.*
Keywords: *Economic efficiency / Farm forestry / Forest innovation / Forest profitability.*

[1] Este traballo resume o *traballo de iniciación á investigación* (TII) *La propiedad forestal en Europa: situación y problemática actual*, presentado por Verónica Rodríguez Vicente, baixo a dirección do Dr. Manuel F. Marey Pérez, no Departamento de Enxeñería Agroforestal da Universidade de Santiago de Compostela no mes de setembro do ano 2003.

1. INTRODUCIÓN

Cunha poboación de preto de 3 millóns de habitantes e cunha superficie duns 29.000 km^2, Galicia é unha das rexións máis densamente poboadas de España, onde dous terzos da súa poboación se concentra en máis de 30.000 entidades rurais (INE, 2005). Estas áreas rurais inclúen unha gran variedade de culturas, paisaxes e actividades económicas que forman un amplo abano de identidades.

Os cambios acaecidos nos usos do solo durante os séculos XIX e XX confírenlle actualmente unha serie de peculiaridades específicas ao medio rural galego, que se materializan na explotación e posesión da terra, así como na xestión e na participación das comunidades rurais na eficiencia económica da rexión. Así, o impacto ocasionado pola proximidade a zonas urbanas, cun maior atractivo de vida e con traballos mellor remunerados nos sectores secundario e terciario, supuxo a deterioración paulatina da viabilidade económica das explotacións agrogandeiras, de forma que as novas xeracións foron abandonando as actividades agrarias co que se orixinou o detrimento paralelo na economía rural (Marey *et al*., 2004). Como consecuencia, as áreas rurais experimentaron un importante descenso nas súas posibilidades produtivas e un incremento no seu grao de marxinalización.

Este escenario, determinante das actuais superficies forestais (especialmente as máis produtivas), acentúa o interese das institucións e dos centros de investigación nunha xestión e valoración da actividade forestal na que esta sexa recoñecida coma unha actividade clave para o mantemento da vitalidade económica, do atractivo social e da integridade ambiental das áreas rurais (Elands e Wiersum, 2001). Neste sentido, destaca unha cuestión de grande importancia: a xestión forestal eficiente como perspectiva de futuro nas áreas rurais. A estreita relación existente entre cobertura forestal e oportunidades de desenvolvemento rexional determina o importante papel que estes recursos desenvolven tanto como fonte xeradora de emprego como de ingresos económicos nas rexións máis desfavorecidas, isto é, nas comunidades rurais (Marey *et al*., 2006).

Actualmente, Galicia presenta 2 millóns de hectáreas forestais –o 68% da superficie total–, das que 1,2 millóns son terras arboradas de diferente composición e estrutura (MMA, 1998). Co 9,5% da superficie arborada de España, as masas forestais galegas almacenan o 19,7% do volume madeirable español (Prada *et al*., 2005), sendo a primeira Comunidade en crecemento volumétrico anual (11.022.004 m^3). Cunha ratio de superficie arborada por habitante de 0,75 ha, Galicia sitúase á altura dos recursos forestais propios de certas rexións centroeuropeas, como Alemaña, Austria ou Italia (UNECE/FAO, 2000).

Outro factor relevante que explica o peso deste recurso na rexión é a posesión da terra, dominada por un gran número de propietarios privados, representando a propiedade pública apenas un 2% (MMA, 1998). Dentro da propiedade forestal privada, destaca particularmente a propiedade particular, non só pola súa maior extensión senón tamén por ocupar as mellores terras, isto é, presentar unha maior produtividade potencial (Fernández *et al*., 2006). Así, Galicia reparte dous terzos

do seu terreo forestal e un 80% do seu arborado en máis de 672.000 propietarios individuais, para unha superficie media de explotación forestal inferior a 2 ha subdividida nunha media de 10 parcelas (Marey, 2003). Este notable parcelamento do monte galego dificulta unha xestión forestal eficiente, asociada á inexistencia dunha política xeneralizada de reforma da propiedade da terra na rexión. En relación co outro terzo de terreo forestal privado, isto é, unhas 673.000 ha, este responde a un réxime de propiedade colectiva único no contexto europeo: os *montes veciñais en man común* (MVMC), actualmente xestionados por 2.835 comunidades (Fernández *et al*., 2006). Estas extensións forestais, cunha superficie media de preto de 237 ha, constan dunha serie de potencialidades que non se atopan no resto do monte galego, configurando unidades clave no desenvolvemento e na implementación de políticas forestais de desenvolvemento rural. O seu réxime xurídico –proceso democrático-asembleario– non establece cotas diferenciadas entre copropietarios, a residencia ou a veciñanza determina o acceso, igualitario e libre para os veciños, e non é posible a herdanza ou a venda dos dereitos do seu gozo (Marey, 2003).

Hoxe a contribución estatal do monte galego obsérvase na produción final agraria xerada polo subsector forestal en España, onde o 23% o proporciona o monte galego, importancia que adquire un maior peso se se compara co 2% que supón esta Comunidade no sector agrícola español. A estes datos únese a representatividade do monte galego no valor engadido bruto e no emprego da rexión, ambos os dous representando un 3% en Galicia (Chas *et al*., 2002). Outros países europeos onde o sector forestal é un importante xerador de emprego son Francia, Suecia, Austria, Portugal ou Finlandia.

Os datos achegados polas estatísticas oficiais mostran unha Comunidade cunha gran produtividade forestal que, porén, nunha análise polo miúdo manifesta fortes carencias en xestión, especialmente no que se refire a técnicas silvícolas baixo criterios de eficiencia económica. Dada a representatividade da propiedade privada –individual e comunal– en Galicia, onde as actividades agrarias se combinan co coidado do monte, esta unidade forestal é clave para implementar políticas europeas de desenvolvemento rural, onde a relación monte-sociedade ten que afrontar novos retos, pero tamén superar unha serie de incertezas.

O presente traballo estrutura unha revisión de metodoloxías europeas para unha explotación forestal eficiente, organizada atendendo a criterios de xestión forestal sostible e, desde a óptica da súa posible aplicabilidade á rexión galega, de cara á consolidación dun sector socioeconomicamente viable.

2. PRINCIPAIS RETOS PARA UNHA XESTIÓN FORESTAL EFICIENTE EN GALICIA

Para coñecer os retos que o actual sector forestal galego ten que alcanzar é necesario analizar *a priori* as principais características do seu predecesor agrario. Así,

o minifundismo da terra xunto coa propia estrutura social do ámbito rural galego, caracterizada por un escaso investimento tecnolóxico e por unha insuficiente man de obra na actividade agraria, imposibilitan que este sector poida garantir o benestar económico de numerosas familias (Marey *et al*., 2004). Na figura 1 preséntanse as liñas de traballo e os retos que cómpre desenvolver para o conxunto do sector forestal en Galicia a partir dunha análise cuantitativa de anuarios públicos, así como de datos cuantitativos e cualitativos obtidos a partir de enquisas a propietarios forestais da rexión (Marey, 2003).

Figura 1.- Planificación estratéxica do sector forestal en Galicia

CORRIXIR	PALIAR
Ausencia de experiencia forestal	Paulatino éxodo rural
Estrutura territorial de minifundio	Avellentamento da poboación
Produtos forestais de escasa calidade	Deterioración da explotación familiar
Escasa dimensión da industria forestal	Alto nivel de desemprego
Descoñecemento da realidade económica	Escaso nivel formativo
POTENCIAR	**APROVEITAR**
Aptitude agroforestal do territorio	Aproveitamento múltiple do monte
Gran superficie forestal arborada	Concienciación polos recursos forestais
Gran volume madeirable en existencias	Medidas de incentivación económica
Motor de materia prima para España	Demanda de materia prima de calidade
Vínculo emocional poboación-monte	Asociacionismo e/ou cooperación forestal

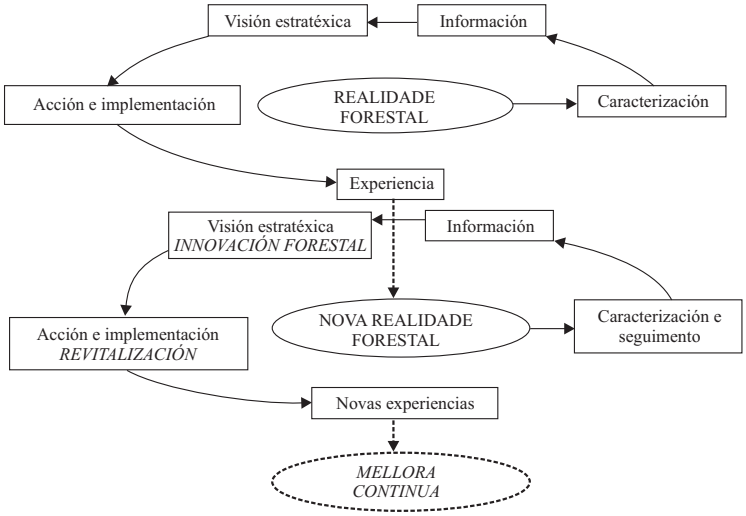
FONTE: Marey *et al*. (2006).

Mediante a coherencia nas actuacións que cómpre desenvolver, recuperar a confianza nun sistema forestal de enorme capacidade produtiva, pero xestionado coma un investimento de escaso interese, requirirá potenciar e aproveitar de forma sostible aquelas fortalezas e oportunidades do monte galego a fin de corrixir e paliar as principais debilidades e ameazas do noso medio rural (Marey *et al*., 2006). Así, podemos dicir que o actual subsector forestal galego é o resultado da crise dos subsectores agrícola e gandeiro, máis ca unha aposta decidida polo monte como actividade economicamente rendible. Dese modo, é habitual atoparnos nesta rexión con sistemas forestais infraexplotados tecnolóxica e economicamente (agás casos excepcionais), asentados máis na súa capacidade produtiva natural ca no desenvolvemento de modelos de actuación silvícola que, partindo do estudo da realidade produtiva, xeren respostas eficientes que maximicen o rendemento. Como sinalan Prada *et al*. (2005), en Galicia poderíase asumir que existe riqueza forestal no que respecta á cantidade pero non así á calidade.

Na figura 2 preséntanse as diferentes etapas no ciclo de mellora da planificación forestal, análise fundamentada en tres piares básicos para garantir unha xestión forestal eficiente: o estudo da realidade socioeconómica da propiedade privada forestal, a existencia de servizos de extensión e innovación forestal, e un apoio legal e

político coherente. Este proceso levarase a cabo a través dun plan estratéxico acorde coa situación forestal existente, cunha espiral de mellora continua como eixe central que permita e que alcance o equilibrio entre recursos forestais existentes e demandas da sociedade en xeral e das industrias forestais de transformación en particular. Dese modo, xérase un sector económico dinámico e equilibrado, onde unha xestión forestal eficiente parte de criterios de experiencia e innovación forestal.

Figura 2.- Ciclo de mellora continua no desenvolvemento forestal



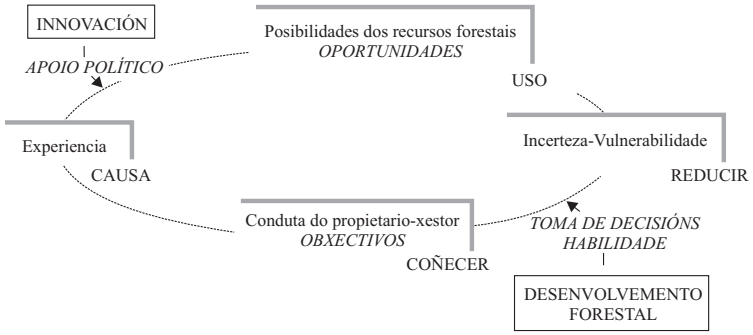
FONTE: Adaptado a partir de *Local Development Process*, de Amdam (2001).

Conforme ao primeiro dos criterios, as experiencias que ata agora se viñeron desenvolvendo en Galicia trataron principalmente con sistemas de prevención e extinción de incendios, aínda que campos como a mellora xenética e silvícola tamén adquiriron relevancia, dada a importancia das plantacións monoespecíficas para a produción de madeira (Chas *et al*., 2002). Porén, o estudo da explotación forestal desde a súa perspectiva socioeconómica non está suficientemente documentado e son estas liñas, dinámicas e adaptadas ás necesidades da explotación forestal galega, as que permitirán superar unha das súas principais carencias: a falta de veracidade na información por descoñecemento do valor económico real da actividade forestal. En Galicia, a gran maioría dos propietarios forestais, especialmente individuais, xestionan as súas masas atendendo aos seus propios obxectivos, xeralmente asociados ao investimento do monte no curto-medio prazo sen criterios de eficiencia. Este comportamento 'individualista' do xestor forestal maniféstase na falta

de traballo con experiencia en modelos de xestión que melloren a capacidade para superar atrancos e a habilidade para aproveitar oportunidades.

Consonte co segundo dos criterios, a innovación partirá da acumulación previa de experiencias en xestión, do coñecemento das posibilidades que pode ofrecer o noso ámbito territorial e da actitude e da aptitude dos verdadeiros actores: os propietarios forestais. E todo isto baixo a supervisión e o apoio da Administración Pública, que debe velar por que se reduzan as dificultades que presenta o investimento nun modelo económico como é o forestal, cunha alta incerteza e con proxección no longo prazo (figura 3).

Figura 3.- Esquema metodolóxico da innovación forestal



En definitiva, o sector forestal en Galicia ten que retomar e completar o seu crecemento con modelos de xestión silvícola adoptados en países que, cunhas certas similitudes, teñen un maior desenvolvemento en investigación e en innovación forestal. Para iso, seleccionáronse catro puntos básicos de estudo en distintos ámbitos europeos para a súa posible adaptación a Galicia: as redes de contabilidade, os modelos de cooperación, os programas de educación e asesoramento, e as medidas públicas de apoio económico. Todos eles serán analizados en tres fases: a descrición das experiencias que desta materia se dispón actualmente en Galicia, base para a posible aplicación ou adaptación de modelos europeos; unha posterior análise dos principais programas ou medidas desenvolvidos en diferentes rexións europeas e, por último, a xeración de criterios para a súa adaptación á Comunidade.

2.1. REDES DE CONTABILIDADE FORESTAL: ANÁLISE DA RENDIBILIDADE ECONÓMICA FORESTAL

Malia a relativa importancia no conxunto económico da rexión e da interrelación con outros sectores, a silvicultura foi sistematicamente marxinada das re-

flexións e negociacións políticas en materia económica. Os estudos realizados ata o momento en Galicia limitáronse ao campo da economía aplicada ou ben se resumiron en estatísticas de diferentes anuarios e informes da Administración Pública, sen desenvolver un plan contable que determinara a progresión socioeconómica dunha mostra de explotacións forestais tipo. Neste sentido, caracterizar polo miúdo a propiedade forestal constitúe a base para a aplicación da rama contable á explotación forestal, sendo esencial avanzar nesta liña para concretar claramente o papel económico do monte en Galicia.

Como consecuencia da falta de referencias bibliográficas, a situación económica da explotación forestal galega comeza a atoparse cunha serie de dificultades para a súa continuidade dentro dunha economía de mercado. Revitalizar un sector forestal familiar implica novas fórmulas metodolóxicas de estudo que desenvolvan unha base de datos completa en canto a esta actividade, especialmente en contabilidade de custos e de ingresos da explotación. En Europa, a pesar da importancia desta actividade, tamén as súas condicións económicas están pobremente documentadas, identificándose repetidamente a ausencia deste tipo de información coma un atranco para o seu perfeccionamento (Hyder *et al.*, 1994; Harrison, 2001). Porén, Galicia presenta un desfasamento temporal en contabilidade forestal con respecto a outros países máis dinámicos nesta materia, atranco que orixinou que os principios económicos do sistema forestal galego non respondan ás características particulares da súa propiedade e industria.

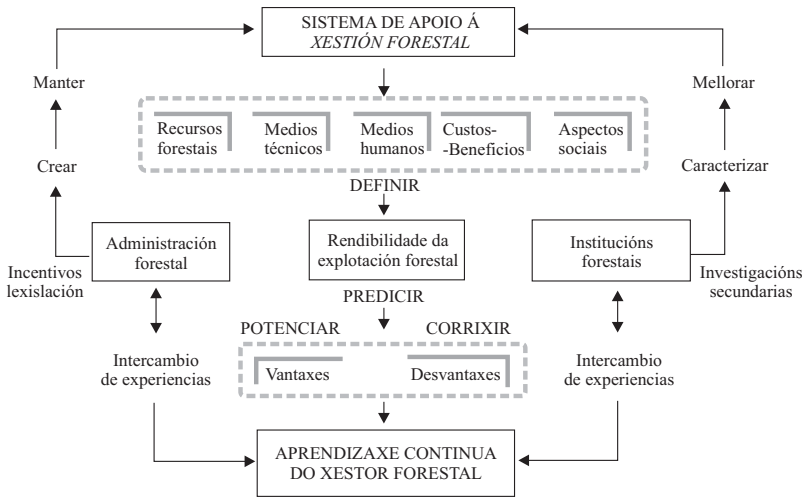
Desde esta perspectiva, a dispoñibilidade de información forestal contable é unha referencia de grande utilidade para os propios xestores. Coñecendo todas as clases de actividade propias dunha explotación proporciónase a estrutura ideal para unha valoración completa do papel e significación da silvicultura (Sekot, 2001), desenvolvendo metodoloxías públicas ou programas lexislativos efectivos que resolvan problemas específicos na toma de decisións e na xestión (figura 4). Pero ademais destes factores intrínsecos á explotación forestal, para un completo estudo económico é necesario involucrar axentes externos a esta, como son os provedores de materia prima, as industrias do sector e os servizos de seguimento e administración (Harrison e Qureshi, 2000).

Polo tanto, e dado que a silvicultura computa unha pequena parte de todas as actividades agrícolas e non agrícolas dunha explotación, establecer unha rede pura de contabilidade forestal para o seguimento da súa rendibilidade é unha tarefa complexa e, neste sentido, menciónase a posible adaptación e proxección á silvicultura das estatísticas económicas agrícolas existentes.

En Europa, a socioeconomía da silvicultura a pequena escala foi –e é– amplamente estudada en países cunha gran tradición en anuarios forestais de contabilidade ou con redes permanentes de seguimento silvícola (Niskanen e Sekot, 2001; Brandl, 2002). Así, en Finlandia destaca, entre outros, o *Statistical Yearbook of Forestry* (*Anuario Estatístico de Silvicultura*) do *Finnish Forest Research Institute* (*Metsäntutkimuslaitos-METLA*); no Reino Unido, a *Forestry Commission* recompi-

la anualmente información estatística relativa a múltiples aspectos da actividade forestal de Inglaterra, Gales, Escocia e norte de Irlanda no anuario *Forestry Facts & Figures* (*Información Detallada sobre Silvicultura*); en Noruega, o servizo *Statistics Norway* (*Statistisk Sentralbyrå*), servizo oficial de estatísticas do país e que depende administrativamente do Ministerio de Finanzas, realiza anualmente un estudo exhaustivo do subsector forestal en colaboración con outras institucións; e en Suecia, a *Swedish Forest Agency* (*Skogsstyrelsen*), institución pública responsable en materia forestal e con competencia en estatística oficial do monte, presenta anualmente o *Swedish Statistical Yearbook of Forestry* (*Anuario Estatístico Sueco de Silvicultura*). Como sinala Sekot (2001) na súa revisión de experiencias e resultados de redes contables forestais en Austria, estas metodoloxías demostran mellorar a xestión da explotación forestal.

Figura 4.- Esquema dunha rede de contabilidade forestal



Así e todo, a información contable existente na actualidade mostra unha serie de deficiencias que é necesario mellorar tanto na fase de creación coma na de mantemento deste tipo de redes. De feito, as redes contables desenvolvidas ata o momento, como submostras dunha rede de contabilidade agrícola, non revelan a significación ou a representatividade da silvicultura na explotación agroforestal. A este problema de definición únense os inconvenientes asociados á inexistencia dun plan contable na maioría das explotacións que, xunto coa gran variabilidade en terminoloxía forestal entre países, dificulta a súa análise e comparativa. Outro problema na formulación dunha rede contable é a selección e a representatividade da mostra que

reflicta de forma obxectiva a evolución do modelo de explotación analizada e que permita obter conclusións estatisticamente fiables. Coñecida a mostra motivo de análise, é necesario reducir a incerteza propia da toma de datos, considerando o grao de fiabilidade dos resultados achegados polo xestor forestal. Ademais, ás dificultades propias do establecemento dunha rede uniranse os potenciais inconvenientes do seu seguimento. Entre estes cítanse a falta de cooperación e de continuidade na rede por parte dos seus participantes, a fiabilidade dos datos achegados polos propietarios integrantes e o elevado custo de seguimento.

Polo tanto, é preciso establecer un amplo rango de aspectos metodolóxicos dentro dunha estrutura analítica detallada para alcanzar de forma eficiente uns resultados estándares imparciais. Cambiar esta situación require activar ou mobilizar as redes xa existentes e establecer outras novas que proporcionen un maior coñecemento da economía da explotación forestal. A aplicación de redes contables en Galicia debe partir dunha análise previa das explotacións forestais existentes e a súa agrupación posterior a partir de factores produtivos. Esta rede proporcionará a información contable necesaria para ser utilizada de forma directa na medición de indicadores socioeconómicos de sostibilidade forestal propios da certificación.

2.2. MODELOS DE COOPERACIÓN: PARTICIPACIÓN E XESTIÓN EN COMUNIDADES FORESTAIS

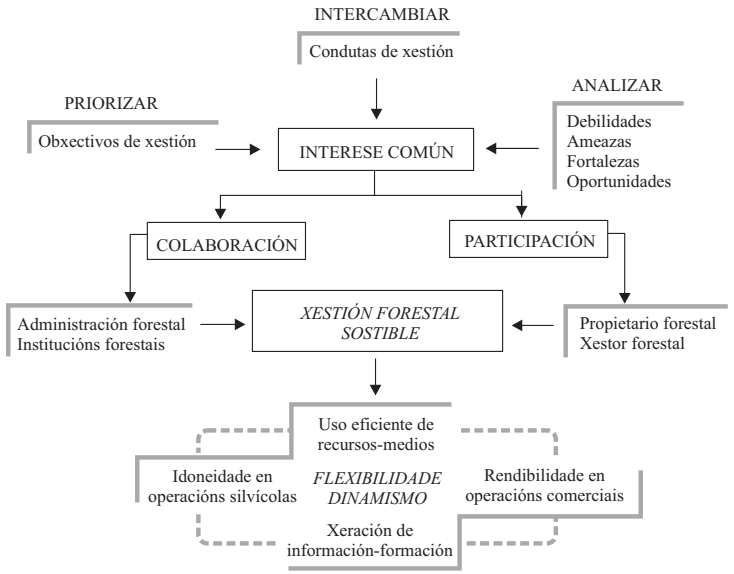
Aos problemas socioeconómicos citados anteriormente únense as desvantaxes propias da fragmentación territorial de Galicia, atranco importante para un manexo silvícola eficiente. Partindo desta base, asegurar a competitividade e a rendibilidade desta actividade require desenvolver novas formas de cooperación e melloras loxísticas e informativas que atenúen este inconveniente (Mitchell-Banks, 2001; Uusivuori e Kuuluvainen, 2001; Marey *et al*., 2004).

Neste sentido, as comunidades, agrupacións, asociacións e/ou cooperativas forestais demostraron un maior grao de dinamismo e de flexibilidade fronte aos novos desafíos na xestión forestal ca outras formas de posesión da terra (Bollin e Eklkofer, 2000; Frank, 2001). Como modelo operativo de xestión, este tipo de comunidades estimulan a continua interacción e cooperación entre propietarios forestais de cara a un fin común. Cuestións como, entre outras, de que medios humanos e técnicos se dispón?, cales son as metas de xestión que hai que alcanzar? ou, que procedemento se ten que seguir?, son materializadas nun plan estratéxico de actuación silvícola e comercial de maior eficacia e adaptabilidade, que permite a incorporación de novas tecnoloxías e a cualificación de recursos humanos. A figura 5 mostra como conseguir unha administración e xestión forestal responsable partindo de dous piares: o interese común dos propietarios e a flexibilidade e o dinamismo das solucións achegadas.

A aplicación a Galicia deste modelo de xestión forestal comunitaria xa existe e lévase a cabo mediante os *montes veciñais en man común* (MVMC) no 33% da súa

superficie forestal. Como xa se dixo, nun número superior a 2.800 comunidades este tipo de "grupos forestais" xestionan máis de 670.000 hectáreas na rexión. Con diferentes teorías en canto á súa orixe, neste tipo de propiedade privada colectiva ser "veciño comuneiro" implica legalmente ter dereito a participar nun proceso democrático-asembleario de decisión colectiva sobre unha serie de asuntos relacionados co monte: o dereito de acceso, o dereito de uso e o dereito de participación no rendemento económico da explotación forestal (Fernández *et al*., 2006).

Figura 5.- Principios operativos da cooperación forestal



Estas comunidades caracterízanse na súa gran maioría por ser deficitarias en capital humano, e están principalmente integradas por comuneiros de avanzada idade, retirados da actividade agrogandeira, sen información nin formación forestal e que participan nestes colectivos sen percibir contraprestacións económicas individuais, factores que poden aumentar as posibilidades de abandono ou de infrautilización das terras (Fernández *et al*., 2006). Se a este problema de xestión colectiva lle sumamos que cada vez con maior frecuencia unha importante fracción destas comunidades veciñais está representada por profesionais de fóra da agricultura ou da gandería, non depender dos recursos colectivos e non obter beneficios da participación poden determinar tamén o absentismo ou a falta de acción na xestión (Ostrom, 1990). Así, no rural galego a inexistencia dunha base social que permita desenvol-

ver ou continuar proxectos de aproveitamento colectivo nos MVMC conforma unha importante debilidade (Fernández *et al*., 2006), a pesar de seren espazos clave para o sector forestal galego e fonte de renda para as comunidades rurais (Prada *et al*., 2005).

En Europa, atopámonos con múltiples exemplos de cooperación ou de asociacionismo forestal, destacando especialmente a Unión de Silvicultores do Sur de Europa, que agrupa xestores franceses, españois, gregos, portugueses e italianos. En Austria, destacan as cooperativas locais de propietarios forestais *Waldwirtschaftsgemeinschaft*, a miúdo integradas en asociacións federais de propietarios. En Francia existen unhas 11.000 comunidades forestais (*Communes Forestières*), a maioría en zonas de montaña, que agrupan preto do 20% da superficie forestal total do país. En Italia, a *Magnifica Comunitá*, no val de Fíeme, é un exemplo de asociación forestal de montaña que proporciona un modelo *bottom-up* (de abaixo a arriba) de sostibilidade no uso dos recursos (Merlo, 1995), sendo menos coñecida a *Comunaliae Pamensi* no norte dos Apeninos. Xa no ámbito europeo, a *European Federation of Municipal and Local Community Forests* é unha alianza de propietarios e de comunidades de montes, e nalgúns casos de xestores, cuxo obxectivo é a xestión dos intereses e motivacións forestais dos distintos países membros. Esta alianza, que representa uns mil propietarios forestais, engloba unha superficie de 25 a 30 millóns de hectáreas arboradas.

O proceso democrático-asembleario dunha comunidade forestal como organización colectiva ten que resolver, ademais, outro inconveniente de carácter interno. Como a propia palabra indica, "participar" implica un conxunto de individuos, de diferentes opinións, perspectivas e intereses con respecto ao uso e á xestión dos recursos da comunidade. Ante este feito xorden conflitos internos na comunidade que poden determinar a non participación dos integrantes e a paralización das actividades. No seu estudo sobre conflitos de participación e xestión en comunidades forestais, Skutsch (2000) sinala que non recoñecer a existencia destes conflitos internos pode ter desencadeado e seguir desencadeando o fracaso –colapso– de numerosos proxectos en comunidades forestais: se non se identifica a existencia de conflito, non se poderá entender e analizar a súa natureza e, polo tanto, non se poderá resolver. En definitiva, a "participación" é o mellor camiño, a forma máis eficiente para alcanzar obxectivos en xestión forestal e non un tópico relacionado "cos dereitos ou coas autorizacións políticas" (Skutsch, 2000).

2.3. PROGRAMAS DE EDUCACIÓN E ASESORAMENTO: EXTENSIÓN FORESTAL

Outro factor de relevancia que é necesario investigar na eficiencia forestal é o capital humano. Así, Stefanou e Saxena (1988) verifican a importancia da educación e da formación dos propietarios forestais para unha explotación eficiente, é dicir, as habilidades e as calidades, sendo tamén especialmente importante a propia

experiencia adquirida, o saber facer (Evans, 1987; Marey *et al*., 2006). Noutras palabras, a carencia de educación formal entorpece, aínda que non impide, a mobilización produtiva do monte (Fernández *et al*., 2006).

En Galicia non existe un servizo de extensión forestal como tal, polo que un dos problemas máis significativos aos que se enfronta o propietario galego para o seu efectivo desenvolvemento e completa implicación na súa explotación é a ausencia de formación. Por iso, a ordenación de montes, a pesar de ser Galicia unha das rexións españolas de maior vocación forestal e de capacidade produtiva, non tivo unha implantación adecuada. A pequena superficie de xestión, o escaso peso dos ingresos silvícolas na economía da explotación e, en definitiva, o paulatino desarraigamento pola propiedade maniféstanse na falta de formación e de interese forestal por parte do propietario. Pero a falta de información e de formación do xestor forestal tamén se asocian á descoordinación entre departamentos administrativos como, por exemplo, entre agricultura e montes, ou outros servizos públicos de asesoría afíns. Estas deficiencias provocan a necesidade de xerar, mediante a participación activa de todas as partes interesadas, un sistema de información transparente, que se plasme en iniciativas forestais coherentes coa realidade existente.

Neste sentido, Hermelin (2001) sostén que son tres os puntos que hai que desenvolver para motivar o xestor forestal de cara a unha explotación racional dos recursos dentro dunhas condicións de mercado determinadas: a dispoñibilidade de servizos de información forestal, a preparación técnica e o asesoramento profesional. Polo tanto, a educación e a formación dos propietarios de terras, xunto coa interacción destes con outros propietarios e profesionais forestais, xera experiencia e mellora as habilidades de xestión (Mahapatra e Mitchell, 2001). Deste modo, é posible recuperar a confianza pola actividade forestal como fonte de ingresos tanxibles e beneficios non comerciais, reducíndose a incerteza á hora de innovar ou de adoptar novas tecnoloxías na explotación (Pattanayak *et al.*, 2003).

Os sistemas de asesoría –extensión– forestal, medios habituais de consulta en rexións de ampla tradición forestal, demostraron ser o medio máis efectivo para promover unha xestión forestal sostible e revitalizar a silvicultura familiar. Dese modo, asegúrase a integridade dos recursos forestais no tempo e refórzase o papel dos ingresos forestais na economía familiar. E dado que os propietarios non só adoptan medidas en función dos seus intereses senón que nalgúns casos seguen tendencias conxuntas con outros membros da súa comunidade rural (Mahapatra e Mitchell, 2001), é necesario que esta información alcance o seu equilibrio a través dos organismos competentes. Por tradición e por coñecementos, os profesionais forestais han de iniciar unha xestión adaptativa do monte, minimizando as consecuencias do conflito xerado entre diferentes intereses e valores en canto ao uso e ao manexo dos recursos forestais. E este proceso implica que a Administración desenvolva unha información e consulta pública continua e transparente, que baixo os criterios dunha comunicación efectiva leve a un entendemento común (figura 6). En definitiva, o obxectivo estratéxico da extensión forestal ha ser a promoción

dunha información e formación continua e renovada, facilitando a toma de decisións de éxito nesta actividade e que proporcione a habilidade e os recursos necesarios para iso.

Hoxe, as principais fontes de información forestal dispoñibles en Galicia son os servizos administrativos da Xunta de Galicia, a través dos servizos de extensión agraria ou a través dos distritos forestais, e as organizacións e asociacións forestais. A Administración Pública destaca especialmente polo seu particular compromiso na coordinación de información e formación profesional en materia de montes, incentivando liñas de educación, investigación e innovación forestal a través de institutos ou de escolas profesionais e fomentando a sensibilización por unha xestión sostible dos recursos forestais. Dentro dos servizos administrativos, os "distritos forestais" conforman a unidade pública básica de asesoramento, xestión e execución forestal máis directa e práctica, especialmente importante naqueles montes consorciados ou conveniados coa Administración. Este tipo de asistencia pública constituiría o modelo de extensión forestal desexable para Galicia, aínda que as súas funcións informativas e formativas teñen que mellorar de forma continuada mediante unha auténtica coordinación e avaliación *ex-ante*, *mid-term* e *ex-post* daquelas prácticas forestais, comerciais e industriais realizadas no territorio obxecto de intervención do distrito.

Figura 6.- Promoción da educación forestal

Con todo, a extensión forestal en Galicia é principalmente asumida e desempeñada por asociacións sen ánimo de lucro de propietarios de montes, conformando actualmente un eixe clave no asesoramento e profesionalización forestal na rexión. Como ben definen Fernández *et al*. (2006), estas entidades nacen ante a necesidade

de mellorar a rendibilidade das explotacións forestais e a calidade dos seus produtos e servizos mediante actividades de formación e divulgación, de asesoramento técnico, administrativo e xurídico, financiadas parcialmente pola Administración Pública. A clave do éxito deste tipo de asociacións radica fundamentalmente no traballo e na estreita cooperación entre técnicos da organización e propietarios asociados en todas aquelas materias relacionadas co monte, desde a plantación ata a comercialización de produtos, protexendo os seus intereses e axudando a alcanzar os seus obxectivos de xestión.

2.4. MEDIDAS PÚBLICAS DE APOIO ECONÓMICO: DIMENSIÓN POLÍTICA DA XESTIÓN FORESTAL

Nun escenario coma o sector forestal galego, cunha gran variedade de actores con múltiples intereses, é indispensable asegurar, en primeiro lugar, a coordinación a todos os niveis para poder alcanzar, en segundo lugar, unha xestión forestal sostible mediante ferramentas públicas de apoio consensuadas e aceptadas por todos os axentes implicados. Como sinalan Prada *et al*. (2005), a participación na elaboración e a aplicación das decisións políticas, tanto por parte da poboación afectada coma dos axentes que han de aplicalas, aumentan as probabilidades de que os obxectivos se alcancen dunha forma eficaz.

Esta diversidade de poboación obxectivo, con notables diferenzas socioeconómicas (idade, educación, sexo, renda familiar, […]), territoriais (localización, tamaño, parcelamento da propiedade, […]), e de actitude e práctica forestal, limita ou imposibilita que as distintas medidas, ferramentas ou programas públicos de apoio económico á actividade forestal se axusten razoablemente ao perfil do demandante. En Galicia, considerando a dinámica evolutiva e a situación actual da actividade forestal, é importante diferenciar dous perfiles básicos de propietario e/ou de xestor forestal: o "agricultor", cun marcado vínculo emocional coa terra e cunha importante dedicación á actividade forestal, e o "novo propietario de monte", non vinculado á agricultura, xeralmente menos aferrado á propiedade e máis proclive a contratar asistencia profesional en materia forestal (Marey, 2003).

Nesta Comunidade, a dimensión política do monte veuse centrando de forma xeneralizada na produción e na innovación tecnolóxica de plantacións monocultivo de escasas especies comerciais de crecemento rápido. Ao igual ca outras rexións, estas políticas de forestación pretendían frear posibles desequilibrios territoriais e xerar riqueza económica en áreas rurais claramente desfavorecidas, así como manter e mellorar os recursos naturais existentes. Así, cítase a reforma europea da *Política Agraria Común* (PAC) do ano 1992, amplo marco político que buscaba en última instancia promover unha planificación territorial e un desenvolvemento rural ambientalmente sostible. Dentro das súas medidas de acompañamento, cítanse especialmente os Regulamentos comunitarios (CEE) 1610/89, polo que se establecen accións de desenvolvemento e de aproveitamento dos bosques en zonas rurais, e

2080/92, polo que se establece un réxime comunitario de axudas ás medidas forestais na agricultura, para compensación de rendas agrarias, mediante a forestación de terras agrarias marxinais e a súa mellora silvícola. Ambas as dúas liñas se fusionaron no Regulamento 1257/99 sobre axudas ao desenvolvemento rural, a cargo do Fondo Europeo de Orientación e de Garantía Agrícola-FEOGA.

En Galicia, os Regulamentos (CEE) 1610/89 e 2080/92 serían implementados mediante o Decreto autonómico 250/93 polo que se aproba o programa rexional de axudas a medidas forestais na agricultura, centrado en tres liñas de traballo: as "axudas forestais en agricultura" (liña verde), as "axudas a accións de desenvolvemento e ordenación dos bosques" (liña azul) e as "axudas para a mellora e conservación dos bosques de frondosas" (liña amarela). Así, entre os anos 1993 e 1997 investíronse en Galicia 16,1 millóns de euros para financiar plantacións forestais e os seus tratamentos de mellora e 1 millón de euros para manter as forestacións e compensar as perdas de ingresos (Valero, 1997).

Fóra do financiamento público mediante pagamentos directos á actividade forestal, outro mecanismo de intervención pública en Galicia é a subscrición de convenios e consorcios por parte da Administración forestal con comunidades de MVMC. Nestes contratos, o principal obxectivo é a repoboación forestal total ou parcial das terras, regulándose a distribución das cargas e dos beneficios derivados do monte en porcentaxes variables en función do contrato existente, consorcio ou convenio. Segundo Fernández *et al*. (2006), os MVMC tiñan, no ano 1999, 959 convenios e 618 consorcios asinados coa Administración, englobando o 56% destas comunidades de montes e o 45% da súa superficie total.

Porén, o volume total de investimento real da Xunta de Galicia en materia de montes mantívose practicamente estancado, en moedas constantes, nas últimas décadas, especialmente entre os anos 1999-2001 (Fernández *et al*., 2006). Polo tipo de investimento, estes autores poñen de manifesto que os fondos destinados á prevención e á defensa contra incendios forestais supuxo o 60% dos orzamentos públicos entre os anos 1994-2001, para incrementarse ata un 70% durante o exercicio 1999-2001 en detrimento dos investimentos en ordenación, reestruturación e desenvolvemento do sector forestal. Dentro destes últimos fondos, os investimentos destinados a tratamentos silvícolas parecen terse duplicado en moeda constante entre os anos 1994 e 2001, principalmente en detrimento dos investimentos a repoboacións que durante este período se reduciron nunha cuarta parte. En definitiva, a estratexia pública en Galicia parece centrarse na actuación directa en materia de incendios forestais, deixándolle o investimento forestal á iniciativa privada mediante incentivos económicos (Fernández *et al*., 2006).

O contexto forestal actual demanda, así e todo, novos enfoques no deseño de programas ou de medidas públicas de carácter económico para o sector nun intento de abarcar ou de cubrir a multiplicidade de obxectivos relacionados co desenvolvemento rural en xeral e coa xestión forestal sostible en particular. Así, asístese a un cambio na valoración dos recursos naturais, especialmente dos espazos rurais, onde os valores ou as actividades tradicionais se combinan cos ambientais e cos

culturais (Prada *et al*., 2005). Neste contexto, as políticas públicas de conservación, ordenación e planificación forestal xeraron unha lexislación particularmente significativa, así como novos retos de futuro para o desenvolvemento económico, social e ambiental das áreas rurais en función dos recursos forestais.

3. CONCLUSIÓNS

Analizar o crecemento do sector forestal en Galicia mediante indicadores de superficie pode apuntar, en primeiro termo, cara a unha aposta decidida por parte dos propietarios de terras por este subsector agrario. Porén, estes índices non reflicten realmente a situación do monte galego, posto que este incremento se asenta principalmente na crise dos subsectores agrícola e gandeiro, así como na falta de alternativas para a terra que non pasen en moitos casos pola súa forestación. Na actualidade, case un 70% da superficie da Comunidade galega é terreo forestal, o que supón un enorme potencial socioeconómico que aínda non se viu referendado polas características produtivas deste sector, principalmente polas súas deficiencias estruturais e pola falta de definición de obxectivos e de modelos de desenvolvemento forestal.

O punto de partida para o desenvolvemento do sector forestal en Galicia está naqueles procedementos que permitan caracterizar a súa situación actual. Neste caso, as redes de contabilidade constitúen unha ferramenta de enorme importancia para coñecer a repercusión do sector nos niveis micro e macroeconómico, e a súa implantación e desenvolvemento ten que partir dun rigoroso estudo que permita identificar baixo criterios estatísticos aquelas explotacións representativas dunha subpoboación do universo poboacional.

Un elemento que pode afectar tanto nestas primeiras etapas de caracterización da situación de partida coma no posterior desenvolvemento de modelos de xestión silvícola constitúeo as carencias en materia de extensión forestal. Esta actividade debe ser acometida de forma prioritaria, dado que as actuais insuficiencias neste factor poñen en cuestión a consideración desta como sector económico e técnico, onde a desconfianza e o receo por parte do propietario forestal cara a outros actores da cadea é un elemento característico. Dada a escasa tradición que no manexo forestal presenta a rexión, as campañas de formación e de extensión forestal deben partir dun diagnóstico do nivel actual de desenvolvemento e deben enfocarse cara á capacitación dos silvicultores galegos como colectivo dinámico e eficiente no menor prazo de tempo posible.

Outro dos problemas do noso monte asóciase á súa propia estrutura. A importante fragmentación e o pequeno tamaño da propiedade individual fan inviables medidas de mellora nas explotacións. A principal solución pasa polo asociacionismo e pola formación de comunidades de propietarios forestais das que xa se dispón de experiencia en Galicia, posto que os montes veciñais en man común son realmente comunidades de propietarios forestais baixo outro réxime xurídico. Así, a

cooperación e a asociación forestal permitiría afrontar novos retos inabordables de forma individual.

Por último, asegurar a competitividade do sector forestal galego require desenvolver futuros modelos de cooperación e conseguir compromisos de dedicación entre todos os actores involucrados, especialmente a Administración Pública. Unha política forestal de éxito necesitará esforzos en todos os niveles e desde os distintos eixes clave na súa dinamización para realzar un sector artesanal en paulatino abandono. E isto ten que partir dun coñecemento exhaustivo e continuo da realidade galega que, mediante un enfoque multidisciplinar, dirixa o sector cara a unha economía de mercado.

Non se trata, pois, de romper a lóxica existente no noso medio rural, senón de complementalo mediante a súa adaptación e modernización ás novas condicións de produción e organización forestal: aproveitar a oportunidade produtiva do monte en Galicia sen abandonalo ante o atraso en formación e en xestión forestal.

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RESEARCH PAPER

Characterization of nonindustrial private forest owners and their influence on forest management aims and practices in Northern Spain

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Abstract Explaining and predicting nonindustrial private forest (NIPF) owner land management based on social, economic, and environmental factors is an increasingly important issue in policy arenas and academic research on rural development and planning. This study empirically explores and assesses management behavior by NIPF owners by analyzing attributes of landowner profile (age, educational level, primary occupation, engagement in farming, membership of professional groups, training in forestry, availability of market information, and specific knowledge and use of production criteria for timber harvesting). With the aim of predicting outcomes, a multiple regression model was constructed to investigate and quantify the probabilities of and factors influencing the participation of owners in agricultural and forestry associations. In March 2004, 103 resident forest landowners were interviewed about their commitment to and involvement in land management during 1999–2003 in Mariña Oriental, a forest region of Galicia, Northern Spain. Results suggest that professional occupation, particularly farming background, is the main factor affecting, either directly or indirectly, the forest management behavior of NIPF owners in the area. In particular, our logistic regression model for landowner membership of professional groups explained 77.9% of the variability observed in the study population, which suggests that the agricultural background of NIPF owners and their expectations from forests, represented by their future intention to enlarge the forestland base, play an important role in membership. In the region, forestry could be a valuable economic activity but it is not considered as such today. Findings could be used as a guide for design,

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planning, and implementation of research and policy measures that allow NIPF landowners to promote sustainable forestry for rural development.

Keywords Farming · Forestry · Nonindustrial private forest (NIPF) owner · Planting · Silviculture and harvesting practices

Introduction

Explaining and predicting nonindustrial private forest (NIPF) owner land management based on social, economic, and environmental factors is an increasingly important issue in policy arenas and academic research on rural development and planning, particularly because of the large diversity of factors and the complexity of characterizing and providing a framework for the management objectives and goals of NIPF owners. Because the nature of NIPF ownership differs notably from country to country, defining the meaning of this term is difficult; this type of individual forest ownership consists of a single or small number of planting blocks, nonprofessional management, and often a lack of silvicultural skills, with little planning for future marketing (Herbohn 2001). NIPF owners' commitment to and involvement in land-use and management stems from a dynamic environment in which personal and family decisions and/or needs, geographic context, and policy guidelines are closely interrelated. According to Beach et al. (2005), forest owners produce a variety of forest products and benefits using several types of inputs including forestland, growing timber stock, labor, technical assistance, materials, and machinery to perform various land management activities.

In particular, forests owned by NIPF owners are a part of the total land-use system of the holding, and management goals are not solely focused on industrial timber production; NIPF owners own and manage land for a wide variety of purposes, and thus their practices and values are equally diverse. Therefore, understanding and modeling the determinants of NIPF owners' land-use and management behavior is a complex task, insofar as any analysis must consider the interaction between many decision-making and motivational factors. More specifically, understanding the land management behavior of NIPF owners requires knowledge of the agroforestry system and of the landowners' personal goals and circumstances. Because NIPF owners are key actors in sustainable development and welfare in rural areas, their land management behavior has been studied extensively by researchers from different disciplines, such as sociology, economics, ecology or land planning. Accordingly, there is a growing descriptive, theoretical and empirical literature on the land management behavior of NIPF owners.

In this way, understanding why NIPF owners engage in forestland management has been seen as key by many authors concerned with the choice and level of investment in forest management practices such as tree planting and forest stand improvement (Doolittle and Straka 1987; Straka and Doolittle 1988; Hyberg and Holthausen 1989; Löyland et al. 1995; Hardie and Parks 1996; Gunter et al. 2001; Zhang and Flick 2001; Zhang and Mehmood 2001; Kline et al. 2002; Arano et al. 2004; Ross-Davis et al. 2005), timber harvesting (Hyberg and Holthausen 1989;

Dennis 1990; Kuuluvainen and Salo 1991; Löyland et al. 1995; Kuuluvainen et al. 1996; Prestemon and Wear 2000; Zhang and Mehmood 2001; Bolkesjø and Baardsen 2002; Conway et al. 2003; Størdal et al. 2008), and nontimber forest activities (Pattanayak et al. 2002; Conway et al. 2003; Kittredge 2005; Potter-Witter 2005; Van Gossum et al. 2005; Van Gossum and De Maeyer 2007; Boon and Meilby 2007). The choice and level of investment in different forest management practices has been analyzed as a function of different variables that may affect land management decisions and practices. Pattanayak et al. (2002), Amacher et al. (2003), and Beach et al. (2005) concisely and systematically review some empirical studies focused on land management decisions made by NIPF owners.

The Autonomous Community of Galicia, a region in Northern Spain, provides an interesting setting for the analysis of NIPF owners' management. During the last 50 years, forestry in Northern Spain has undergone significant changes brought about by Spain's entry into a highly competitive market. Such changes have altered the landscape patterns of the region. Fewer farms, decreasing rural populations, and increasing fragmentation of forest property have led to significant alterations in the traditional farming system (Marey-Pérez et al. 2006; Marey-Pérez and Rodríguez-Vicente 2008). These changes have also affected forests. After a period of neglect, the current approach to forest management emphasizes timber production using fast-growing species. Galicia has over 2 million ha of forestland, which accounts for 50% of the total land area of this region and 8% of the total land area of Spain. The Galician forestry sector has grown slowly but steadily over the last 15 years, and is currently one of the economic mainstays of the region. According to the 1998 Spanish forestry survey (MMA 1998), almost 50% of the timber produced in Spain comes from Galicia, which is the Spanish region with the highest standing volume and growing stock.

Land-use changes have affected the social and economic structure of land management in Galicia. Until the mid 19th century, the typical land manager profile in Galicia was a crop or livestock farmer clearly linked to family knowledge and needs. In other words, the Galician rural economy was largely based on subsistence farming, with a large share of forestland. From that moment, the diversification and specialization of the industrial sector and the development of a range of policy tools for encouraging the capitalization of marginal agricultural lands have brought about important socioeconomic changes in many Galician rural areas, which have affected land management and planning (Marey-Pérez and Rodríguez-Vicente 2008). From the mid 20th century, a new profile of forest landowner and/or manager has emerged. New forest landowners and/or managers are different from traditional crop or livestock farmers, and have different goals and decision-making processes about their commitment to and involvement with the land. Today, Galician forests are mostly managed by private owners, with about 425,000–673,000 NIPF owners managing over two-thirds of the forest area (Marey-Pérez 2003).

The rapid expansion of forest area has generated many studies and statistical reports concerned with the current state and evolution of forestry resources in Galicia. However, none of these studies has focused empirically on the social and structural factors affecting forest decision-making and management. Despite the long agroforestry tradition of Galicia, few evaluations of its current state and future

prospects have been conducted, which has led research institutions to investigate individual private property management and planning. Small-scale forestry must be recognized as a productive activity in order to invigorate the economy, to make the sector socially attractive, and to maintain the environmental integrity of rural areas (Marey-Pérez et al. 2004).

Knowing and understanding the factors that may influence individual forest management decisions and practices is essential to improve the forestry sector and to shape it as a social, economic, and environmental mainstay in Galicia, and consequently in Spain. As reported by Karppinen (1998), forest management, as a voluntary action, is primarily driven by the motivations of the landowners, i.e., their values and goals. As assumptions about landowner objectives have evolved, so has our understanding of the decisions they make (Amacher et al. 2003). Therefore, the starting point for understanding why NIPF owners engage in land management is to analyze and explain their motivations and objectives with regard to forestlands.

Our aim is to explore and assess NIPF owners' management behavior based on an empirical analysis of attributes of landowner profile, focusing on a sample of forest holdings surveyed in Northern Spain. Thus, based on a thorough analysis of individual landowner characteristics pertaining to age, educational level, primary occupation, engagement in farming, membership of professional groups, training in forestry, availability of market information, and specific knowledge and use of production criteria for timber harvesting, this paper aims to analyze in detail and better understand forest management behavior in the region. Accordingly, we search for a possible statistical relationship or difference between these variables and other factors related to family unit, forest property and land-use changes, or forest economics. In order to complete the results, we have included three practices traditionally used in the relevant literature to predict forest management behavior of NIPF owners, i.e., planting and silviculture on forestland, and timber harvesting on woodland (Löyland et al. 1995; Hardie and Parks 1996; Kuuluvainen et al. 1996; Prestemon and Wear 2000; Zhang and Flick 2001; Kline et al. 2002; Conway et al. 2003; Arano et al. 2004; Potter-Witter 2005; Ross-Davis et al. 2005; Størdal et al. 2008). In addition, these variables are statistically analyzed with respect to the characteristics pertaining to the profile of forest owners.

The characterization of landowners and the identification of patterns in their forest management practices may allow policy-makers to improve existing policies and develop further public measures based on different landowner profiles in terms of their motivations and needs in forestry that encourage landowners to adopt sustainable land management.

Materials and methods

Identification of the population and questionnaire design

This study updates and expands an earlier analysis by Marey-Pérez (2003) exploring private ownership and forest management in the Autonomous Community of Galicia. Data was collected from face-to-face interviews with randomly selected

NIPF owners in Mariña Oriental pilot area, located in Northeast Galicia, Spain (Fig. 1). The study area is representative of much of Northern Spain, where forests cover most of the land (53%) and forestry is an increasing activity (over 46% of

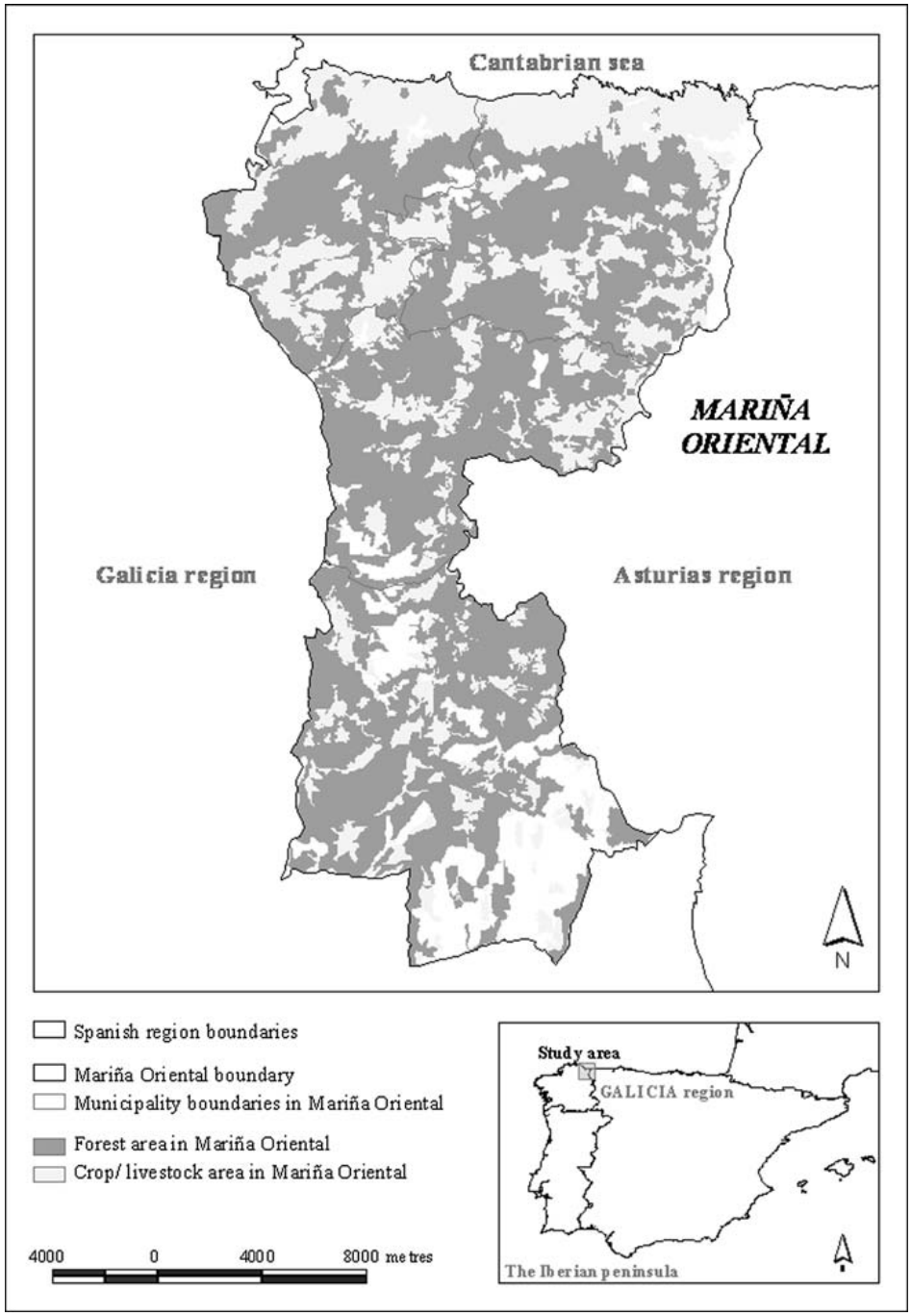

Fig. 1 Location of Mariña Oriental in Galicia, Northern Spain

forests are woodlands). Forestlands are owned by 3,043 NIPF owners, who manage more than 90% of the forested area in the region. In Mariña Oriental, forestland increased by 8.5% between 1957 and 2001 because of the conversion of agricultural land and shrubland into forests, such that the agricultural and farmland area in the region currently accounts for 27% of the total surface area. According to INE (1999), the number of farm holdings declined by 33.7% in Mariña Oriental between 1962 and 1999. Such a decline in the number of farm holdings was caused mainly by social and production deficiencies in rural areas. However, the most important land-use change in the study area and in the Galician region was the composition of woodlands. Monospecific stands increased considerably between 1962 and 1999, about 300%, probably because of the spread of the forest species *Eucalyptus globulus* Labill. (blue gum). Plantations of blue gum increased by more than 63% in Mariña Oriental between 1957 and 2001 (Marey-Pérez 2003). Today, *Eucalyptus globulus* Labill. and *Pinus pinaster* Ait. spp. atlantica (maritime pine) are the main productive forest species in the area and cover more than 71% of the forestland, with a mean timber yield of 26.4 m^3/ha per year, at a rotation age of 12 and 25 years, respectively, for blue gum and maritime pine.

The strong increase in timber-producing forests in the study region, in Galicia, and in many other areas of Northern Spain was due to significant changes in the traditional agricultural and forestry system during the 1950s. As a result of increasing urban and industrial development during the mid 19th century, traditional agricultural and forestry activities were no longer economically viable for many rural communities, and active population largely shifted to urban agglomerations, similarly as in other European countries (Marey-Pérez and Rodríguez-Vicente 2008). Changes in land use at farm level are widely acknowledged as a response to decreased agricultural economic viability (Marey-Pérez et al. 2004). The lack of labor in rural areas brought about an increase in abandoned agricultural land, which was gradually occupied by shrub or planted with native trees. From the late 19th century, the Spanish government attempted to tackle the situation by promoting forest plantations primarily used for further processing in the fiber and chipboard industries. The measure reached its peak in the mid 20th century and was aimed at improving the low productivity, low profitability, and deforestation of Spanish forests (Marey-Pérez and Rodríguez-Vicente 2008). Later, European Council Regulation (EEC) no. 2080/1992 of 30 June 1992, instituting a community aid scheme for forestry measures in agriculture, favored the establishment of large forest plantations in Galicia, especially during the period 1993–1997, when grant-aided afforestation constituted an important choice for private landowners who wished to improve the productivity of marginal lands through tree plantations, mainly with *Pinus* spp. and *Eucalyptus* spp.

The addresses of NIPF owners and the attributes of their holdings, such as location, land uses, and size, were identified from the Land Register. In agreement with European Council Regulation (EEC) no. 571/1988 of 29 February 1988, on the organization of community surveys on the structure of agricultural holdings, the study population was composed of individual forest owners who owned at least 1 ha of productive forestland in Mariña Oriental, which totaled 750 forest owners and covered 2,009 ha of productive forestland. The 1-ha threshold value was selected based on the

assumption that only forest owners with a certain land area would have the information necessary to account for their management goals and practices.

A high percentage of the selected owners did not live, however, in the region where their land was located (Marey-Pérez et al. 2004) because of the 20th century migration patterns in Northern Spain, mainly migration from rural to urban areas (Beiras-Torrado 1975). More specifically, over two-thirds of the population of nonresidents lived in other areas of Galicia, and the rest of nonresidents lived in other Spanish regions or in other countries. Consequently, we decided not to include owners who were emigrants or descendants of emigrants because they did not directly manage or monitor their land properties in the study area, and they did not have more or less continuous contact with the land. Moreover, including nonresident owners in the analysis would not guarantee the possibility of obtaining useful information for this research. Accordingly, we used population census data to restrict the study population to registered individual landowners who lived in the area. From among the original population of 750 NIPF owners, 376 were registered as residents, but only 333 actually lived in Mariña Oriental. The remaining 43 NIPF owners were living in the house of a recently deceased relative. Consequently, we had access to around 50% of the owners who met the first condition for the study population. This group of landowners owned 1,154 ha of productive forestland, which accounts for 42% of all productive forestland in the region, including plots smaller than 1 ha. Land Register data proved rather divergent from population census: while according to the Land Register almost all the 750 cadastral landowners lived in Mariña Oriental, the population census suggested that only 45% of landowners actually lived in the region.

Because the large number of variables included in the Land Register was highly heterogeneous, stratification was a key factor in the characterization and subsequent validation of results. According to the Land Register database, the variable "productive forest area per landowner" was the most suitable variable to determine the minimum threshold of NIPF owners that should be interviewed and to stratify landowners. In order to determine the number of strata and the cutoff points required, NIPF owners were classified based on data pertaining to timber harvesting in Mariña Oriental. Landowner stratification was defined by the size of productive forestland that enabled NIPF owners to fell the equivalent of the mean annual harvest per plot in the region (Marey-Pérez 2003), set at 3.5 ha of productive forestland, considering a weighted rotation age of 15 years for the two main forest species in the region, *Eucalyptus globulus* Labill. and *Pinus pinaster* Ait. spp. *atlantica*. NIPF owners were classified into four groups according to this value (Table 1).

We designed a questionnaire based on the subjective method of sample selection. Sample size was designed to achieve a 5% sampling error at the 95% confidence level. A priori, the error level was set at 3% for quantitative answers (mean estimation) and 6% for qualitative answers (proportion estimation). In order to obtain complete and reliable results, we enlarged as much as possible the interviewable landowner sample and minimized the economic costs of the interview during the design of the sampling size. A self-weighting design was used; sample size was determined accordingly and allocated using Neyman allocation (Sukhatme

Table 1 Classification of NIPF owners interviewed per stratum

Stratum	Productive forestland (ha)	No.	%
A	1.00–1.70	22	21.4
B	1.71–3.50	28	27.2
C	3.50–7.00	31	30.1
D	>7.01	22	21.4
		103	100

1953). The results showed that an initial estimate of 3% (mean estimate) required the completion of a total of 101 questionnaires, whereas for an initial estimate of 4% (proportion estimate) completion of 99 questionnaires was required. From 333 NIPF owners, each responsible for more than 1 ha of productive forestland and permanently resident in Mariña Oriental, the self-weighting sample size was finally formed by 103 NIPF owners, who were contacted and interviewed in person (Table 1). Thus, the error level was finally 4% for quantitative answers (mean estimate) and 8% for qualitative answers (proportion estimate).

The NIPF landowners who were interviewed owned 12% of the forestland and 13% of the woodland (i.e., productive forestland) in the region. For the principal productive forest species planted in the area (mainly blue gum and, to a lesser extent, maritime pine), the population of interviewed NIPF owners applied a very simple model for silviculture treatment and forest production. The model was very similar for all the owners and was characterized by an average planting density of 1,100 trees/ha, a minimum use of silviculture treatments, and the use of timber for further processing in the fiber and chipboard industries (Marey-Pérez 2003).

A variety of questionnaires was tested before deciding on a final version, which collected information on owner profile, family unit, forest property and land-use changes, and forest economics during the 1999–2003 period. The survey was carried out in two stages in March 2004. The first stage consisted of a telephone interview conducted between 20:00 and 22:00 h, which inquired into the owner's willingness to participate in the study. If the owner was willing to participate, the interviewer arranged for a face-to-face interview within 1 or 2 days (the second stage). If the owner refused to participate in the face-to-face interview, the interviewer posed the questions included in the landowner-profile section. Each interview lasted an average of 36 min. Finally, data obtained from interviews was complemented with official Land Register data.

The study variables for the present research were based on the information obtained from personal interviews. Such information was redefined and coded into nominal, ordinal or binary variables that summarized data from the survey and met the assumptions of the statistical analyses. For the formulation of ordinal variables, we used SAS/STAT™ and STAT-GRAPHICS™ software. First, we produced descriptive statistics and frequency histograms for the explanatory variables and we selected measures of location and dispersion, i.e., mean x and standard deviation σ, respectively (Cao-Abad 2002). Then, we considered the measure of location (x) as the centre of the explanatory variables considered, and calculated the class intervals

from the measure of dispersion (σ). Definition of the variables considered in the present study, divided into four main topics, along with the number of owners interviewed in each category, are shown in Appendix Table 7, along with the main descriptive statistics for the continuous variables used in the study (x; σ).

Given that forest decisions and/or practices of a representative NIPF owner are the result of a combination of individual decisions and/or practices regarding planting and silviculture treatments on forestland, as well as harvesting on woodland, these three individual forest practices were also included in the personal interviews and later defined as continuous variables in the present study (Appendix Table 7).

Finally, to control the inflation rate, all the economic variables analyzed in the study were adjusted to constant euros for 2004 and were summarized in mean annual euro amounts per hectare owned, with the exception of family households and stumpage timber price. The information source was the Spanish consumer price index of the National Statistics Institute (INE 2004).

Statistical analyses

The statistical analyses performed in this study were based on distribution-free tests, i.e., nonparametric tests. The nonparametric approach considered the types of variables measured in the study, i.e., continuous, nominal/ordinal, and binary variables, and was defined in order to provide a statistical explanation of NIPF owners' management by analyzing attributes related to landowner profile. The study variables (landowner characteristics) were empirically associated with other attributes pertaining to family unit, forest property and land-use changes, and forest economics, as well as with planting, silvicultural, and harvesting management practices observed in Mariña Oriental region. Thus, the strength and significance of the linear correlation among the variables was firstly tested, and the significant differences found were subsequently contrasted at 95% confidence limit and a minimum 0.05 level of statistical significance.

Somers' D coefficient and its critical significance level were applied to measure the statistical relationship among nominal, ordinal, and/or binary variables by using contingency tables. Then, significant differences in frequency distribution across nominal, ordinal, and/or binary variables of the cross-tabulation were computed and detected by using Pearson's chi-square statistic χ^2 and two-tailed asymptotic significance.

Spearman's rho coefficient ρ was used to estimate the statistical association between the continuous variables and the nominal, ordinal, and/or binary variables at 0.01 and 0.05 significance levels. The mean distribution across variables was analyzed using the Kruskal–Wallis' H test, a nonparametric test of variance homogeneity equivalent to one-way analysis of variance (ANOVA). In addition, pairwise comparisons were performed by using Dunnett's T3 test to determine which categories (levels) of nominal/ordinal variables showed behaviors (means) that differed significantly from the behavior of the continuous variables. After significant differences were tested, post hoc analyses were completed with a Tukey's honest significant difference (HSD) test, which was used to define

homogeneous subgroups of nominal/ordinal variables that displayed a similar statistical behavior with regard to the continuous variables.

Finally, to complete the research presented in this paper, we modeled the relationship between the variables FARM, ASSOC, and IMARKET as binary responses (1 = the owner fulfilled the condition; 0 = the owner did not fulfil the condition) and a combination of explanatory variables that enabled the statistical characterization of these three landowner attributes. The variable TRAINING was not used in the present model because it did not fulfil the balance between responses required to develop a statistically significant model.

Because of the binary nature of the three dependent variables, we used logistic regression by backward stepwise selection, a method based on a cumulative probability function whose main objective is to model how the presence or otherwise of diverse factors, and the value or levels of such factors, affect the probability of an occurrence (Ryan 1997), i.e.:

$$P_i = E(Y = 1\ x_i) = \frac{1}{1 + \mathrm{e}^{-(\beta_0 + \beta_i x_i)}} \tag{1}$$

where x_i are the independent variables, $P(Y) = P$ is the probability that the forest owner fulfils the condition set by the dependent variable, which takes a value of 1 when the NIPF owner is an active farmer, a member in a professional group, and had specific training in forest markets, and a value of 0 when the NIPF owner does not fulfil any of the preset conditions, β_0 is the independent term in the logistic regression model, and β_i are the coefficients of the logistic regression model, significantly different from 0.

The estimates of the different regression coefficients were obtained by maximum-likelihood estimation (MLE). Testing of the statistical significance of each of the regression coefficients in the model was carried out by Wald's method, at a significance level of 0.05 (Hosmer and Lemeshow 2000), i.e.:

$$\mathrm{WALD} = \frac{(\hat{\beta}_1)^2}{\left(EE_{\hat{\beta}_1}\right)^2} \tag{2}$$

This statistic follows a chi-squared distribution with k degrees of freedom χ^{2k},where $k = 1$ if the independent variable is quantitative, and k = number of categories—1, if the independent variable is qualitative, whether nominal or ordinal.

The empirical models developed for the three landowner attributes analyzed were based on a function that included regressor variables, related to other characteristics of the landowner's profile, the family unit, the forest land-holding and land-use changes, the forest economy, and the three forest management activities considered (planting, silviculture, and harvesting), which were significant at 0.05 level. Appendix Table 7 shows the definition and descriptive statistics of independent regressor variables.

The fit for the logistic regression models for the three landowner characteristics analyzed (the dependent variables FARM, ASSOC, and IMARKET) provided significant results only for landowner membership of an agroforestry association (ASSOC variable). Consequently, we decided to include and discuss only the

predictive model obtained for the behavior of resident NIPF owners in Mariña Oriental in terms of participation in professional groups.

Results and discussion

Owner age

According to literature (Kuuluvainen and Salo 1991; Löyland et al. 1995; Kuuluvainen et al. 1996; Conway et al. 2003; Størdal et al. 2008), owner age appeared to be a significant factor in timber harvesting in the area ($H = 5.672$). Middle-aged owners were the most likely to harvest woodlands, a behavior that differed significantly from the remaining study population. With an annual harvesting rate over 6%, middle-aged owners harvested between four and almost seven times more woodland annually than older and younger owners, respectively. Except for Conway et al. (2003), the authors cited above found that landowner age had a significant negative effect on forest management, particularly on timber harvesting behavior. As suggested by Beach et al. (2005) in their review of empirical economics literature about the forest management behavior of NIPF owners, such a relationship may reflect the landowner's intention to provide standing timber as a bequest to heirs, and this bequest intention may be significant in the productive forest land use of heirs according to their preferences (Amacher et al. 2003).

A moderate negative correlation was found between landowner age and level of formal education ($\rho = -0.550$; $P < 0.01$), a relationship that would indirectly show the key role of the owner's education in forest management. Doolittle and Straka (1987), Straka and Doolittle (1988), Dennis (1990), Löyland et al. (1995), Karppinen (1998), Gunter et al. (2001), and Arano et al. (2004), among others, reported a positive significance of landowner educational level on his/her forestry management goals and decisions. In this sense, younger owners were more likely to have a higher level of education. Thus, all younger owners had formal education, mainly secondary studies (75%), while 63% of middle-aged and older landowners completed primary studies or did not receive formal education ($\chi^2 = 43.792$).

Owner age was strongly and negatively correlated with owner occupation and, more specifically, age was moderately and negatively correlated with the condition of the owner as an active farmer ($\rho = -0.772$ and -0.451, respectively; $P < 0.01$). Significant differences were found for landowner primary occupation and for his/her condition as an active farmer as a function of the AGE group ($\chi^2 = 71.454$ and 25.167, respectively). As expected, retired landowners belonged to the older group (93.2%); farming was the most common professional category among middle-aged owners (50%), while <25% of the younger group had farming as their primary occupation. Taking into account that younger owners were the most active planters but the least active harvesters in Mariña Oriental, it could seem reasonable to assume that owners who did not actively work in their property (absentee owners) would be more likely to invest in their lands in order to keep

them productive, as supported by the findings reported by Gunter et al. (2001) and Marey-Pérez et al. (2004).

Landowner age was barely and positively correlated with the likelihood of requesting public subsidies ($\rho = 0.230$; $P < 0.05$). None of the younger landowners asked for financial assistance to make forest management viable, whereas 21.4% of middle-aged and older landowners asked for economics aids. Instead, the likelihood of asking for subsidies showed significant differences according to the owners' willingness to plant former agricultural lands, i.e., to convert marginal meadows into woodlands ($\chi^2 = 3.095$). In Indiana, Ross-Davis et al. (2005) suggested that a shift in land use (afforestation) was occurring on marginal agrarian lands and that public incentives seemed to encourage such a shift. Over 23.5% of owners who did not ask for subsidies converted marginal meadows into woodlands as a production alternative for their holding, as compared with 55.6% of landowners who applied for public funding. In fact, the investment in annually improving and planting the holding weakly increased with the payment of public subsidies received annually in forestry ($\rho = 0.297$; $P < 0.01$ and 0.246; $P < 0.05$, respectively). Hyberg and Holthausen (1989), Hardie and Parks (1996), Zhang and Flick (2001), and Kline et al. (2002) are some of the authors who demonstrated that forest planting is positively associated with availability of public financial programmes. As detailed in the following sections, we should also point out that: (i) this type of land-use change was more common among retirees, and (ii) the annual amount of payment per public subsidy was higher in landowner groups formed by retired and active farmers.

Usually, absent landowners do not have time to devote to their forestlands because they are completely busy with other labor requirements. Finley (2002) maintains that this situation may be an additional barrier to organizing in professional groups. Contrary to this assumption, the probability that landowners were member of a professional group or cooperative in the region barely declined in relation to landowner age ($\rho = -0.271$; $P < 0.05$). The younger group had the highest share of members of professional groups, tripling the participation index of older owners ($\chi^2 = 6.624$). Considering that the participation in an agroforestry group in the area was mainly associated with agricultural primary occupations, the considerable share of landowners who worked outside their property and were members of professional groups could be linked to their willingness to balance absenteeism by gaining access to accessory information and technical assistance in land management. According to Kittredge (2005), information cooperation grows significantly as NIPF owners become increasingly detached from their land through absentee ownership and a new generation of younger owners with less interest/experience in management emerges.

The moderate negative association found between annual family income per household and owner age ($\rho = -0.416$; $P < 0.01$) might indirectly contradict the argument put forward by certain authors who have considered timber harvesting as a supplementary source of income for the family during economically difficult times. Hyberg and Holthausen (1989), Dennis (1990), and Kuuluvainen and Salo (1991) concluded that landowner income negatively influenced timber harvesting behavior. However, our findings are in agreement with the results reported by Bolkesjø and

Table 2 Mean annual income (€/year) for homogeneous AGE subgroups

AGE		<40 years old	40–65 years old	>65 years old	*P*-value
Percentage of interviewed landowners		4.6	44.2	51.2	
HOUSEHOLD	Retired landowner			11,917.8	1.000
	New landowner	24,378.55	22,617.03		0.897

Baardsen (2002) and Potter-Witter (2005) insofar as no statistical evidence was found between these factors. Table 2 shows that the mean value of the annual income of the household is significantly different among age groups when the owners studied are classified according to age. Particularly, the annual family income of older owners was significantly lower than income of middle-aged owners ($H = 22.474$). Thus, 11.4% of older owners earned more than 18,000 €/year, compared with 60.5% of middle-aged landowners who earned that amount; in contrast, 75% of younger owners received an annual income exceeding the economic threshold mentioned.

The degree of parcellation of productive forestland and owner age were weakly and positively correlated ($\rho = 0.257$; $P < 0.05$). Pairwise comparisons suggested that the degree of parcellation of productive forestlands in the region was significantly different for younger and older owners ($H = 4.575$). The number of plots per unit of productive forestland ranged between 1.52 and 3.4 for all younger owners, whereas 48.3% of middle-aged and older owners managed more than 3.4 plots per unit of productive forestland. Such a result could be probably linked to the agricultural occupation of the owner. As reported by Butler et al. (2004), Marey-Pérez et al. (2006), and Marey-Pérez and Rodríguez-Vicente (2008), the demand for improving and increasing current or former agricultural productivity might be one of the main predictors and reasons for fragmenting/parcelling land. This statement would indirectly explain why the most heavily parcelled productive forest holdings belonged to middle-aged and older owners.

Besides, annual planting and silviculture rates in Mariña Oriental barely decreased with increasing parcellation degree of productive forestland ($\rho = -0.293$ and -0.312, respectively; $P < 0.01$). In addition, the share of woodland harvested annually weakly decreased with increasing number of plots per unit of productive forestland ($\rho = -0.216$; $P < 0.05$). This result might therefore corroborate that larger tracts are more likely to be managed, in agreement with the findings reported by other authors (Doolittle and Straka 1987; Straka and Doolittle 1988; Hyberg and Holthausen 1989; Hardie and Parks 1996; Conway et al. 2003; Potter-Witter 2005; Arano and Munn 2006; Bolkesjø et al. 2007; Størdal et al. 2008).

Level of formal education

The educational level of landowners seemed to statistically influence the planting behavior in the region. The annual rate of planting barely increased with increasing educational level ($\rho = 0.269$; $P < 0.05$). Doolittle and Straka (1987), Straka and Doolittle (1988), Gunter et al. (2001), and Arano et al. (2004), among others,

statistically confirmed this relationship. Educational level is usually interpreted as the owner's ability to manage the existing resources and value them as new opportunities or management challenges, that is, formal education trains and encourages professionalism in certain management skills. In our analysis, landowners with secondary education were the most active planters in the area, with an annual rate of planting significantly different from the rate for uneducated landowners, as shown in Table 3 ($H = 6.685$). According to this table, owners without formal education and owners with secondary education are characterized by clearly different rates of planting. Considering the mean value obtained for this forest practice, these two education-level groups were termed "family planter" and "new planter," respectively. The other groups of owners (primary education and university education) showed an annual rate of planting that could define them as either "family planter" or "new planter." Mean annual expenditures on planting also varied significantly according to the EDUC group; once again, significant differences were between uneducated and secondary-education groups ($H = 4.713$). On average, landowners with secondary education invested annually twice the amount invested by the uneducated group in planting.

The owner profile allowed us to clarify the reason behind this forest management trend in the area. Landowner formal education was moderately and negatively correlated with age, as suggested in the above section ($\rho = -0.550$; $P < 0.01$). As described in Table 3, the tertiary-education group included significantly younger landowners as compared with owners who were uneducated or had completed primary education; furthermore, the mean landowner age for uneducated and primary-education groups differed significantly ($H = 26.173$). Considering the importance of the owner age in his/her educational level and labor situation, we

Table 3 Mean annual rates of planting (%), owner age (year), family income (€/year), and size of productive forest holding (ha) for homogeneous EDUC subgroups

EDUC		No education	Primary education	Secondary education	Tertiary education	*P*-value
Percentage of interviewed landowners		37.2	47.7	9.3	5.8	
PLANT	Family planter	0.69	1.76		1.54	0.765
	New planter		1.76	4.17	1.54	0.088
AGE	New forester			51.00	48.00	0.931
	Farmer		62.24	51.00		0.116
	Retiree	72.66	62.24			0.163
HOUSEHOLD	Farmer traditionalist	13,137.75	18,935.55	18,875.54		0.535
	New professional		18,935.55	18,875.54	26,714.99	0.270
SIZE	Small landowner	3.26	5.15	6.68		0.150
	Large landowner		5.15	6.68	8.14	0.248

additionally verified that the owner's level of formal education and his/her primary occupation were positively correlated ($D = 0.406$). All owners with tertiary education and half of the owners with secondary education were active workers not linked to agriculture, while 75% and 43.9% of owners who were uneducated or had completed primary education, respectively, were retired farmers; the largest share of active farmers, over 30%, was found in primary-education and secondary-education groups ($\chi^2 = 39.148$).

Landowner level of formal education was also positively correlated with training in forestry, and particularly with the knowledge of timber market conditions ($D = 0.145$ and 0.188, respectively). Of landowners with secondary education 37.5% were trained in forestry, as compared with 5.2% of landowners who were uneducated or had completed primary education; none of the owners with tertiary education was trained in forestry ($\chi^2 = 10.780$). With regard to the availability of timber market information, primary-education and secondary-education groups included the largest share of landowners with this type of knowledge, near 81%; 56.6% of uneducated owners and owners with tertiary education had information related to timber market. Furthermore, none of the owners with tertiary education had the machinery necessary to carry out forest activities; the best equipped holdings were managed by uneducated owners and owners with primary education, 75.6% and 87.5% of whom, respectively, owned some type of machinery ($\chi^2 = 14.839$). As pointed out in the sections below, engagement in farming could be the reason why owners who had primary or secondary formal education were trained in forestry and had timber market knowledge and logistic resources.

As suggested above, a better level of education would generally improve prospects and success in the labor market. The annual income per family unit weakly increased with the landowner's level of education ($\rho = 0.336$; $P < 0.01$). Significant differences were found between uneducated and tertiary-education groups, with a mean difference in income of more than 13,550 €/year ($H = 10.396$), as shown in Table 3. The positive significant correlations found between landowner's educational level and annual family income or annual rate of planting could indirectly support the findings of many authors who have suggested that high plantation investments are made by landowners with greater household incomes (Doolittle and Straka 1987; Straka and Doolittle 1988; Hardie and Parks 1996; Gunter et al. 2001; Mahapatra and Mitchell 2001; Arano et al. 2004). For example, Beach et al. (2005) mentioned that landowner income may be normally used as a measure of their available resources for forest investment and, hence, better income may imply better access to the capital necessary for planting. However, annual income per family unit was not a significant factor in planting in the region, which is in agreement with Zhang and Flick (2001). We could only verify that the annual expenditure on forest planting increased slightly in relation to annual household income ($\rho = 0.220$; $P < 0.05$), and that there were significant differences in annual household income between the owners who did not invest in planting and the owners who spent between 127.0 and 250.0 €/ha annually ($H = 9.038$).

As described by Dewees (1992), Kurttila et al. (2001), and Marey-Pérez et al. (2004), while some owners would be less dependent on forestry because of the increased proportion of other incomes, farmers as land managers would clearly

seem to be more dependent on forestry as a source of revenue because of a reduced development of the agricultural income. This fact would explain why the annual fraction of forest reinvestments, i.e., the annual rate of forest products that are used within the family unit for self-consumption, increased weakly with the landowner's level of education in the study area ($\rho = -0.215$; $P < 0.05$). The owners with primary and secondary education, which were the groups with the largest share of active farmers, actively benefited from forests for self-consumption, with reinvestments averaging 60.4 €/ha per year. Uneducated landowners, mainly retired farmers, had a mean forest reinvestment valued at 90.5 €/ha per year; this mean value was four times the mean fraction for the tertiary-education group, composed of professionals outside agriculture, in which over two-thirds of them did not exploit forest for self-consumption.

The size of productive forestland and the landowner's level of formal education were barely and positively correlated ($\rho = 0.294$; $P < 0.01$), while the degree of parcellation of the productive forestland was barely and negatively correlated with the educational level ($\rho = -0.236$; $P < 0.05$). Table 3 shows that the mean values of the area of productive forestland in ownership were significantly different between educational groups. The productive forest holdings of uneducated owners were significantly smaller than the holdings belonging to owners with primary education ($H = 7.721$). As regards the number of plots per unit of productive forestland, the largest rate of forest parcellation was observed in uneducated and secondary-education groups, where 26.6% of landowners managed more than 5.29 plots per hectare of productive forestland. As expected, 40% of landowners with tertiary education had <1.52 productive forest plots per hectare. Based on the characterization of landowner's main occupation according to his/her level of formal education, we could verify that there might be a close link between land parcellation and farming activity.

Primary occupation

Karppinen (1998) affirmed that the most significant characteristic of the structural change among NIPF owners was the transfer of forest ownership from farmers to nonfarmers through inheritance, which should be reflected in forestry practices. As a measure of professional occupation, Gunter et al. (2001), Arano et al. (2004), and Potter-Witter (2005) confirmed that the place of residence of the landowner was significantly related to the planting decision. In the region, annual rates of silviculture and timber harvesting showed significant mean differences according to the owner's occupation. As detailed in Table 4, entrepreneurs were the most active silviculturists in the area, differing significantly from the remaining groups, excluding self-employees ($H = 5.155$). Significant differences were found between the mean rates of timber harvesting for retirees and self-employees ($H = 3.053$); retirees annually harvested seven times more woodland than self-employees, who showed the lowest annual rate of timber harvesting in the region. Authors such as Kuuluvainen and Salo (1991) and Kuuluvainen et al. (1996) found a negative statistical association between the intensity of timber harvesting and the landowner's professional occupation. In Central Virginia, Conway et al. (2003) tested that absentee landowners, whose

Table 4 Mean annual rates of silviculture (%) and owner age (years) for homogeneous OCCUP subgroups

OCCUP		Retiree	Farmer	Hired worker	Self-employee	Entrepreneur	Other	*P*-value
Percentage of interviewed landowners		51.2	24.4	9.3	3.5	4.6	7.0	
TREAT	Nonsilviculturist	0.66	1.01	0.65	0.53		0.90	1.000
	Silviculturist					6.29		1.000
AGE	Active		54.90	48.67	50.88	55.25	53.33	0.763
	Retiree	74.50						1.000

residences were located at least 50 miles from their properties, were less likely to harvest.

The strong and negative relationship between landowner age and his/her professional category ($\rho = -0.772$; $P < 0.01$), and the positive relationship between primary occupational and level of formal education ($D = 0.406$) allowed us to characterize landowners who annually carried out considerable forest improvement and timber harvesting in Mariña Oriental. Table 4 shows the means for the owner age that showed significant differences for the study population when such a population was classified according to professional occupation. Particularly, retired farmers were significantly older than the landowners in the other groups, excluding self-employees ($H = 58.282$). In relation to landowner education level, over 55% of retired farmers did not have formal studies, as compared with 37.5% and 31.3% of active farmers and entrepreneurs, respectively, who had tertiary education ($\chi^2 = 39.148$). Based on the landowner profile described here, it would not be surprising that annual income per family unit was slightly and positively correlated with landowner's primary occupation ($\rho = 0.379$; $P < 0.01$). Retired farmers annually received a household income that was significantly lower than the family income of active farmers, with a mean difference of almost 11,500 €/year ($H = 21.396$).

Engagement in farming might probably account for the significant differences observed in the level of membership of professional groups and in the availability of machinery according to the OCCUP group ($\chi^2 = 24.687$ and 12.935, respectively). Of retired and active farmers 49.5% were members of a professional organization, while 29.2% of hired workers and self-employees and none of the entrepreneurs and other professionals was associated. According to these results, the condition of the landowner as an absentee did not seem to be an added barrier to organizing professional groups, contrary to Finley's (2002) report. The best equipped landowners were active farmers and self-employees, 95.3% of whom owned some kind of agroforestry machinery; logistic resources were available for almost two-thirds of retirees and hired workers. Accordingly, the annual rate of silviculture seemed to be weakly and positively correlated with machinery availability ($\rho = 0.373$; $P < 0.01$), and the family labor-force devoted annually to the holding was based on accessibility to this resource ($\chi^2 = 11.158$). Some of the machinery

available, such as chain-saws, pruning-saws or hand-weeders, could be used for forest improvement activities by family labor.

Therefore, the annual amounts of personal and family labor spent within the holding were interrelated ($\chi^2 = 101.468$). The landowners who devoted between 11 and 100 personal labor-days per year to forestry annually benefited from a family labor-force ranging from 11 to 50 labor-days for forestry, while owners who annually spent <5 personal labor-days on the holding received <10 family labor-days per year. In addition, professional assistance in forestry proved an important factor in keeping and making forestry viable in the area, as suggested by other studies about NIPF management (Löyland et al. 1995; Hardie and Parks 1996; Zhang and Flick 2001; Zhang and Mehmood 2001). Thus, the annual amount of professional labor-force on the holding differed significantly according to landowner primary occupation ($\chi^2 = 36.601$). In fact, the annual rates of planted and improved forestlands increased moderately with the number of professional labor-days annually hired in forestry ($\rho = 0.408$; $P < 0.01$ and 0.251; $P < 0.05$, respectively). More specifically, 67% of retired and active farmers hired professional labor amounting to <5 days per year, in comparison with 44.5% of the other owner groups, who annually hired professional labor amounting to 51–100 labor-days. These results could clarify the noticeable commitment of professionals outside agriculture to forest improvements, who seemed to hire technical guidance to compensate for their absenteeism in forestry.

The land acquisition pattern varied significantly based on the main occupation of owners ($\chi^2 = 22.191$). Retired farmers represented a specific group, with holdings that were mainly acquired by purchasing or inheriting. In brief, retired farmers would be more likely to make land transactions, probably to improve and increase their former agricultural productivity, and hence show a more significant land mobility (Marey-Pérez et al. 2004). Thus, whereas 59.1% of retirees managed inherited and purchased lands, purchase was the sole pattern of land acquisition for 22.9% of hired workers and self-employees; inherited and purchased lands were combined in 25.8% of the remaining occupational groups. This orientation towards farming could again clarify the significant differences found in the annual rate of forest reinvestment between retired or active farmers and self-employees or entrepreneurs ($H = 15.833$). Over 70.5% of retired and active farmers took advantage of forest reinvestments between 71 and 233.7 €/ha per year, whereas 66.7% of self-employees owners and none of the entrepreneurs obtained forest products for self-consumption.

Annual expenditure on forest plantation and landowner's professional category were weakly and positively correlated ($\rho = 0.235$; $P < 0.05$). None of the active farmers allocated more than 250 €/ha per year on planting forestlands, probably associated with a greater likelihood of managing agricultural land, but large expenditures were exclusively incurred by retired farmers or professionals unrelated to agriculture. Thus, self-employees and entrepreneurs annually invested in planting the highest amounts in the region, over 355 €/ha per year. This annual amount exceeded the mean expenditure on planting by retired and active farmers, almost 165 €/ha per year. In keeping with previous studies (Karppinen 1998; Gunter et al. 2001; Marey-Pérez et al. 2004), the owners that were more likely to invest in lands

to keep them productive seemed to be the owners outside agriculture who worked part-time at their property, and also retired and older landowners.

The key role of public subsidies in forest involvement in Mariña Oriental was again evidenced by the large share of owners who were financially compensated by means of public funding in forestry. Thus, the annual amount of public subsidies and the landowner's professional occupation were barely and negatively correlated ($\rho = -0.236$; $P < 0.05$). None of the landowners unrelated to agriculture, that is, hired workers, self-employees, entrepreneurs, and other professionals, received public financial aid for forestry. On the contrary, the greatest beneficiaries of this type of measure were farmers; 76.9% of retired owners and all of the active farmers who asked for public incentives for forestry finally received the subsidies, with a mean payment of 54.7 €/ha per year. The degree of parcellation of productive forestland and the landowner's occupational group were barely and negatively correlated ($\rho = -0.265$; $P < 0.05$), which confirms that agricultural productivity could be an important factor in land parcellation in the study area. The largest number of plots per unit of productive forestland corresponded to retired and active farmers, with an average of 3.5 plots per hectare of productive forestland. Conversely, hired workers and entrepreneurs managed the least parcelled holdings, with over 2.4 plots per unit of productive forestland.

Condition as an active farmer

Literature concerned with the land management behavior of NIPF owners suggests that farmers, as land managers, are distinct from other landowners in terms of their commitment to and involvement in forestry. Thus, Hardie and Parks (1996) found that the level of planting was negatively associated with the landowner's condition as a farmer. However, Hyberg and Holthausen (1989) observed that the choice of timber harvesting was positively related to the landowner's profile as a farmer. Similarly, Kuuluvainen and Salo (1991) reported that farmers were characterized by significantly lower harvest volumes than other types of NIPF owners. In Mariña Oriental, only a weak positive correlation was found between the annual rate of silviculture and the landowner's condition as an active farmer ($\rho = 0.212$; $P < 0.05$). The fact that active farmers were slightly more active with regard to silviculture could be explained by considering that these landowners were occupied in agriculture full-time ($H = 3.829$). In agreement with Löyland et al. (1995), landowner's occupation outside his/her property may mean having less time available for working the land, and therefore the landowner is less likely to carry out forest practices him/herself. Because of their close association with the land, farmers would actively manage their property themselves and, particularly, they would generally have more time for forest management (Zhang and Mehmood 2001; Lindroos et al. 2005).

The moderate and negative relationship between landowner age and his/her condition as an active farmer ($\rho = -0.451$; $P < 0.01$), and the small and positive relationship between the annual family income and the owner's occupational profile ($\rho = 0.343$; $P < 0.01$) allowed us to characterize active farmers in the area. Post hoc analyses revealed that the mean age of active farmers was significantly

lower than the mean age of nonfarmers, with a difference of almost 15 years ($H = 17.297$). With regard to the landowner's household income, active farmers annually received an average family income of 23,855 €, exceeding by more than 8,800 € the income of the remainder ($H = 10.023$). Such distributions would be probably associated with the inclusion of all the retirees in the nonfarmer group (which accounts for 51.2% of the whole study population in Mariña Oriental), which would increase owner age and decrease the landowner's mean earning per family unit in this group.

As suggested in preceding sections, the professional associations in the area could be mainly agricultural groups, especially cooperatives or trade unions. The equipment available on the majority of holdings could be a proof of the nature of the associations. The assumptions were confirmed by the positive correlations observed between these two factors and the owner's condition as an active farmer ($D = 0.508$ and 0.312, respectively). Only 20% of nonfarmers were members of a professional organization, as compared with 76.2% of active farmers ($\chi^2 = 22.422$). With regard to the availability of agroforestry machinery, active farmers were characterized by a large personal labor-force annually devoted to forest management, which would explain why 90.5% of them had equipment on their holding, as compared with 55.4% of the other landowners ($\chi^2 = 8.478$). In fact, the agricultural link might also explain the low increase in the annual amount of forest reinvestments when the landowner was actively related to agriculture ($\rho = 0.304$; $P < 0.01$). The active farmers annually took advantage of forest reinvestments twice as often as the nonfarmer group ($H = 7.840$).

Moreover, the profile of owners as active farmers and their production requirements and goals for land management would explain why such landowners could consider the option of using part of their forestlands for agricultural production. Consequently, significant differences in the likelihood of converting forestlands into meadows according to the FARM group were tested ($\chi^2 = 6.338$). As expected, none of the nonfarmers adopted this productive orientation for their holding, and only 9.5% of active farmers considered such an option. Furthermore, we could verify that professional engagement in agriculture and the pattern of land transmission were negatively correlated, for the reasons already explained ($D = -0.255$). Of the nonfarmer group 53.8% were characterized by managing inherited and purchased lands, as compared with 19% of active farmers; for each nonfarmer who owned a fully inherited landholding, there were almost two active farmers who owned this type of holding ($\chi^2 = 7.769$). Patterns of land acquisition and future transmission may be important indicators of NIPF owner land decisions; thus, Hardie and Parks (1996) and Ross-Davis et al. (2005) showed that maintaining the viability of the property by land management by future landowners through inheritance may be a key in securing continuity of the forestry sector.

The following results verified this hypothesis about land capitalization for the study area: first, the pattern of land acquisition in the region significantly influenced the annual rate of planting forestlands ($H = 5.973$), and second, annual expenditure in planting weakly increased in forest holdings that combined inherited and purchased lands ($\rho = 0.224$; $P < 0.05$). Landowners whose holdings combined inherited and purchased lands, which was a group largely represented by retirees,

annually planted over seven times more forestland than owners whose holdings were acquired solely through purchasing, and almost twice the forestland planted by owners whose holdings were acquired solely through inheritance. In addition, owners with inherited and purchased lands annually spent almost ten times more in planting than the others ($H = 6.732$).

A negative association was found between the conversion of marginal meadows into woodlands and the condition of the landowner as an active farmer ($D = -0.233$). The farming group hardly considered such a shift in land use for their holding (9.5%), as compared with 33.8% of nonfarmers who put it into practice in order to keep their land productive ($\chi^2 = 4.667$). Therefore, land capitalization might largely respond to the owner's willingness to improve land productivity and to ensure a complementary source of household income by means of forest investment. Landowners who implemented such a land-use change declared having done so as a way of ceasing farming (67%) and because of the higher profitability of forestry (21%). These findings would support the statement by Beach et al. (2005) that the increase in forest income with respect to agricultural income may tend to increase forest management.

Membership of agricultural and forestry groups

Landowners who are members of cooperative organizations share information, techniques, experiences, and advice with one another (Kittredge 2005; Van Gossum and De Maeyer 2007). The most representative model of professional associations in the study area was a private professional group partially supported by public funds. Participating as a member in this type of landowner organization appeared to be a significant determinant in the annual planting and silviculture management behaviors in Mariña Oriental ($H = 3.648$ and 3.376, respectively). The associated landowners were slightly more active with regard to planting and silviculture than the nonassociated group. The biggest impact on uptake of planting by the segment of landowners who were members of an organization was also tested by Doolittle and Straka (1987), Straka and Doolittle (1988), and Mahapatra and Mitchell (2001). Such active forest management behavior of associated landowners could be due to the fact that professional groups offer information sources and technical advice for members. However, we were unable to associate this finding with the access of landowners to professional services from agricultural and forestry groups, as Mahapatra and Mitchell (2001), Kittredge (2005) or Van Gossum et al. (2005) suggested.

The important role of professional groups in planting and silviculture management would seem to be related to the owner's engagement in farming. As cited above, the level of participation in a professional body was positively correlated with the landowner's occupation in agriculture ($D = 0.508$). Only 8.8% of nonassociated owners were active farmers, as opposed to almost 55.2% of associated owners ($\chi^2 = 22.422$). More specifically, 59.6% of nonassociated owners were retired farmers, as compared with more than 34.5% of associated owners ($\chi^2 = 24.687$). This result could explain why participation in such groups was weakly and negatively correlated with owner age ($\rho = -0.271$; $P < 0.05$), but weakly and

positively correlated with annual family income ($\rho = 0.259$; $P < 0.05$). Associated owners were almost 10 years younger than nonassociated owners ($H = 6.249$). With regard to the annual household income, associated owners earned almost 7,000 €/year more than nonassociated owners ($H = 5.691$).

The owner profile, and particularly his/her occupation as an active farmer, could justify that the level of participation in professional groups and the availability of equipment on the holding were positively correlated ($D = 0.433$). There were two associated owners for every nonassociated owner who had suitable agroforestry machinery to support land management ($\chi^2 = 16.128$). Technology users would seem to be more likely to participate in social groups and to share experience, which verifies the findings reported by Hodges and Cubbage (1990). Taking into consideration the statistical relationship between the availability of machinery and the annual rate of silviculture, and the significant differences in this forest practice depending on the landowner's level of participation in professional groups, it would not be surprising to find that associated owners were more interested in changing their current productive forest species in the short/mid-term. Thus, the intention of replacing the current productive forest species in the future increased with the level of participation of landowners in professional groups ($D = 0.207$). The number of associated owners who intended to change the main productive forest species in the near future was matched by the number of nonassociated owners, possibly due to the larger labor-force devoted to silviculture ($\chi^2 = 3.902$). This statement was supported by the finding that 80% of owners intended to replace the current productive forest species with *Eucalyptus globulus* Labill. The weak positive correlations found between this future land-use intention and the annual rate of and expenditure on silviculture confirmed this hypothesis ($\rho = 0.238$ and 0.216, respectively; $P < 0.05$). Landowners who intended to replace the main productive forest species annually treated four times more forestland ($H = 4.809$), and invested in silviculture almost twice as much as those who did not ($H = 3.833$), hence their interest in eucalyptus, a fast-growing forest species that is highly productive and easy to manage.

Other future intentions, such as increasing woodlands on the holding, increased with the participation of landowners in professional groups ($D = 0.211$). Over 58% of associated owners mentioned their intention of increasing their productive forestlands in the near future, as compared with 37% of nonassociated owners ($\chi^2 = 3.697$). The major reason for this behavior could be attributed to previous harvests and timber sales, that is, to the interest in timber production. In fact, the annual rate of harvesting woodlands in the region increased strongly in proportion to annual income from timber sales and stumpage price per unit ($\rho = 0.809$ and 0.781, respectively; $P < 0.01$). Kuuluvainen and Salo (1991), Bolkesjø and Baardsen (2002), and Bolkesjø et al. (2007) statistically proved that timber price (roundwood, pulpwood or sawtimber) positively affects harvest choice and intensity or volume, and timber supply. The future intention of enlarging woodlands weakly increased with the annual rate of timber harvesting ($\rho = 0.242$; $P < 0.05$). Landowners who had the intention of enlarging woodlands harvested annually twice as much woodland as the remaining owner population ($H = 4.972$), with an annual timber income of 100 €/ha more ($H = 3.118$) at almost twice the stumpage price per unit

($H = 3.104$). On average, associated landowners annually benefited from a 1.5 times higher timber income, with a stumpage price per unit 0.61 €/T higher than the price for the nonassociated group. In addition to the purpose of changing the current productive forest species, the future increase in woodlands seemed to correspond to landowners with an extensive surface area. In keeping with Hodges and Cubbage (1990) and Van Gossum et al. (2005), we observed that the productive forest holdings managed by owners who were members of a professional group were somewhat larger than the holdings of owners uninterested in participating in such groups. As mean values, associated owners had almost 1 ha more than the nonassociated group ($H = 3.768$).

Table 5 shows the results of the logistic regression model for estimating landowner membership of agricultural and forestry associations. At 1% statistical significance, the fitted model correctly predicted 77.9% of the overall observations. The binary variables FARM and MACHINERY, represented as the status of the owner as an active farmer and his/her availability of agroforestry machinery within the holding, respectively, and the binary variable IFOREST, represented as the owner's intention of enlarging the productive forestland in the short/mid-term, proved to have a significant positive effect on explaining the landowners' condition as a member of a professional group in the study region, as previously suggested and analyzed:

$$P(\text{ASSOC}) = \frac{1}{1 + e^{(-3.873 + 1.425\text{IFOREST} + 2.380\text{MACHINERY} + 2.460\text{FARM})}}$$

These results show that active farmers were almost 12 times more likely to be included in an agroforestry association than were retired farmers or other professionals not related to agriculture. Those landowners who had agroforestry machinery within their holding as support to land management were almost 11 times more likely to partake in an association related to the sector than landowners without any type of logistic resources. Finally, those owners who had the future aim

Table 5 Parameter estimates of the logistic regression model that examines the factors affecting NIPF landowner membership of agroforestry associations

Variable	Coefficient	Wald	*P*-value	Standard error
FARM	2.460	12.661	0.000	0.691
MACHINERY	2.380	7.750	0.005	0.855
IFOREST	1.425	5.167	0.023	0.627
Constant	−3.873	17.012	0.000	0.939
−2 Log likelihood	71.637			
Model $\chi 2$	38.300*			
Nagelkerke R^2	0.498			
Obs. with ASSOC = 1	51.7			
Obs. with ASSOC = 0	91.2			
Overall % correct	77.9			

* $P \leq 0.01$

of increasing the productive forestland base were four times more likely to be members of a professionals group than landowners who tried to keep their territorial system stable.

Specific knowledge about forestry: availability of market information

Zhang and Mehmood (2001) stated that NIPF owners are nowadays characterized by increasing information and education. Gunter et al. (2001) and Arano et al. (2004) are some of the authors who have statistically confirmed that information sources (books, bulletins or the media, among others) and attendance to educational programs, respectively, affect forest decision-making and management level. In the study area, only the annual rate of harvesting woodlands increased barely with landowner timber market knowledge ($\rho = 0.274$; $P < 0.05$). The annual rate of timber harvesting for the group of owners who had market information was twice the rate for the remaining landowners ($H = 6.391$). Actually, the stumpage price per unit from previous harvests weakly rose when the owner had information on the timber market ($\rho = 0.282$; $P < 0.05$). Owners with this type of knowledge sold timber at 2 €/T more than owners who did not have timber market information ($H = 6.442$).

As expected, the likelihood of having knowledge about timber market conditions and training in forestry were positively correlated ($D = 0.184$). All trained owners knew about timber market conditions, as compared with 63.3% of untrained owners ($\chi^2 = 3.877$). As suggested earlier, knowledge of forestry would correspond mainly to owners engaged in farming; 57.1% and 28.6% of trained landowners were retired and active farmers, respectively, and were usually characterized by a low level of formal education. Moreover, the landowners' knowledge of forestry and the availability of timber market information were positively associated with the level of formal education ($D = 0.145$ and 0.188, respectively). All trained owners completed, at least, primary studies, an educational level that 39% of untrained owners did not complete ($\chi^2 = 10.780$); all the landowners with tertiary education belonged to the untrained group, and there were seven trained owners for every untrained owner who had secondary education.

As previously mentioned, the farmers surveyed generally managed their lands themselves and had more experience and better knowledge about forest management than did other landowners. This could explain why owners who were better trained in forestry were statistically more likely to spend more personal time on the holding annually ($D = 0.209$). All owners with forest training worked annually more than 50 personal labor-days on the holding, and 14.3% of them exceeded 100 labor-days per year; in contrast, 58.3% of untrained owners spent <50 personal labor-days per year on forestry ($\chi^2 = 10.113$). Spending more time working on the property could effectively result in better forestry training, which would qualify landowners for managing lands and taking a more active role in forestry. This pattern of personal forest management would also clarify why agroforestry machinery was a more common resource on holdings managed by owners who were better trained in forestry ($D = 0.192$). All trained owners were equipped with suitable machinery to work on their property, as compared with 60.8% of owners

who were not trained in forestry ($\chi^2 = 4.295$). These results would confirm that active and retired farmers were better trained in forestry.

Considering the profile of the owner, and according to the above results, it was not surprising that the likelihood of managing inherited and purchased lands was positively correlated with training in forestry and availability of timber market information ($D = 0.195$ and 0.169, respectively). Almost 54.4% of untrained owners had holdings acquired by inheritance, whereas more than 71.4% of trained owners managed inherited and purchased lands ($\chi^2 = 5.715$). Moreover, all trained owners intended to pass their holding on to their heirs, regardless of profitability, while 9% of the untrained group expected to sell it in the near future ($\chi^2 = 5.011$). Land transfer governed by emotional values (i.e., bequeathing) could be a good reason to care for the holding and pass it on to future generations, which would explain why landowners in the region continued to work their land in spite of not receiving regular income from it. Thus, the ownership of the forests may be more important as symbolic capital than as a source of income (Niskanen et al. 2007). In fact, significant differences were found between the personal labor-force used annually for forestry and the future plans for the property ($\chi^2 = 18.287$). All landowners who intended to pass some part of their land on to their heirs spent more than 10 labor-days per year on their holding, and more specifically, half of them worked more than 100 labor-days per year; on the contrary, 67% of owners who intended to sell all their lands devoted <2 labor-days per year to forestry. As suggested by Karppinen (1998), Hugosson and Ingemarson (2004), and Ingemarson et al. (2006), NIPF owners can have many different goals and motivations that affect their forest practices in different ways and, in this sense, bequeathing might be a significant motivation for securing the continuity of forest management, according to the future heirs' preferences (Amacher et al. 2003).

Knowledge and use of production criteria for timber harvesting

In a review of economic models for timber supply, Wear and Parks (1994) concluded that the manager's optimum harvest age depended on current and expected market conditions. Thus, the owner can decide whether or not to harvest timber commercially based on market perspectives. In Mariña Oriental, the annual rate of timber harvesting slightly increased when the landowner understood and carried out forest rotation at the appropriate age ($\rho = 0.347$; $P < 0.01$). Moreover, the mean annual rate of timber harvesting varied significantly depending on the owner's knowledge and use of production criteria ($H = 10.909$). Post hoc analyses showed that owners who knew and applied the suitable rotation age in timber harvesting were the most active harvesters in the region, even though significant differences were statistically observed between the two remaining groups of owners (T_{E1} and T_{E2} groups). Table 6 shows that the mean values of the annual rate of harvesting significantly differed among the owners studied when they were classified according to their knowledge and use of forest requirements. These results allowed us to identify two landowner subgroups, where particularly nonharvesters might not apply the suitable rotation age for their productive forest species, in spite of understanding productive forest criteria.

Table 6 Mean annual rates of harvesting (%), family income (€/year), and stumpage price per unit (€/T) from timber sales for homogeneous TECHNIC subgroups

TECHNIC		No knowledge–no application	Knowledge–possible application	Knowledge–application	*P*-value
Percentage of interviewed landowners		8.1	81.4	10.5	
HARV	Nonharvester	0.00	3.07		0.416
	Harvester			9.84	1.000
TINCOME	Non-wood seller	0.00	178.28		0.072
	Wood seller		178.28	210.70	0.913
TPRICE	Non-timber industrialist	0.00	4.00		0.054
	Timber industrialist		4.00	6.95	0.199

Forest management practices that consider the suitable rotation age for the productive forest species generate high-quality timber products and, as a result, timber is of higher value. The timber selling price fixed from previous harvests weakly increased when the landowner had knowledge of and applied the optimum rotation age ($\rho = 0.337$; $P < 0.01$). As Table 6 shows, owners who did not know and did not apply productive forest criteria sold timber at a significantly lower stumpage price per unit than the rest ($H = 9.941$); 44.4% of landowners who knew and applied the suitable rotation age in timber harvesting fixed a timber selling price higher than 48.9 €/T, as compared with 13.6% of the owners who knew these forest requirements but did not apply them in previous harvests. More than 30% of these owners harvested below/above the rotation age of their productive forest species, because they imitated the harvesting pattern of adjoining landowners (20%) or because they wanted to improve their family economy (12%). As expected, annual timber income barely increased when the landowner took into account these production requirements ($\rho = 0.265$; $P < 0.05$). As Table 6 also shows, owners who did not know and did not apply productive forest requirements stood out with a significantly lower annual timber income than the remaining population ($H = 7.946$).

In the profile of the owner who knew and used the suitable rotation forest age, we observed that almost 60% of owners who had knowledge of the suitable rotation age (T_{E2} and T_{E3} groups) were retired farmers, as compared with owners who lacked this technical requirement (T_{E1} group), who were mainly active farmers and professionals outside agriculture (42.9% and 28.5%, respectively). The relationship of the landowner with agriculture would explain why the pattern of land acquisition significantly varied according to the TECHNIC group ($\chi^2 = 10.352$). More than 88% of owners who knew and applied productive forest requirements in previous harvests mainly managed inherited and purchased lands, as compared with half of the other landowners, who owned holdings acquired solely through inheritance. As already explained, improving and increasing agricultural productivity could make the increase of land mobility among retired farmers possible (Marey-Pérez et al. 2004). Former engagement in agriculture would also explain the significant differences found for the rate of conversion from forestland into meadow, and the opposite land-use change from marginal meadow into woodland, as a function of

the knowledge and application of production requirements in timber harvesting. None of the owners who knew and applied the suitable rotation age converted forestlands into meadows, while 7.9% of the remaining landowners considered agricultural production in their forestlands ($\chi^2 = 4.870$). Conversely, none of the owners who did not know or apply technical requirements in timber harvesting considered changing marginal meadows into woodlands, as opposed to 22% of the rest of owner groups who decided to invest in forestry ($\chi^2 = 4.824$). This finding would support that both retired farmers and professionals not linked to farming were initiating forestry over marginal lands as an asset.

Conclusions and implications

Individual forest decision-making and management are complex processes that result from the personal landowner's goals and interests with regard to his/her land property. In turn, the goals and interests of NIPF owners are dependent on social, cultural, economic, political, and environmental factors. As a previous step to promoting supporting policies and tools for NIPF land management, the present study examined individual forest management by empirical analysis of the role and importance of characteristics of the landowner profile. Among the factors affecting individual forest management are the family unit, the territorial system, and the forest economy, in addition to the preferences and circumstances of the managers. Within this analysis framework, our study was based on land management data for 1999–2003 obtained from a personal questionnaire completed in 2004 by 103 resident NIPF owners, each of them responsible for more than 1 ha of productive forestland in Mariña Oriental region, located in Northern Galicia, Northern Spain.

The results suggested that:

(i) The owner's level of formal education and his/her membership of professional groups were associated with forest planting. Landowners who completed intermediate studies and those who were members of professional groups were the most active planters in the region. This NIPF owner profile corresponded to a middle-aged owner with a high family income, who did not earn his/her living from agriculture and who managed a large productive forest holding.

(ii) The landowner's primary occupation, specifically his/her condition as an active farmer, and membership of professional groups were related to stand improvement treatments. Active workers not related to farming stood out by being more likely to invest in silviculture by hiring professional assistance. However, it was necessary to distinguish a group of planters and silviculturists who were clearly different from this profile. Such owners were retired and active farmers who invested significant amounts in planting and silviculture, respectively. In this case, forest training, membership of professional groups, and machinery availability noticeably supported forest management based on personal and family labor-force.

(iii) The principal occupation of the owner was linked to timber harvesting, as well as his/her age, the availability of information about timber market conditions, and knowledge and use of productive forest criteria from previous harvests. The most dynamic harvesters obtained a higher income from their forests at a better stumpage price per unit. These owners were mainly profiled as middle-aged owners, professionals outside agriculture or active farmers, and those who usually had information related to timber market conditions and experience in forest production criteria.

From among the landowner characteristics analyzed in this study as binary responses, only the participation of owners in agricultural and forestry associations could be modeled in relation to other sociodemographic and territorial attributes. The logistic regression model for landowner membership of professional groups, a condition associated with the annual planting and silviculture practices in the area, suggested that landowner membership of professional groups was significantly and positively influenced by aspects related to farming activity (owner's status as an active farmer and his/her availability of agroforestry machinery on the holding). However, the owners' future intention of enlarging the productive forestland in the short/mid-term was also found to be important.

In conclusion, a solid agricultural tradition seems to result in a distinct land user and manager, a farmer or a descendant of farmer who is familiar with forests. Such a NIPF owner profile would be characterized by a close relationship with working the land, which is associated with the physical proximity of the landowner to his/her forest holding, but a lack of professionalism in forest matters. Forestry, as a land practice clearly differentiated from other land uses, seems to be in an initial state of implementation within rural economies, sharing many objectives and management practices with agriculture, but not at the same level in economic and training terms. Moreover, forestry is not widely adopted as a primary occupation. Consequently, forestlands are an important part of the surface area of a landowner's rural holding and are usually considered as a possible investment for complementing family income and contributing to land capitalization. As a result, the interest of NIPF owners in forestry cannot be expressed in explicit economic terms (forestland as a means of generating income from timber production) or in sociological terms (land as capital to bequeath to future generations), but rather as a combination of both land management behaviors.

Our findings can be used as a guide for the design, planning, and implementation of research and policy measures that allow NIPF owners to promote forestry for rural development according to two main profiles, forest farmers and nonfarming foresters, with clearly different goals and prospects for the land. Based on this assumption, public tools and programmes focused exclusively on forestry and applied separately from other land-use alternatives in an agricultural region would partially encourage land capitalization and management by means of forest production. Such tools and programmes would not improve sustainable rural development or land planning. Rather, they would further unbalance the agroforestry land-base and social structure. In brief, suitable research and policy measures must focus on rural development and welfare, supporting an entrepreneurial attitude

among individual private landowners and managers, such that the productivity of their holdings is improved and the economic viability of rural areas is promoted. Hence, an interesting direction for future research involves examining the role of efficient forest management in ensuring the future prosperity of rural areas. Such an analysis would imply identifying the key determinants of forest management by characterizing landowners, their holdings and the market or policy framework. According to such an analysis, measures could better represent the landowners' socioeconomic perceptions and values, trying to develop sustainable forestry and farming in the same individual economy, and with rural planning as a key framework.

Appendix

See Table 7.

Table 7 Definition of the study variables for statistical analyses

Variable	Code	Definition	No. of interviewed NIPF owners
Landowner forest management practices			
PLANT Continuous	–	Forest planting, measured as the proportion of area planted annually in the entire forest area ($x = 1.57\%$; $\sigma = 2.66\%$)	103
TREAT Continuous	–	Stand improvement treatments, measured as the proportion of the area in which silvicultural treatments are carried out annually within the entire forest area ($x = 1.02\%$; $\sigma = 2.93\%$). This includes activities such as the use of fertilizers, application of insecticides, pesticides or herbicides, thinning of competing vegetation, and other treatments to improve stands	103
HARV Continuous	–	Timber harvesting, measured as the proportion of the area harvested annually in the entire wooded forest area ($x = 3.53\%$; $\sigma = 6.12\%$)	103
Landowner profile			
AGE		Age of the owner, in years ($x = 64.24$; $\sigma = 13.63$)	
Ordinal	1	If owner was <40 years old	5
	2	If owner was 40–65 years old	45
	3	If owner was more than 65 years old	53
EDUC		Regulated education of the owner	
Ordinal	1	If owner did not have studies	38
	2	If owner had primary education	49
	3	If owner had secondary education	10
	4	If owner had tertiary education	6

Table 7 continued

Variable	Code	Definition	No. of interviewed NIPF owners
OCCUP		Main primary occupation of the owner	
Nominal	1	If owner was a retired owner	53
	2	If owner was an active farmer	24
	3	If owner was a hired worker	10
	4	If owner was a self-employee	4
	5	If owner was an entrepreneur	5
	6	If other	7
FARM		Condition of the owner as an active farmer	
Binary	1	If owner was an active farmer	24
	0	If otherwise	79
ASSOC		Participation of the owner in professional associations	
Binary	1	If owner was a member of a professional association	35
	0	If otherwise	68
TRAINING		Forestry training of the owner	
Binary	1	If owner participated in a forestry course	8
	0	If otherwise	95
IMARKET		Specific training in market (timber prices, supply-demand, etc.)	
Binary			
	1	If owner had market information	35
	0	If otherwise	68
TECHNIC		Knowledge and use of production criteria for timber harvesting	
Nominal			
	1	If owner did not know about and did not take into account rotation age	8
	2	If owner knew about and did not take into account rotation age	84
	3	If owner knew about and took into account rotation age	11
Family unit			
INHERIT		Acquisition of the forest holding	
Nominal	1	If owner inherited lands	53
	2	If owner inherited and bought lands	46
	3	If owner bought lands	4
BEQUEST		Intention of bequeathing the forest holding	
Nominal	1	If owner intended to bequeath lands to heirs	97
	2	If owner intended to bequeath some lands to heirs and sell the remainder	2
	3	If owner intended to sell lands	4
HOUSEHOLD		Annual net family income in euros during 1999–2003 ($x = 17{,}224.94$; $\sigma = 10{,}339.69$)	
Ordinal			
	1	If net household income was <6,000	11
	2	If net household income was between 6,000 and 9,000	18
	3	If net household income was between 9,001 and 18,000	37

Table 7 continued

Variable	Code	Definition	No. of interviewed NIPF owners
	4	If net household income was between 18,001 and 30,000	20
	5	If net household income was more than 30,000	17
REINVEST Ordinal		Annual reinvestment for household consumption in euros during 1999–2003, per unit of forest area ($x = 71.01$; $\sigma = 81.32$)	
	0	If owner did not obtain reinvestments	29
	1	If reinvestment was <71.0	33
	2	If reinvestment was between 71.0 and 152.4	24
	3	If reinvestment was between 152.5 and 233.7	11
	4	If reinvestment was between 233.8 and 315.0	4
	5	If reinvestment was more than 315.0	2
PERSONAL Ordinal		Personal labor-days spent annually on forestry during 1999–2003	
	1	If personal labor was <2	31
	2	If personal labor was between 2 and 5	11
	3	If personal labor was between 6 and 10	13
	4	If personal labor was between 11 and 50	32
	5	If personal labor was between 51 and 100	12
	6	If personal labor was more than 100	4
FAMILY Ordinal		Family labor-days spent annually on forestry during 1999–2003	
	1	If family labor was <2	44
	2	If family labor was between 2 and 5	12
	3	If family labor was between 6 and 10	8
	4	If family labor was between 11 and 50	15
	5	If family labor was between 51 and 100	18
	6	If family labor was more than 100	6
MACHINERY		Logistic resources available for forestry activities	
Binary	1	If owner had agricultural and forestry machinery	66
	0	If otherwise	37
PROFESS Ordinal		Professional labor-days spent annually on forestry during 1999–2003	
	1	If professional labor was <2	41
	2	If professional labor was between 2 and 5	6
	3	If professional labor was between 6 and 10	23
	4	If professional labor was between 11 and 50	12
	5	If professional labor was between 51 and 100	19
	6	If professional labor was more than 100	2
Forest property and land-use changes			
FMEADOW Binary		Past conversion of forestland into meadow during 1999–2003	

Table 7 continued

Variable	Code	Definition	No. of interviewed NIPF owners
	1	If owner made this land-use change	2
	0	If otherwise	101
MWOOD Binary		Past conversion of marginal meadow into woodland during 1999–2003	
	1	If owner made this land-use change	29
	0	If otherwise	74
CSPECIE Binary		Future intention of changing the current productive forest species	
	1	If owner had this future purpose	23
	0	If otherwise	80
IFOREST		Future intention of increasing the productive forestland	
Binary	1	If owner had this future purpose	46
	0	If otherwise	57
PLOT Ordinal		Number of plots per hectare of productive forestland in ownership ($x = 3.40$; $\sigma = 1.88$)	
	1	If fragmentation degree was smaller than 1.52	14
	2	If fragmentation degree ranged between 1.52 and 3.40	41
	3	If fragmentation degree ranged between 3.41 and 5.29	29
	4	If fragmentation degree was larger than 5.29	19
SIZE Ordinal		Area of productive forestland in ownership, in hectares ($x = 4.76$; $\sigma = 3.86$)	
	1	If ownership sized between 1.00 and 1.70	22
	2	If ownership sized between 1.71 and 3.50	24
	3	If ownership sized between 3.51 and 7.00	32
	4	If ownership sized more than 7.00	25
Forest economics			
INVEST Ordinal		Annual investment in holding improvement in euros during 1999–2003, per unit of forest area ($x = 10.35$; $\sigma = 24.56$)	
	0	If owner did not invest in the forest holding	76
	1	If owner invested <39.7	15
	2	If owner invested more than 39.7	12
PEXP Ordinal		Annual expenditure on plantation in euros during 1999–2003, per unit of forest area ($x = 193.48$; $\sigma = 176.28$)	
	0	If owner did not spend on planting forestlands	5
	1	If owner spent <127.0	61
	2	If owner spent between 127.0 and 250.0	25
	3	If owner spent between 250.1 and 400.0	7
	4	If owner spent between more than 400.0	5
TEXP Ordinal		Annual expenditure on silviculture treatments in euros during 1999–2003, per unit of forest area ($x = 71.83$; $\sigma = 81.76$)	

Table 7 continued

Variable	Code	Definition	No. of interviewed NIPF owners
	0	If owner did not spend on forestland improvement	12
	1	If owner spent <90.7	63
	2	If owner spent between 90.7 and 221.7	20
	3	If owner spent more than 221.7	8
REQUEST Binary		Formal application for a forest management subsidy during 1999–2003	
	1	If owner applied for economic aid	22
	0	If otherwise	81
SUB Ordinal		Annual forest subsidy in euros during 1999–2003, per unit of forest area ($x = 4.92$; $\sigma = 20.09$)	
	0	If owner did not apply for economic aid or was not finally compensated	95
	1	If owner received <25.0	2
	2	If owner received between 25.0 and 50.1	2
	3	If owner received between 50.2 and 75.2	2
	4	If owner received more than 75.2	2
TINCOME Ordinal		Annual income from timber sales in euros during 1999–2003, per unit of forest area ($x = 166.62$; $\sigma = 193.39$)	
	0	If owner did not receive timber income	46
	1	If owner received <195.1	18
	2	If owner received between 195.1 and 425.2	19
	3	If owner received more than 425.2	20
TPRICE Ordinal		Stumpage price in euros during 1999–2003, per ton ($x = 3.99$; $\sigma = 4.25$)	
	0	If owner did not sell timber	46
	1	If stumpage price per unit was <48.9	40
	2	If stumpage price per unit was between 48.9 and 74.3	11
	3	If stumpage price per unit was more than 74.3	6
NTINCOME Ordinal		Annual income from land sales in euros during 1999–2003, per unit of forest area ($x = 170.79$; $\sigma = 281.77$)	
	0	If owner did not receive nontimber income	35
	1	If owner received <381.8	52
	2	If owner received more than 381.8	16

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ORIGINAL ARTICLE

Assessing the role of the family unit in individual private forestry in northern Spain

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Abstract
Farm forestry has been often linked to family knowledge and needs, and even to local expertise through several generations. Among the several factors that may influence farm forestry, family welfare and support on forest decision making and management are nowadays key arguments to provide a richer and better understanding of the land behaviour of non-industrial private forest owners (NIPFOs). This paper empirically explores and assesses the potential direct effects of the characteristics of the family unit (bequests, household income, forest reinvestments, personal and family labour, logistic resources and professional assistance) on individual forest management in terms of planting, silvicultural and harvesting practices. In March 2004, 103 forest landowners were personally interviewed about their commitment to and involvement in land management during 1999–2003, considering a forest region in northern Spain. The pattern of land acquisition, household dependence on forest products for self-consumption, the availability of machinery, in addition to family labour force and technical guidance in forestry, are all significantly related to the ability to manage and use forestland as a capital asset. These issues may be essential for advancing research in individual forestry and for improving policy objectives and programmes on forest planning and management within the increasing demands for sustainable forestry and rural development.

Keywords: *Bequest, forest labour, forest reinvestment, household income, logistic support, non-industrial private forest owner.*

Introduction

Nowadays, the territorial system is characterized worldwide by urban development. Populations tend to concentrate in large cities, where the supply of services and infrastructures available is greater and better than in rural areas. Such a polarization of population has brought about patterns of gradual and increasing socioeconomic recession in rural areas, changing land ownership and reducing land management as the requirements and prospects of land managers adapt to new economic opportunities. In the face of such a process of loss of values and rural heritage, agricultural and forestry activities are no longer economically viable for many rural communities, and many rural landscapes have begun to be abandoned because of the lack of an active population and the ageing residents who maintain and conserve them (Karppinen, 2005; Kittredge, 2005; Marey et al., 2006). Consequently, as rural landscapes become increasingly unmaintained, many approaches to land management become more relevant at different scales.

In the past few decades, the unsustainable growth of a large part of the urban areas and the new needs of the current population have promoted the consideration of forests as the social, economic and environmental hope for a future recovery and renewal of rural areas, aimed at reorientating their traditional values and activities (Marey et al., 2004). Therefore, scientific and public organizations, as well as policy statements of many countries, have begun to focus on rural development issues, especially those centred on forest sustainability, and try to resolve questions such as which style of forestry can generate the best bundle of benefits by means of land-use decision making among diverse stakeholders (Slee & Wiersum, 2001).

This issue is particularly worrying in regions where forestland is largely owned and managed by non-industrial private forest owners (NIPFOs), and

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all the efforts are mainly targeted at these regions. Modelling and predicting NIPFOs' land management requires a more complex analysis, given that the objectives and motivations of these owners for managing the land and their prospects about them are widely heterogeneous (Kline et al., 2002; Ross-Davis et al., 2005). Trying to describe, discuss and understand what influences NIPFOs' land decisions and practices acquires more relevance considering that these landowners play an important role in the economy and welfare of rural regions (Arano et al., 2004), and that many NIPFO families are less dependent on forestry because the income from other activities has increased (Bolkesjø & Baardsen, 2002).

One statement seems consistent across the broad range of world literature related to individual forest management: forestry has usually been linked to or dependent on family knowledge and needs, and on local expertise, for several generations. Thus, identifying and quantifying the relevance of family welfare and support on forest decision making and management becomes a key argument, not only for providing a richer and better understanding of the land behaviour of NIPFOs, but also for improving the current situation and prospects of family-owned forests as a decisive engine in rural areas.Therefore, the purpose of this study is to explore and assess the potential direct effects of the family unit on individual forest management, focusing on the forest holdings surveyed in an area of northern Spain. The three traditional practices used to predict NIPFOs' forest management, i.e. planting, silviculture and timber harvesting (Löyland et al., 1995; Hardie & Parks, 1996; Kuuluvainen et al., 1996; Conway et al., 2003), were considered and analysed empirically in terms of the characteristics linked to the NIPFO family unit as independent and explanatory variables of influence.

The focus of this article is on family characteristics, represented by the pattern of land transmission, household income and forest reinvestment, labour force and logistic resources. In addition, a possible statistical relationship or distinction between these explanatory variables and other independent factors related to landowner profile, forest property, land-use changes and forest economics, was searched for. Characterizing the family environment in this way and identifying NIPFOs' land behaviour patterns may allow policy makers to focus objectives on sustainable forest planning and management within the framework of rural development and to promote the relevant programmes.

Materials and methods

Study area

The present study updates and expands an earlier analysis by Marey (2003), which explored individual private ownership and forest management in the autonomous community of Galicia, northern Spain. The data used for this study were collected from face-to-face interviews with randomly selected NIPFOs in the Mariña Oriental pilot area, located in north-east Galicia (Figure 1). This forest region was chosen for the study because it is representative of much of northern Spain, where forests cover most of the land (53%) and forestry activity is increasing (over 46% of its forests are woodlands). Forestlands are owned by 3043 NIPFOs, who manage more than 90% of the forested area in the region.

The NIPFOs' address list and the attributes of their holdings, such as location, land use and size, were identified from the Land Cadastre. In agreement with Council Regulation (EEC) No. 571/88 of 29 February 1988, on the organization of Community surveys on the structure of agricultural holdings, the sampling frame first consisted of all NIPFOs who lived in Mariña Oriental and owned at least 1 ha of productive forestland. Such a sampling scheme was proposed by Marey (2003). This forestland threshold excluded many forest owners who would probably not have the information necessary to account for their management goals and practices. As a result of the migratory phenomena that occurred in Galicia during the twentieth century (Beiras, 1975), a high percentage of NIPFOs did not reside in the study area (Marey et al., 2004). This circumstance meant that the population census had to be reviewed for reclassifying landowners into non-residents and residents. From among the 750 NIPFOs who manage more than 1 ha of productive forestland in the region, 333 were registered as permanent residents, owning 1154 ha of woodland, which accounts for 42% of all productive forestland in the area, including plots of less than 1 ha.

A questionnaire was chosen that used statistical sampling, within the subjective methodology of analysis, in which the sample size was designed to achieve a 5% sampling error at the 95% confidence level. The error level was set at 3% for quantitative answers (mean estimation) and 6% for qualitative answers (proportion estimation).

Because the great variety of variables contained in the Land Cadastre showed a remarkable heterogeneity for the study population, stratification was a key factor in the characterization and subsequent validation of results. The cadastral database indicated that the variable named *productive forest area*

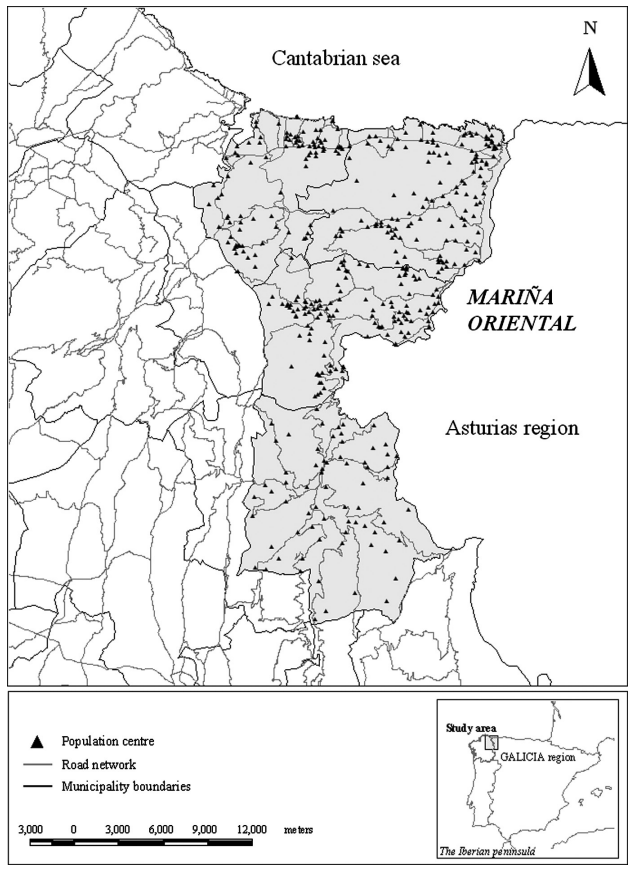

Figure 1. Location of the Mariña Oriental region in Galicia (northern Spain).

per landowner was the most suitable variable for determining the minimum threshold of NIPFOs that should be interviewed and for stratifying landowners. Then, the classification of NIPFOs conducted to determine the number of strata and the cut-off points was based on information concerning timber harvesting in Mariña Oriental; the size of productive forestland that allowed NIPFOs to harvest annually the mean annual harvesting in the area would define landowner stratification (Marey, 2003). This value was set at 3.5 ha of productive forestland, considering a weighted rotation age of 15 years for the two main forest species in the region, *Eucalyptus globulus* Labill. and *Pinus pinaster* Ait. ssp. *maritima*. Four NIPFO groups were formed from this value (Table I).

To obtain complete and reliable results, the authors tried to enlarge as much as possible the interviewable landowner population, and to minimize the economic costs of the development of the interview during the design of the sampling size. A

Table I. Classification of interviewed non-industrial private forest owners per stratum.

Stratum	Productive forestland (ha)	*n*	%
A	1.00–1.70	22	21.4
B	1.71–3.50	28	27.2
C	3.50–7.00	31	30.1
D	>7.01	22	21.4
		103	100

self-weighting design was used, and a sample size was accordingly determined and allocated using Neyman allocation (Sukhatme, 1953). Nevertheless, from among the 333 NIPFOs who were responsible for more than 1 ha of productive forestland and permanent residents of Mariña Oriental, 103 were finally contacted and personally interviewed (Table I). The NIPFOs interviewed owned 12% of the forestland and 13% of the woodland in the region.

A variety of questionnaires was tested before a final version was chosen. It was divided into five sections, which collected information on owner profile, family unit, forest property, land-use changes and forest economics during the period 1999–2003. The final questionnaire was completed in two stages during March 2004. The first stage consisted of a telephone interview carried out between 20.00 and 22.00 h, which enquired into the owner's willingness to participate in the study. If confirmed, the interviewer arranged for a face-to-face interview within 1 or 2 days (the second stage). If the owner refused to allow the face-to-face interview, the interviewer only asked the questions included in the owner-profile section directly on the telephone. Each face-to-face interview lasted for an average of 36 min. This information was finally complemented with the official data contained in the Land Cadastre.

Description of variables

Returning to the principal aim of this study, the forest decision and/or practice of a representative NIPFO should be the result of combining or associating the individual decisions and/or practices of planting, making silvicultural treatments on forestlands, and harvesting from woodlands. These three traditional practices have been used frequently to predict NIPFOs' forest management (Löyland et al., 1995; Hardie & Parks, 1996; Kuuluvainen et al., 1996; Conway et al., 2003). In the present study, these three individual forest practices were defined by the following continuous variables:

- PLANT: forest plantation activity, measured as the share of annual planted area in the total forest area.
- TREAT: improvement treatment activity, measured as the share of annual silviculture area in the total forest area; this practice included activities such as the use of fertilizers, application of insecticides, pesticides or herbicides, thinning of competing vegetation, and other management or improvement treatments.
- HARV: timber harvesting activity, measured as the share of annual harvested area in the total wooded forest area.

From the extensive literature focused on NIPFOs' land management, (1) the pattern of land transmission (the way in which forestland passes from one generation to the next), (2) the family requirements (household income and products from forests that improve and complement the family's well-being), and (3) the labour and logistics capital invested in forest practices (personal and family labour force, availability of agricultural and forestry machinery and professional assistance on the holding) may provide a useful measure of the knowledge and understanding of NIPFOs' management and behaviour over time.

Thus, the patterns of land acquisition and future transmission may be important indicators of owners' decision making, especially for long-term investments such as forestry (Conway et al., 2003; Ross-Davis et al., 2005; Marey et al., 2006). These forest decisions are usually adapted to family needs, as are farming aims (Kuuluvainen & Salo, 1991; Kuuluvainen et al., 1996; Zhang & Flick, 2001). Accordingly, landowners who rely on forest management and monitoring and try to involve their family in these activities are generally more able to take advantage of forests and have a more favourable attitude towards adopting sustainable forestry (Kuuluvainen & Salo, 1991; Hardie & Parks, 1996).

The three forest activity variables, PLANT, TREAT and HARV (dependent variables), and the family unit characteristics (independent variables) were obtained from the personal questionnaire for the 1999–2003 period. Although the main focus was on family characteristics, a possible statistical relationship or distinction between these explanatory variables was also searched for, related to the family unit and other independent factors related to landowner profile, forest property, land-use changes and forest economics, which were obtained from the personal interview.

All the explanatory variables were redefined and coded in nominal, ordinal or binary variables that summarized the surveyed data and met the assumptions of the statistical analyses. For the formulation of ordinal variables, simple statistical criteria were applied by using SAS/STAT^{TM} and STATGRAPHICS^{TM} software (Marey, 2003). First, descriptive statistics and frequency histograms for the explanatory variables were produced and, then, statistics of location and dispersion were selected, i.e. the mean (x) and standard deviation (SD; σ), respectively (Cao, 2002). Then, this location measurement was considered (x) as the centre of the explanatory variables considered, and the class intervals were calculated from the dispersion statistics (σ). Table II lists and describes the independent variables considered in this study and shows the

Table II. Definition of independent variables for the statistical analyses: mean and SD (%) for annual ratios of planting, silvicultural and harvesting practices.

Variable	Code	Definition	% of interviewed NIPFOs	PLANT		TREAT		HARV	
				Mean	SD	Mean	SD	Mean	SD
Landowner profile									
AGE Ordinal		Age of the owner (years)							
	A_{G1}	1 if owner was <40 years old	4.6	2.44	3.65	0.50	0.88	0.86	1.51
	A_{G2}	2 if owner was 40–65 years old	44.2	1.57	2.24	1.35	4.03	5.83	8.31
	A_{G3}	3 if owner was >65 years old	51.2	1.49	2.95	0.78	1.67	1.79	2.42
EDUC Ordinal		Regulated education of the owner							
	E_{D1}	1 if owner did not have studies	37.2	0.69	0.88	0.51	0.89	2.88	4.84
	E_{D2}	2 if owner had primary education	47.7	1.76	2.91	1.54	4.11	3.69	5.15
	E_{D3}	3 if owner had secondary education	9.3	4.17	4.58	0.90	0.89	5.80	13.35
	E_{D4}	4 if owner had tertiary education	5.8	1.54	1.83	0.20	0.32	2.74	4.59
OCCUP Nominal		Main primary occupation of the owner							
	O_{C1}	1 if owner was a retired owner	51.2	1.42	2.65	0.66	1.54	2.21	3.10
	O_{C2}	2 if owner was an active farmer	24.4	1.23	2.15	1.01	1.31	4.99	6.76
	O_{C3}	3 if owner was a hired worker	9.3	0.99	1.06	0.65	0.68	6.14	13.19
	O_{C4}	4 if owner was self-employed	3.5	3.86	3.95	0.53	0.82	0.30	0.29
	O_{C5}	5 if owner was an entrepreneur	4.6	2.83	2.75	6.29	12.44	6.84	9.88
	O_{C6}	6 if other	7.0	2.69	4.71	0.90	1.06	4.06	4.22
FARM Binary		Condition of the owner as an active farmer							
	F_{R1}	1 if owner was an active farmer	24.4	1.23	2.15	1.01	1.31	4.99	6.76
	F_{R0}	0 if otherwise	75.6	1.68	2.81	1.02	3.30	3.06	5.87
ASSOC Binary		Participation of the owner in professional associations							
	A_{S1}	1 if owner was member of a professional association	33.7	1.74	2.24	1.04	1.31	3.58	4.97
	A_{S0}	0 if otherwise	66.3	1.49	2.87	1.01	3.49	3.51	6.67
TRAINING Binary		Forestry training of the owner							
	T_{R1}	1 if owner participated in a forest course	8.1	1.94	2.66	1.16	1.38	8.33	13.60
	T_{R0}	0 if otherwise	91.9	1.54	2.68	1.01	3.03	3.11	4.93
IMARKET Binary		Specific formation in market (timber prices, supply–demand, etc.)							
	I_{M1}	1 if owner had market information	33.7	1.79	3.14	1.25	3.55	4.89	5.76
	I_{M0}	0 if otherwise	66.3	1.15	1.22	0.57	0.72	2.84	6.22
TECHNIC Nominal		Knowledge and use of productive criteria in timber harvesting							
	T_{E1}	1 if owner did not know about and did not take into account rotation age	8.1	1.08	1.65	0.46	0.74	0.00	0.00
	T_{E2}	2 if owner knew about and did not take into account rotation age	81.4	1.62	2.78	1.17	3.22	3.07	4.50
	T_{E3}	3 if owner knew about and took into account rotation age	10.5	1.55	2.48	0.29	0.40	9.84	12.86
Family unit									
INHERIT Nominal		Acquisition of the forest holding							
	I_{H1}	1 if owner inherited lands	51.2	1.36	2.79	0.87	1.69	3.83	5.25
	I_{H2}	2 if owner inherited and bought lands	45.3	1.92	2.60	1.25	3.98	3.42	7.18
	I_{H3}	3 if owner bought lands	3.5	0.25	0.33	0.26	0.26	0.64	1.11
BEQUEST Nominal		Intention of bequeathing the forest holding							
	B_{E1}	1 if owner intended to bequeath lands to heirs	94.2	1.56	2.69	0.75	1.36	3.63	6.26
	B_{E2}	2 if owner intended to bequeath some lands to heirs and sell the remainder	2.3	1.60	1.39	0.85	1.02	1.70	0.33
	B_{E3}	3 if owner intended to sell lands	3.5	1.94	3.31	8.33	14.39	2.14	3.70

Table II (*Continued*)

Variable	Code	Definition	% of interviewed NIPFOs	PLANT Mean	PLANT SD	TREAT Mean	TREAT SD	HARV Mean	HARV SD
HOUSEHOLD Ordinal		Annual net family income (€) during 1999–2003							
	H_{H1}	1 if net household income was <6000	10.5	0.64	1.11	0.38	0.48	2.29	2.97
	H_{H2}	2 if net household income was 6000–9000	17.4	0.72	0.64	0.62	1.03	1.39	2.28
	H_{H3}	3 if net household income was 9001–18,000	36.0	2.00	3.60	0.92	1.89	3.44	7.08
	H_{H4}	4 if net household income was 18,001–30,000	19.8	1.25	1.92	0.60	0.61	4.98	7.98
	H_{H5}	5 if net household income was >30,000	16.3	2.53	2.78	2.60	6.54	5.08	5.28
REINVEST Ordinal		Annual reinvestment for household consumption (€) during 1999–2003, per unit of forest area							
	R_{E0}	0 if owner did not obtain reinvestments	27.9	1.40	2.08	1.49	5.07	4.42	8.83
	R_{E1}	1 if reinvestment was <71.0	32.5	2.52	3.70	1.11	1.99	3.32	3.55
	R_{E2}	2 if reinvestment was 71.0–152.4	23.3	0.84	0.88	0.48	0.54	2.34	4.07
	R_{E3}	3 if reinvestment was 152.5–233.7	10.5	1.46	3.03	1.07	1.25	2.23	3.76
	R_{E4}	4 if reinvestment was 233.8–315.0	3.5	0.20	0.14	0.06	0.03	4.20	3.97
	R_{E5}	5 if reinvestment was >315.0	2.3	0.37	0.08	0.68	0.26	8.40	7.94
PERSONAL Ordinal		Personal labour-days spent annually on forestry during 1999–2003							
	P_{E1}	1 if personal labour was <2	30.2	2.25	4.04	1.07	2.01	2.79	3.98
	P_{E2}	2 if personal labour was 2–5	10.5	0.75	1.28	0.52	0.71	1.77	3.47
	P_{E3}	3 if personal labour was 6–10	12.8	1.22	1.69	2.99	7.40	3.15	3.51
	P_{E4}	4 if personal labour was 11–50	31.4	1.16	1.16	0.43	0.54	3.72	6.37
	P_{E5}	5 if personal labour was 51–100	11.6	2.19	3.08	0.49	0.52	7.87	11.78
	P_{E6}	6 if personal labour was >100	3.5	1.11	1.28	2.01	1.76	0.49	0.85
FAMILY Ordinal		Family labour-days spent annually on forestry during 1999–2003							
	F_{M1}	1 if family labour was <2	43.0	1.51	2.19	1.43	4.13	4.14	7.07
	F_{M2}	2 if family labour was 2–5	11.6	2.35	4.91	1.16	2.98	2.04	2.35
	F_{M3}	3 if family labour was 6–10	8.1	0.34	0.55	0.27	0.23	1.55	3.51
	F_{M4}	4 if family labour was 11–50	14.0	0.74	0.69	0.48	0.53	3.22	6.22
	F_{M5}	5 if family labour was 51–100	17.4	1.52	1.39	0.78	1.00	3.97	6.37
	F_{M6}	6 if family labour was >100	5.9	4.43	5.32	0.74	0.99	4.23	6.92
MACHINERY Binary		Logistic resources available for forest activities							
	M_{A1}	1 if owner had agricultural and forestry machinery	64.0	1.71	2.52	1.30	3.42	4.09	6.83
	M_{A0}	0 if otherwise	36.0	1.32	2.93	0.53	1.71	2.54	4.51
PROFESS Ordinal		Professional labour-days spent annually on forestry during 1999–2003							
	P_{R1}	1 if professional labour was <2	39.5	0.75	0.89	0.61	0.92	1.60	3.03
	P_{R2}	2 if professional labour was 2–5	5.8	0.13	0.18	0.23	0.42	2.77	3.96
	P_{R3}	3 if professional labour was 6–10	22.1	0.82	0.85	0.29	0.36	4.15	6.19
	P_{R4}	4 if professional labour was 11–50	11.6	1.84	2.45	0.49	0.53	3.34	5.07
	P_{R5}	5 if professional labour was 51–100	18.6	3.93	4.67	3.27	6.26	7.08	10.04
	P_{R6}	6 if professional labour was >100	2.4	6.16	2.44	1.56	2.21	4.85	6.41
Forest property and land-use changes									
FMEADOW Binary		Past conversion of forestland into meadow during 1999–2003							
	F_{M1}	1 if owner made this land-use change	2.3	0.23	0.11	0.45	0.59	0.79	1.11
	F_{M0}	0 if otherwise	97.7	1.60	2.69	1.03	2.96	3.60	6.17
MWOOD Binary		Past conversion of marginal meadow into woodland during 1999–2003							
	M_{W1}	1 if owner made this land-use change	27.9	1.56	1.91	1.87	5.00	1.95	2.80

Table II (*Continued*)

Variable	Code	Definition	% of interviewed NIPFOs	PLANT Mean	PLANT SD	TREAT Mean	TREAT SD	HARV Mean	HARV SD
	M_{W0}	0 if otherwise	72.1	1.58	2.92	0.69	1.46	4.15	6.91
CSPECIE Binary		Future intention of changing the current productive forest species							
	C_{S1}	1 if owner had this future purpose	22.1	1.92	3.39	2.46	5.63	4.76	9.23
	C_{S0}	0 if otherwise	77.9	1.47	2.44	0.61	1.28	3.18	4.94
IFOREST Binary		Future intention of increasing the productive forestland							
	I_{F1}	1 if owner had this future purpose	44.2	1.98	2.87	1.48	4.03	5.22	8.02
	I_{F0}	0 if otherwise	55.8	1.25	2.47	0.66	1.56	2.20	3.59
PLOT Ordinal		Number of plots per hectare of productive forestland in ownership							
	P_{L1}	1 if fragmentation degree was <1.52	14.0	3.21	4.44	3.54	7.25	7.88	10.41
	P_{L2}	2 if fragmentation degree was 1.52–3.40	39.5	1.89	2.78	0.88	1.08	2.32	4.23
	P_{L3}	3 if fragmentation degree was 3.41–5.29	27.9	1.02	1.67	0.38	0.47	4.86	6.33
	P_{L4}	4 if fragmentation degree was >5.29	18.6	0.50	0.56	0.38	0.97	0.85	1.66
SIZE Ordinal		Area of productive forestland in ownership (ha)							
	S_{I1}	1 if ownership sized 1.00–1.70	20.9	0.17	0.27	0.46	0.93	2.90	6.61
	S_{I2}	2 if ownership sized 1.71–3.50	23.3	0.33	0.28	0.32	0.50	5.12	9.66
	S_{I3}	3 if ownership sized 3.51–7.00	31.4	1.09	0.82	0.65	0.95	2.59	3.46
	S_{I4}	4 if ownership sized >7.00	24.4	4.58	4.00	2.65	5.53	3.77	3.67
Forest economics									
INVEST Ordinal		Annual investment in holding improvement (€) during 1999–2003, per unit of forest area							
	I_{V0}	0 if owner did not invest in the forest holding	74.1	0.91	1.46	0.47	0.83	3.15	5.30
	I_{V1}	1 if owner invested <39.7	14.1	4.51	4.97	1.84	2.62	3.47	3.48
	I_{V2}	2 if owner invested >39.7	11.8	2.31	2.58	3.54	7.60	6.34	11.57
PEXP Ordinal		Annual expenditure on plantation (€) during 1999–2003, per unit of forest area							
	E_{P0}	0 if owner did not spend on planting forestlands	4.7	0.00	0.00	0.04	0.05	1.53	3.06
	E_{P1}	1 if owner spent <127.0	58.8	0.53	0.64	0.41	0.86	2.34	4.34
	E_{P2}	2 if owner spent 127.0–250.0	24.7	2.25	1.81	1.03	0.74	4.17	5.02
	E_{P3}	3 if owner spent 250.1–400.0	7.1	1.74	1.08	0.80	0.81	11.73	15.18
	E_{P4}	4 if owner spent >400.0	4.7	10.42	4.52	9.23	11.24	2.98	2.63
TEXP Ordinal		Annual expenditure on silviculture treatments (€) during 1999–2003, per unit of forest area							
	E_{T0}	0 if owner did not spend on forestland improvement	12.0	1.04	2.46	0.05	0.08	1.77	2.80
	E_{T1}	1 if owner spent <90.7	61.4	0.86	1.27	0.48	0.86	3.23	5.35
	E_{T2}	2 if owner spent 90.7–221.7	19.3	2.69	2.93	1.18	0.83	3.51	4.54
	E_{T3}	3 if owner spent >221.7	7.3	4.93	6.38	3.08	3.40	9.74	14.62
REQUEST Binary		Formal application for a forest management subsidy during 1999–2003							
	R_{Q1}	1 if owner applied for economic aid	20.9	2.91	4.33	2.64	6.02	2.84	2.97
	R_{Q0}	0 if otherwise	79.1	1.22	1.91	0.59	0.90	3.71	6.71
SUB Ordinal		Annual forest subsidy (€) during 1999–2003, per unit of forest area							
	S_{U0}	0 if owner did not apply for economic aid or was not finally compensated	90.8	1.41	2.25	0.92	2.89	3.60	6.34
	S_{U1}	1 if owner received <25.0	2.3	0.81	0.12	0.39	0.09	0.66	0.94
	S_{U2}	2 if owner received 25.0–50.1	2.3	2.14	0.33	0.12	0.09	1.36	1.93
	S_{U3}	3 if owner received 50.2–75.2	2.3	8.56	10.41	4.90	6.59	6.75	4.60
	S_{U4}	4 if owner received >75.2	2.3	1.06	1.06	2.52	2.01	2.73	3.86
TINCOME Ordinal		Annual income from timber sales (€) during 1999–2003, per unit of forest area							

Table II (*Continued*)

Variable	Code	Definition	% of interviewed NIPFOs	PLANT		TREAT		HARV	
				Mean	SD	Mean	SD	Mean	SD
	T_{I0}	0 if owner did not receive timber income	45.1	0.61	0.99	0.56	1.02	0.00	0.00
	T_{I1}	1 if owner received < 195.1	17.1	2.03	4.25	2.61	6.90	7.34	7.09
	T_{I2}	2 if owner received 195.1–425.2	18.3	3.20	3.54	0.78	0.95	3.64	3.34
	T_{I3}	3 if owner received > 425.2	19.5	1.76	2.24	0.77	0.96	8.18	9.46
TPRICE Ordinal		Stumpage price per unit (€ t^{-1}) during 1999–2003							
	T_{P0}	0 if owner did not sell timber	45.1	0.61	0.99	0.56	1.02	0.00	0.00
	T_{P1}	1 if stumpage price per unit was <48.9	39.0	2.42	3.64	1.73	4.61	5.90	5.56
	T_{P2}	2 if stumpage price per unit was 48.9–74.3	11.0	1.83	2.53	0.39	0.56	6.46	7.04
	T_{P3}	3 if stumpage price per unit was >74.3	4.9	2.61	3.54	0.44	0.40	8.17	12.17
NTINCOME Ordinal		Annual income from land sales (€) during 1999–2003, per unit of forest area							
	nT_{I0}	0 if owner did not receive non-timber income	33.7	1.69	2.73	0.57	0.91	0.81	0.92
	nT_{I1}	1 if owner received <381.8	50.6	1.37	2.75	1.33	4.07	2.14	3.13
	nT_{I2}	2 if owner received >381.8	15.7	2.11	2.64	1.06	1.25	8.86	5.79

Note: NIPFO =non-industrial private forest owner.

percentage of interviewed owners for each category, as well as the mean and SD parameters observed for planting, silvicultural and harvesting practices during the 5 year study period.

Finally, all the economic variables analysed in the present study were adjusted to constant euros for 2004 to control the inflation rate, and summarized in mean annual eco amounts per hectare owned, with the exception of family households. The information source was the Spanish consumer price index of the National Statistics Institute (INE, 2004).

Statistical analyses

Given that the study population was not adjusted to the Kolmogorov–Smirnov goodness-of-fit test for the normality *K-S* test, or to the Levene test for homogeneity of variances, the statistical analyses conducted in this study were based on distribution-free tests, that is, non-parametric tests. The non-parametric procedure took into account the typology of variables measured in the study, i.e. continuous, nominal/ordinal and binary variables, and was defined to explain statistically the planting, silvicultural and harvesting management practices in Mariña Oriental in relation to family unit characteristics. In addition, these explanatory variables were associated with other attributes linked to landowner profile, forest property, land-use changes and forest economics. Thus, first, the strength and significance of the linear correlation among the variables were tested, and then the significant differences among them contrasted at a 95% confidence limit and a minimum 0.05 level of statistical significance.

Using Somers' *D* coefficient and its critical significance level, the statistical relationship among nominal, ordinal and/or binary variables was measured using contingency tables. Table III details the degree of correlation found for this type of explanatory factor considered in the study. Significant differences in the frequency distribution across nominal, ordinal and/or binary variables of the cross-tabulation were computed and detected using Pearson's chi-square statistic (χ^2) and the two-tailed asymptotic significance (Table IV).

Spearman's rho coefficient (ρ) was used to estimate the statistical association between the continuous variables and these measures versus nominal, ordinal and/or binary attributes at 0.01 and 0.05 significance levels. Table V shows the Spearman's correlation coefficients for the three forest management practices of reference and the family attributes. This table also shows the values of the correlation parameter between the group of characteristics selected to describe the family unit and the remaining explanatory variables. Later, the mean distribution

Table III. Correlations among nominal, ordinal and/or binary explanatory variables.

	INHERIT$_{(N)}$	BEQUEST$_{(N)}$	PERSONAL$_{(O)}$	FAMILY$_{(O)}$	MACHINERY$_{(B)}$	PROFESS$_{(O)}$
Landowner profile						
EDUC$_{(O)}$						
D	−0.043	−0.092	−0.100	−0.001	0.073	0.152
p	0.659	0.182	0.332	0.990	0.506	0.101
OCCUP$_{(N)}$						
D	−0.092	0.041	−0.063	0.049	0.091	−0.015
p	0.349	0.580	0.480	0.583	0.387	0.882
FARM$_{(B)}$						
D	−0.255*	−0.025	−0.038	0.149	0.312*	−0.058
p	0.013*	0.766	0.663	0.117	0.000*	0.520
ASSOC$_{(B)}$						
D	−0.077	−0.060	0.061	0.053	0.433*	0.086
p	0.455	0.428	0.522	0.591	0.000*	0.380
TRAINING$_{(B)}$						
D	0.195*	0.100	0.209*	−0.024	0.192*	0.055
p	0.041*	0.515	0.006*	0.756	0.005*	0.456
IMARKET$_{(B)}$						
D	0.169*	0.055	0.045	−0.063	−0.023	−0.052
p	0.050*	0.476	0.638	0.515	0.829	0.574
TECHNIC$_{(N)}$						
D	0.123	−0.013	0.114	0.035	0.039	0.107
p	0.244	0.624	0.151	0.667	0.711	0.249
Family unit						
INHERIT$_{(N)}$						
D		0.135	0.296*	0.006	0.076	0.107
p		0.139	0.000*	0.952	0.460	0.256
BEQUEST$_{(N)}$						
D	0.135		−0.009	−0.074	−0.020	−0.025
p	0.139		0.899	0.184	0.821	0.692
PERSONAL$_{(O)}$						
D	0.296*	−0.009		0.079	0.135	0.116
p	0.000*	0.899		0.438	0.152	0.207
FAMILY$_{(O)}$						
D	0.006	−0.074	0.079		0.063	−0.021
p	0.952	0.184	0.438		0.490	0.822
MACHINERY$_{(B)}$						
D	0.076	−0.020	0.135	0.063		0.019
p	0.460	0.821	0.152	0.490		0.836
PROFESS$_{(O)}$						
D	0.107	−0.025	0.116	−0.021	0.019	
p	0.256	0.692	0.207	0.822	0.836	
Forest property and land-use changes						
FMEADOW$_{(B)}$						
D	−0.001	−0.035	−0.018	−0.010	0.066	0.010
p	0.986	0.216	0.690	0.800	0.151	0.866
MWOOD$_{(B)}$						
D	0.114	0.146	0.116	−0.001	−0.019	0.088
p	0.279	0.195	0.263	0.989	0.862	0.365
CSPECIE$_{(B)}$						
D	0.097	−0.008	0.163*	0.038	0.222*	0.127
p	0.354	0.927	0.050*	0.689	0.018*	0.165
IFOREST$_{(B)}$						
D	0.187*	0.062	0.185*	−0.024	0.034	0.308*
p	0.050*	0.471	0.045*	0.806	0.752	0.001*
Forest economics						
REQUEST$_{(B)}$						
D	0.203*	−0.002	0.087	−0.026	−0.089	0.147
p	0.039*	0.979	0.336	0.781	0.419	0.134

Note: variable subscripts indicate the type of variable used in the statistical analysis (N = nominal; O = ordinal; B = binary).
*Statistically significant ($p<0.05$).

Table IV. Significant differences among nominal, ordinal and/or binary explanatory variables.

	$INHERIT_{(N)}$	$BEQUEST_{(N)}$	$HOUSEHOLD_{(O)}$	$REINVEST_{(O)}$	$PERSONAL_{(O)}$	$FAMILY_{(O)}$	$MACHINERY_{(B)}$	$PROFESS_{(O)}$
Landowner profile								
$EDUC_{(O)}$								
χ^2	5.659	1.769	16.890	11.182	22.500	16.081	14.839*	17.140
p	0.462	0.940	0.154	0.740	0.095	0.377	0.002*	0.311
$OCCUP_{(N)}$								
χ^2	22.191*	12.432	34.207*	27.150	33.709	27.819	12.935*	36.601*
p	0.014*	0.257	0.025*	0.348	0.114	0.316	0.024*	0.050*
$FARM_{(B)}$								
χ^2	7.769*	1.682	12.208*	9.404*	1.570	6.947	8.478*	2.705
p	0.021*	0.431	0.016*	0.050*	0.905	0.225	0.003*	0.745
$ASSOC_{(B)}$								
χ^2	1.666	1.789	12.321*	2.762	1.958	5.030	16.128*	6.750
p	0.435	0.409	0.015*	0.737	0.855	0.412	0.000*	0.240
$TRAINING_{(B)}$								
χ^2	5.715*	5.011*	8.803*	1.062	10.113*	2.844	4.295*	1.450
p	0.050*	0.050*	0.050*	0.957	0.050*	0.724	0.038*	0.919
$IMARKET_{(B)}$								
χ^2	3.074	1.044	6.992	2.700	1.207	3.157	0.046	3.285
p	0.215	0.593	0.136	0.746	0.944	0.676	0.512	0.656
$TECHNIC_{(N)}$								
χ^2	10.352*	1.213	4.230	10.310	13.919	8.217	0.173	9.366
p	0.035*	0.876	0.836	0.414	0.177	0.608	0.917	0.498
Family unit								
$INHERIT_{(N)}$								
χ^2		14.342*	5.966	6.879	16.724*	6.737	1.819	11.002
p		0.006*	0.651	0.737	0.050*	0.750	0.403	0.357
$BEQUEST_{(N)}$								
χ^2	14.342*		4.801	10.754	18.287*	5.856	2.350	7.047
p	0.006*		0.779	0.377	0.050*	0.827	0.309	0.721
$PERSONAL_{(O)}$								
χ^2	16.724*	18.287*	15.895	27.385		101.468*	5.183	19.216
p	0.050*	0.050*	0.723	0.337		0.000*	0.394	0.787
$FAMILY_{(O)}$								
χ^2	6.737	5.856	22.997	25.662	101.468*		11.158*	28.486
p	0.750	0.827	0.289	0.426	0.000*		0.048*	0.286
$MACHINERY_{(B)}$								
χ^2	1.819	2.350	3.929	19.003*	5.183	11.158*		2.179
p	0.403	0.309	0.416	0.002*	0.394	0.048*		0.824
$PROFESS_{(O)}$								
χ^2	11.002	7.047	12.485	23.268	19.216	28.486	2.179	
p	0.357	0.721	0.898	0.562	0.787	0.286	0.824	
Forest property and land-use changes								
$FMEADOW_{(B)}$								
χ^2	0.082	0.126	3.687	22.165*	1.276	2.811	1.154	1.999
p	0.960	0.939	0.450	0.000*	0.937	0.729	0.406	0.849
$MWOOD_{(B)}$								
χ^2	1.201	2.883	4.716	0.783	11.833*	6.019	0.031	3.233
p	0.548	0.237	0.318	0.978	0.037*	0.304	0.526	0.664
$CSPECIE_{(B)}$								
χ^2	0.897	0.788	1.842	5.757	11.377*	8.154	4.341*	9.847*
p	0.639	0.674	0.765	0.331	0.044*	0.148	0.031*	0.050*
$IFOREST_{(B)}$								
χ^2	4.325	0.673	12.004*	1.241	6.522	8.995	0.100	12.387*
p	0.115	0.714	0.017*	0.941	0.259	0.109	0.465	0.030*
Forest economics								
$REQUEST_{(B)}$								
χ^2	6.853*	0.808	4.692	2.846	3.997	2.548	0.696	8.849
p	0.033*	0.667	0.320	0.724	0.550	0.769	0.285	0.115

Note: variable subscripts indicate the type of variable used in the statistical analysis (N = nominal; O = ordinal; B = binary).
*Statistically significant ($p<0.05$).

across variables was analysed using the Kruskal–Wallis' *H* test, a non-parametric test of variance homogeneity equivalent to one-way anova (Table VI). Confirming this premise, pairwise comparisons were conducted using the Dunnett's T3 test to determine which categories (levels) of nominal/ordinal (independent) variables showed behaviours (means) that were significantly different from the

Table V. Correlations among continuous and/or nominal, ordinal and binary variables.

	$INHERIT_{(N)}$	$BEQUEST_{(N)}$	$HOUSEHOLD_{(C)}$	$REINVEST_{(C)}$	$PERSONAL_{(O)}$	$FAMILY_{(O)}$	$MACHINERY_{(B)}$	$PROFESS_{(O)}$
Owner land management practices								
$PLANT_{(C)}$								
ρ	0.124	−0.020	0.208	−0.124	0.130	0.095	0.183	0.408**
p	0.256	0.853	0.055	0.257	0.233	0.385	0.092	0.000**
$TREAT_{(C)}$								
ρ	−0.010	0.013	0.149	0.079	0.014	−0.056	0.373**	0.251*
p	0.926	0.903	0.170	0.470	0.899	0.608	0.000**	0.020*
$HARV_{(C)}$								
ρ	−0.157	−0.014	0.190	−0.032	0.095	0.002	0.133	0.302**
p	0.148	0.901	0.079	0.768	0.382	0.989	0.223	0.005**
Landowner profile								
$AGE_{(C)}$								
ρ	0.146	−0.032	−0.416**	−0.015	−0.018	−0.035	−0.203	−0.062
p	0.179	0.773	0.000**	0.892	0.867	0.752	0.061	0.569
$EDUC_{(O)}$								
ρ			0.336**	−0.215*				
p			0.002**	0.047*				
$OCCUP_{(N)}$								
ρ			0.379**	−0.121				
p			0.000**	0.269				
$FARM_{(B)}$								
ρ			0.343**	0.304**				
p			0.001**	0.004**				
$ASSOC_{(B)}$								
ρ			0.259*	0.151				
p			0.016*	0.164				
$TRAINING_{(B)}$								
ρ			−0.084	−0.079				
p			0.441	0.471				
$IMARKET_{(B)}$								
ρ			−0.122	0.004				
p			0.261	0.974				
$TECHNIC_{(N)}$								
ρ			0.058	−0.016				
p			0.599	0.887				
Family unit								
$INHERIT_{(N)}$								
ρ			−0.009	0.034				
p			0.937	0.757				
$BEQUEST_{(N)}$								
ρ			0.095	0.056				
p			0.382	0.608				
$HOUSEHOLD_{(C)}$								
ρ	−0.009	0.095		0.077	−0.086	−0.107	0.197	0.166
p	0.937	0.382		0.481	0.432	0.327	0.069	0.127
$REINVEST_{(C)}$								
ρ	0.034	0.056	0.077		−0.021	0.099	0.400**	−0.289**
p	0.757	0.608	0.481		0.846	0.363	0.000**	0.007**
$PERSONAL_{(O)}$								
ρ			−0.086	−0.021				
p			0.432	0.846				
$FAMILY_{(O)}$								
ρ			−0.107	0.099				
p			0.327	0.363				
$MACHINERY_{(B)}$								
ρ			0.197	0.400**				
p			0.069	0.000**				
$PROFESS_{(O)}$								
ρ			0.166	−0.289**				
p			0.127	0.007**				
Forest property and land-use changes								
$FMEADOW_{(B)}$								
ρ			0.182	0.214*				
p			0.094	0.048*				
$MWOOD_{(B)}$								
ρ			−0.117	0.003				
p			0.283	0.981				

Table V (*Continued*)

	$INHERIT_{(N)}$	$BEQUEST_{(N)}$	$HOUSEHOLD_{(C)}$	$REINVEST_{(C)}$	$PERSONAL_{(O)}$	$FAMILY_{(O)}$	$MACHINERY_{(B)}$	$PROFESS_{(O)}$
$CSPECIE_{(B)}$								
ρ			0.006	0.161				
p			0.953	0.139				
$IFOREST_{(B)}$								
ρ			0.087	−0.081				
p			0.424	0.458				
$PLOT_{(C)}$								
ρ	0.044	−0.129	−0.250*	0.102	0.058	0.014	−0.119	−0.246*
p	0.685	0.237	0.020*	0.349	0.595	0.897	0.277	0.022*
$SIZE_{(C)}$								
ρ	0.039	0.050	0.085	−0.226*	−0.035	0.109	0.089	0.277**
p	0.721	0.647	0.437	0.036*	0.749	0.317	0.416	0.010**
Forest economics								
$INVEST_{(C)}$								
ρ	0.246*	0.082	0.007	−0.024	0.094	−0.058	0.145	0.308**
p	0.023*	0.455	0.946	0.826	0.394	0.600	0.186	0.004**
$PEXP_{(C)}$								
ρ	0.224*	−0.001	0.220*	0.031	0.225*	0.109	0.174	0.402**
p	0.039*	0.995	0.043*	0.780	0.038*	0.321	0.111	0.000**
$TEXP_{(C)}$								
ρ	0.013	−0.054	0.166	0.097	0.009	0.037	0.073	0.313**
p	0.911	0.627	0.134	0.385	0.939	0.738	0.513	0.004**
$REQUEST_{(B)}$								
ρ			−0.084	−0.153				
p			0.442	0.159				
$SUB_{(C)}$								
ρ	0.073	−0.079	−0.022	−0.005	−0.005	0.022	0.070	0.189
p	0.503	0.467	0.840	0.966	0.964	0.841	0.524	0.082
$TINCOME_{(C)}$								
ρ	−0.097	−0.009	0.151	−0.042	0.177	0.002	0.172	0.207
p	0.387	0.939	0.174	0.707	0.111	0.986	0.123	0.062
$TPRICE_{(C)}$								
ρ	−0.081	−0.056	0.120	−0.042	0.225*	0.114	0.162	0.206
p	0.471	0.617	0.284	0.711	0.042*	0.309	0.145	0.063
$NTINCOME_{(C)}$								
ρ	0.034	0.045	0.105	0.502**	0.079	−0.004	0.203	0.048
p	0.761	0.689	0.346	0.000**	0.480	0.973	0.066	0.664

Note: variable subscripts indicates which typology of variable was used in the statistical analysis (C = continuous; N = nominal; O = ordinal; B = binary).
Statistically significant coefficients: $^{**}p < 0.01$, $^{*}p < 0.05$.

continuous (dependent) variables. Homogeneous subgroups of similar statistical behaviour were finally defined by Tukey's HSD procedure, after the significant differences had been tested.

Results and discussion

Evolution of rural property

Patterns of land acquisition and future transmission may be important indicators of NIPFOs' land decisions. In this sense, Hardie and Parks (1996), Conway et al. (2003) and Ross-Davis et al. (2005) have documented that maintaining the viability of the property by land management by future landowners through inheritance may be a key to securing the continuity of the forest sector. In Mariña Oriental, this study only verified that the INHERIT group significantly affected the annual plantation behaviour ($H = 5.973$). The I_{H2} owners annually planted over 2% of their forestlands, which differed significantly from the owners whose holdings were acquired solely through purchasing (0.3%). A similar trend was observed for the annual investment in this activity; the annual expenditure on planting and the pattern of land acquisition were weakly and positively correlated ($\rho = 0.224$). In this case, significant differences were observed in the mean investment in forest plantation for the I_{H1} and I_{H2} groups ($H = 6.732$). Again, I_{H2} owners developed the most active forest activity, and invested annually in planting almost twice as much as the I_{H1} group.

Furthermore, the main occupation of owners significantly varied based on the pattern of land acquisition ($\chi^2 = 22.191$). Retired farmers represented a specific group with holdings that were mainly acquired by purchasing and inheriting. In brief, retired farmers would be more likely to make land transactions for improving and increasing their former agricultural productivity, and hence show a more significant land mobility (Marey et al., 2004). The large fraction of retired farmers in the I_{H2} group might

Table VI. Significant differences in continuous variables based on nominal, ordinal and/or binary explanatory variables.

	$INHERIT_{(N)}$	$BEQUEST_{(N)}$	$HOUSEHOLD_{(O)}$	$REINVEST_{(O)}$	$PERSONAL_{(O)}$	$FAMILY_{(O)}$	$MACHINERY_{(B)}$	$PROFESS_{(O)}$
Owner land management practices								
$PLANT_{(C)}$								
H	5.973*	1.104	5.352	7.720	4.646	9.527*	2.846	23.670*
p	0.050*	0.576	0.253	0.172	0.461	0.050*	0.092	0.000*
$TREAT_{(C)}$								
H	0.102	0.320	2.062	5.917	4.241	3.371	11.854*	11.541*
p	0.950	0.852	0.724	0.314	0.515	0.643	0.001*	0.042*
$HARV_{(C)}$								
H	2.308	0.441	4.734	7.087*	7.182	2.795	1.497	9.499*
p	0.315	0.802	0.316	0.050*	0.207	0.732	0.221	0.050*
Landowner profile								
$AGE_{(C)}$								
H	7.607*	3.085	18.940*	2.629	2.685	4.971	3.487*	4.128
p	0.022*	0.214	0.001*	0.757	0.748	0.419	0.041*	0.531
Family unit								
$HOUSEHOLD_{(C)}$								
H	0.288	0.774		6.965	2.750	3.996	3.291*	4.917
P	0.866	0.679		0.223	0.738	0.550	0.050*	0.426
$REINVEST_{(C)}$								
H	0.249	0.304	2.842		7.298	7.024	13.631*	9.191
p	0.883	0.859	0.585		0.199	0.219	0.000*	0.102
Forest property and land-use changes								
$PLOT_{(C)}$								
H	0.168	1.733	0.079*	4.643	1.245	2.485	1.194	10.939*
p	0.920	0.420	0.050*	0.461	0.941	0.779	0.274	0.050*
$SIZE_{(C)}$								
H	2.909	0.599	9.159*	21.459*	1.189	4.919	0.670	13.131*
p	0.234	0.741	0.050*	0.001*	0.946	0.426	0.413	0.022*
Forest economics								
$INVEST_{(C)}$								
H	8.975*	0.566	0.697	5.573	13.278*	0.631	1.764	19.907*
p	0.011*	0.754	0.952	0.350	0.021*	0.631	0.184	0.001*
$PEXP_{(C)}$								
H	6.732*	0.699	6.059	2.923	6.568	9.003*	2.553	23.701*
p	0.035*	0.705	0.195	0.712	0.255	0.050*	0.110	0.000*
$TEXP_{(C)}$								
H	0.487	0.980	3.768	6.191	1.434	4.891	0.435	13.599*
p	0.784	0.613	0.438	0.288	0.921	0.429	0.509	0.018*
$SUB_{(C)}$								
H	1.200	0.536	6.348	0.632	4.523	2.124	0.413	6.806*
p	0.549	0.765	0.175	0.986	0.477	0.832	0.521	0.050*
$TINCOME_{(C)}$								
H	1.512	2.288	2.254	7.936	11.509*	8.356*	2.393	7.036*
p	0.470	0.319	0.689	0.160	0.042*	0.050*	0.122	0.050*
$TPRICE_{(C)}$								
H	1.602	1.600	3.475	10.313*	16.877*	10.017*	2.135	9.739*
p	0.449	0.449	0.482	0.050*	0.005*	0.050*	0.144	0.039*
$NTINCOME_{(C)}$								
H	0.256	2.161	2.089	21.207*	2.914	15.083*	3.373*	2.588
p	0.880	0.339	0.719	0.001*	0.713	0.010*	0.066*	0.763

Note: variable subscripts indicate the type of variable used in the statistical analysis (C = continuous; N = nominal; O = ordinal; B = binary).
*Statistically significant ($p < 0.05$).

account for the negative association observed between the pattern of land acquisition and the landowner's condition as an active farmer ($D = -0.255$). None of the I_{H3} owners was a retired farmer, in contrast to the I_{H1} and I_{H2} groups, where retired farmers amounted to 41% and 67%, respectively ($\chi^2 = 7.769$). Condition of the owner as a retired farmer might moreover explain the fact that the mean age of owners in the I_{H2} group was significantly higher than the mean age of the owners included in the I_{H3} group ($H = 7.607$). More than 61% of the I_{H2} owners were more than 65 years old, as opposed to 75% of the owners in the I_{H1} and I_{H3} groups, who were 40–65 years old. The important fraction of retired farmers included in the I_{H2} group and the noticeable planting behaviour of this group could suggest that these landowners invested in agricultural marginal land as capital, as reported by several authors (Karppinen, 1998; Gunter et al., 2001; Kurttila et al., 2001; Arano et al., 2004; Marey et al., 2004).

In addition, the strong forest involvement of the I_{H2} group was evidenced by the large fraction of owners who were interested in increasing their woodland in the near future. In the study area, the intention of further enlarging woodlands on the holding increased in those landowner groups who had inherited and purchased land ($D=0.187$). In particular, 56% of the I_{H2} owners and 34% of the owners in the remaining groups wanted to extend their productive woodland in the short to mid-term. In keeping with other studies, the major cause of this behaviour could be attributed to previous harvests and resulting timber sales, i.e. to the interest in timber production (Hardie & Parks, 1996; Bolkesjø & Baardsen, 2002; Kline et al., 2002; Li & Zhang, 2004). The annual ratio of woodland harvesting increased very strongly in proportion to the annual timber income and stumpage price per unit from previous harvests ($\rho=0.809$ and 0.781, respectively, at $p<0.01$). Moreover, this forest practice grew slightly when the landowner intended to enlarge woodlands in the future ($\rho=0.242$ at $p<0.05$). Landowners who had the intention of enlarging woodlands harvested twice as much woodland per year as the remaining population of owners ($H=4.972$), with a timber income of €100 per year more ($H=3.118$) at almost double unitary price ($H=3.104$).

Verifying the previous hypothesis about land capitalization, the annual investment in holding improvement increased weakly in forest holdings that combined inherited and purchased land ($\rho=0.246$). The I_{H2} owners spent six times more per year on new forest buildings or infrastructure than the I_{H3} group, a statistically significant mean difference ($H=8.975$). Taking into account that converting former meadows into woodlands as a production alternative for the holding was negatively related to the landowner's condition as an active farmer, because such a land practice is clearly linked to retired farmers ($D=-0.233$), it was shown that such landowners were effectively capitalizing on their marginal land by plantation. In addition, the great investment in annually improving and planting the holding rose weakly in relation to the payment of public subsidies received annually in forestry ($\rho=0.297$ at $p<0.01$ and 0.246 at $p<0.05$, respectively). This finding would prove the significant role of public measures in NIPFOs' land management decisions (Hodges & Cubbage, 1990; Gunter et al., 2001; Zhang & Flick, 2001; Kline et al., 2002; Arano et al., 2004). Under these circumstances, the likelihood of applying for public subsidies increased when the owner managed both types of land ($D=0.203$). The proportion of I_{H2} owners who applied for economic subsidies was three times the ratio observed for the I_{H1} group; conversely, none of the I_{H2} landowners applied for forest subsidy ($\chi^2=6.853$).

The status of farmers, both current and former, might justify the personal labour force used for forestry in Mariña Oriental. The surveyed farmers generally managed their land themselves, and in particular, they had more time for forest management, as Zhang and Mehmood (2001) and Karppinen (2005) have pointed out. Thus, the personal time annually devoted to forestry was positively associated with the pattern of land acquisition ($D=0.296$). Landowners who had both inherited and purchased land spent annually a higher amount of personal labour-days in forestry on their holdings. Even though 47% of the I_{H1} and I_{H2} owners spent annually more than 11 personal labour-days on forestry, none of the I_{H3} owners worked on the holding above this threshold ($\chi^2=16.724$).

Spending more time working on the property may result in better forestry training, which would qualify landowners for managing land (Dennis, 1990; Löyland et al., 1995; Mahapatra & Mitchell, 2001; Arano et al., 2004). In the study region, the way in which forestland was acquired was positively correlated with the landowners' forest training ($D=0.195$) and, specifically, with their knowledge about timber market conditions ($D=0.169$). Again, owners who managed inherited and purchased land were generally better trained in these subjects. Over 30% of the I_{H2} owners were trained in forestry, compared with 8% in the remaining groups ($\chi^2=5.715$). In particular, 21% of the I_{H2} owners knew and applied the suitable rotation age in previous harvests, compared with less than 3% of the I_{H1} owners and none of the I_{H3} group who considered these requirements ($\chi^2=10.352$). This result, together with the result obtained for personal time used for forestry, confirmed that forest training may enable landowners to overcome some management difficulties and to take a more active role in forestry, as suggested by Dole (1995), Zhang and Mehmood (2001) and Kittredge (2005), among others.

Furthermore, the results obtained for the future prospects for forestlands based on INHERIT group were significantly different ($\chi^2=14.342$). Over 97% of the I_{H1} and I_{H2} owners wanted to pass the holding on to their heirs, independently of holding profitability, while less than 67% of the I_{H3} owners expected to do so in the near future. As a first conclusion, it may be suggested that land transmission governed by emotional values (inheritance-to-bequeath) seems to be a clear motivation for taking care of the holding and passing it on to future generations as best landowners can. Literature on the relationships between land tenure and forest management has generally recognized legacy as key

to land investment (Conway et al., 2003; Ross-Davis et al., 2005; Marey et al., 2006). Such a strong emotional relationship would additionally explain why landowners in the region continued to work their land, although they did not receive regular income from it.

To complete this hypothesis, the authors tested whether significant differences were observed for the personal labour force used for forestry annually according to the future plans for the property ($\chi^2 = 18.287$). All B_{E2} owners spent more than 11 labour-days per year on their holding, and more specifically, half of the owners in this group worked more than 100 labour-days per year. In contrast, 67% of the B_{E3} owners devoted less than 2 labour-days per year to forestry. In line with Karppinen (1998) and Ingemarson et al. (2006), inheritance-to-bequeath, and not only economic criteria, may be a significant reason for securing the continuity of forest management. As mentioned above, this apparent commitment to land management was linked to the owner's training in forestry, which may reduce some difficulties in forest management. Half of the B_{E2} owners, none of the B_{E3} group and less than 8% of the B_{E1} owners were trained in forestry ($\chi^2 = 5.011$). Again, the important role of forest knowledge in identifying and understanding management opportunities and constraints was proven.

Support to the family economy

Household income. The HOUSEHOLD group was not a significant factor in the three forest practices analysed in the study region, in agreement with Bolkesjø and Baardsen (2002), Pattanayak et al. (2002) and Potter-Witter (2005), but contrary to the results reported by other authors (Dennis, 1990; Kuuluvainen et al., 1996; Gunter et al., 2001; Zhang & Flick, 2001; Arano et al., 2004). This result may be clarified by the fact that none of the interviewed landowners mentioned forestry as his or her main occupation, but rather as a complementary activity that supported the family's well-being. Nevertheless, landowners with a higher annual income per household were more likely to plant and improve their forestlands, and to harvest their woodlands annually. In light of these results, even without statistical evidence, large forest investments may be made by owners with higher family income, in keeping with other studies focused on the positive effects of household earnings on forest involvement (Gunter et al., 2001; Mahapatra & Mitchell, 2001; Arano et al., 2004; Ross-Davis et al., 2005). Timber harvesting may not work as a supplementary source of income for the family unit in times of economic difficulty. Dennis (1990), Kuuluvainen and Salo, (1991) and Kuuluvainen et al. (1996), among other authors, have statistically confirmed that family earnings negatively affect timber harvesting activity.

To verify the previous statement about forest investment intensity based on landowners' income, it was confirmed statistically that annual expenditure on forest plantation weakly increased in relation to annual household income ($\rho = 0.220$). Mean values were not statistically significant; landowners whose income exceeded €9000 per year invested almost €100 ha^{-1} per year more in planting their forestlands than those groups with household earnings not reaching this economic figure. This premise was completed by the assumption that the landowner's intention of further enlarging woodlands was significantly different according to the group of family earnings considered ($\chi^2 = 12.004$). The H_{H5} group included the largest fraction of owners interested in enlarging woodlands (76.5%), whereas this ratio did not reach 43% in the intermediate income groups (H_{H2} and H_{H3} landowners). In contrast, the study population with annual earnings per family unit below €6000 or above €30,000 was clearly the least interested in the measure (21.8%).

The moderate decrease in the annual income earned per family unit with the increase in the landowner's age ($\rho = -0.416$), and the moderate increase in the annual income with the increase in the owner's educational level ($\rho = 0.336$) allowed landowners who received a high annual household income to be characterized. Pairwise comparisons revealed that the mean age of owners in the H_{H2} group was significantly higher than the mean age of the owners included in the H_{H4} and H_{H5} groups ($H = 18.940$). While 67% of the H_{H2} owners were more than 65 years old, 75.2% of the owners included in the H_{H4} and H_{H5} groups were 40–65 years old. The significant differences observed in landowners' mean age according to HOUSEHOLD group classified the study population as shown in Table VII. With regard to landowners' educational level, there were no significant differences. Over 63% of the study population with an annual family income above €9000 had completed primary or secondary education and, in particular, 9.8% of them had completed a university degree. Conversely, none of the owners included in the H_{H1} and H_{H2} groups had an educational level higher than secondary studies, and more than 60% had received no formal education.

The moderate positive correlations found between the annual family income and the owner's primary occupation and his or her specific condition as an active farmer defined the previous landowner profile ($\rho = 0.379$ and 0.343, respectively). Over 71% of the H_{H1}, H_{H2} and H_{H3} owners were retired farmers, an

Table VII. Homogeneous HOUSEHOLD subgroups according to landowner's age (years) and size of productive forest holding (ha).

HOUSEHOLD	H_{H1}	H_{H2}	H_{H3}	H_{H4}	H_{H5}	*p*
% of interviewed landowners	10.5	17.4	36.0	19.8	16.3	
AGE						
New landowner	67.56		68.19	55.65	56.43	0.055
Retired landowner	67.56	71.13	68.19			0.935
SIZE						
Small landowner	2.92	4.59	4.93	3.33		0.575
Large landowner		4.59	4.93		7.51	0.209

occupational group which diminished in the H_{H4} and H_{H5} groups, where more than 56% were professionals not linked to agriculture and 25% were active farmers, respectively ($\chi^2 = 34.207$). The fraction of active farmers was significantly different based on the group of family earnings ($\chi^2 = 12.208$). Therefore, not only were retired farmers more likely to invest in land to keep them productive, as suggested earlier, but also owners who did not work actively on their property were also actively involved in forestry. These results are in line with those reported by Karppinen (1998), Gunter et al. (2001), Marey et al. (2004) and Rickenbach et al. (2005).

Furthermore, the fraction of owners who were trained in forestry was significantly different according to the annual income per family unit ($\chi^2 = 8.803$). For the same reasons discussed in the previous section, the status of the landowner as an active or a retired farmer may justify that all the owners in the study area, except for the H_{H4} and H_{H5} groups, were trained in forestry. The owner's occupation within the farming activity may account for the weak increase in the likelihood of participating in agricultural and forestry bodies observed with the increase in the annual income per family unit ($\rho = 0.259$). Professional associations in Mariña Oriental were mainly agricultural groups, more specifically co-operatives or trade unions, in which 35% and 55% of the participants were active farmers and retired farmers, respectively. On average, for each H_{H1} and H_{H2} owner who was involved in an association, two H_{H4} owners and three H_{H5} owners participated in the association ($\chi^2 = 12.321$).

Finally, the lowest degree of land fragmentation was found in productive forestlands belonging to owners who earned the highest annual household income ($\rho = -0.250$). *Post hoc* analyses showed that H_{H5} landholdings were significantly less fragmented than H_{H3} and H_{H4} productive forestlands ($H = 0.079$). The most prevalent primary occupations in the H_{H1}, H_{H2} and H_{H3} groups were retired (70.4%) and active (18.6%) farmers, respectively, which may explain why the most fragmented plots in the region belonged to these landowners (four plots per unit of productive forestland). As shown by Butler et al. (2004) and Marey et al. (2006), land fragmentation may be motivated mainly by the demand for improving and increasing agricultural productivity. Such a landowner categorization may also clarify the significant differences observed in the production size of the forest holding based on the group of annual household considered ($H = 9.159$). Pairwise comparison analyses revealed that the holdings of the H_{H5} owners were significantly different in size from the holdings of the H_{H1} and H_{H4} owners, and differentiated two significant landowner subgroups in the area (Table VII). Therefore, these results agree with those of Nagubadi et al. (1996): landowners with a higher income were more likely to manage larger forest holdings effectively.

Forest reinvestments. The behaviour of the annual ratio of timber harvesting was significantly different according to the annual rate of dependency on forest products for personal use. In this sense, R_{E5} owners were the most active harvesters in the region, and harvested annually almost three times more woodland than the owners in the R_{E1} group ($H = 7.087$). Table VIII shows two significant forest-consumer profiles in Mariña Oriental. Such a classification would be largely associated with the landowner's primary occupation, more specifically with his or her condition as an active farmer. As described by Dewees (1992), Kurttila et al. (2001) and Marey et al. (2004), while some owners would be less dependent on forestry because of the increased proportion of other incomes, farmers might become more dependent on forestry as a source of revenue because of a reduced development of the agricultural income. Hence, farmers would be great consumers of forest products for self-consumption.

The annual amount of forest products for personal use increased with the owner's involvement in agriculture ($\rho = 0.304$). For each R_{E0} and R_{E1} owner who was an active farmer, two R_{E4} and R_{E5} owners were active farmers ($\chi^2 = 9.404$). More than half of

Table VIII. Homogeneous REINVEST subgroups with regard to annual ratio of harvesting (%) and income from land sales (€ ha^{-1} per year).

REINVEST	R_{E0}	R_{E1}	R_{E2}	R_{E3}	R_{E4}	R_{E5}	*p*
% of interviewed landowners	27.9	32.5	23.3	10.5	3.5	2.3	
HARV							
Non-harvester	4.42	3.32	2.34	2.23	4.20		0.816
Harvester	4.42	3.32	2.34	2.23	4.20	8.40	0.051
NTINCOME							
Non-forest consumer	78.44	141.44	154.87	338.64		426.94	0.260
Forest consumer		141.44	154.87	338.64	548.51	426.94	0.124

the landowners included in the R_{E0} and R_{E1} groups were retired farmers. Educational level was another landowner attribute that was statistically associated with annual dependency on forestry. The annual fraction of forest products for self-consumption weakly declined in relation to the owner's formal education ($\rho = -0.215$). The descriptive statistics showed that owners with primary studies, a group comprising mainly active farmers, actively benefited from forests for self-consumption, with an average reinvestment of €65 ha^{-1} per year, which was three times the mean value obtained for the owners with tertiary education. Even though this result was not statistically proven, the profile of the owner as an active farmer and his or her forest management guidelines suggest that these landowners were active harvesters, in line with the findings reported by Mahapatra and Mitchell (2001) and Pattanayak et al. (2002). Thus, the annual ratio of timber harvesting by farmers reached twice the fraction observed for other landowners in the study area. In Mariña Oriental, only the annual ratio of silviculture was weakly correlated with the owner's condition as an active farmer ($\rho = 0.212$ at $p < 0.05$).

As previously suggested for the level of participation of landowners in professional bodies, farming occupation and, therefore, a stronger relationship with land management, may also justify the moderate increase in availability of equipment according to the annual rate of forest reinvestment ($\rho = 0.400$). In fact, both the level of participation in associations and the availability of machinery increased with the owner's status as an active farmer ($D = 0.508$ and 0.312, respectively). All R_{E5} owners had machinery on the holding, while less than half the R_{E0} and R_{E1} owners had these resources for forest management ($\chi^2 = 19.003$). As suggested by Hodges and Cubbage (1990), it may be concluded that technology users seemed to be more likely to participate in social groups and to share experience.

The owner's main occupation may also account for the slight increase in the annual amount of professional forest labour on the holding with the decrease in the annual amount of forest products for self-consumption ($\rho = -0.289$). According to the literature reviewed (Löyland et al., 1995; Zhang & Mehmood, 2001; Finley, 2002; Conway et al., 2003; Arano et al., 2004; Kittredge, 2005; Potter-Witter, 2005), forestry would generally be less feasible for managers with occupations outside the property. The absence of the landowner would consequently force him or her to hire an important fraction of professional assistance in forestry. Hardie and Parks (1996), Gunter et al. (2001) and Zhang and Flick (2001) analysed the role of technical guidance in forest adoption and management. Landowner absence from the holding may explain the fact that R_{E4} owners hired workers for less than 5 labour-days per year, whereas the R_{E0} group spent 11–50 labour-days annually on professional labour. This technical advice from professional foresters may cause the significant mean differences in the stumpage price per unit between R_{E5} landowners and landowners in the R_{E0}, R_{E1} and R_{E2} groups ($H = 10.313$). The R_{E1} owners were characterized by having sold timber at the best stumpage price per unit, a mean of €5.70 t^{-1}. Thus, R_{E0}, R_{E1} and R_{E2} landowners sold timber from previous harvests at a unitary price that was twice as high as the economic value fixed by the R_{E5} group.

The change from forestland into meadow was weakly and positively correlated with the annual rate of forest reinvestment ($\rho = 0.214$). All R_{E5} owners were active farmers and, as expected, all of them made this land-use change; conversely, none of the R_{E0} and R_{E1} owners had converted forestlands into meadows, but 29% of them had made the opposite land-use change, from marginal meadow into woodland ($\chi^2 = 22.165$). This finding finally supported that both retired farmers and professionals not related to farming initiated forestry over marginal land, following the production trend observed for the great majority of NIPFOs (Karppinen, 1998; Gunter et al., 2001; Kurttila et al., 2001; Arano et al., 2004; Marey et al., 2004). Land sale also seemed to be clearly dependent on the landowner's

condition as an active farmer. In the study area, the annual income from land sales was largely and positively associated with the annual rate of forest reinvestment for self-consumption ($\rho = 0.502$). Owners in the R_{E4} and R_{E5} groups benefited from a non-timber income that was significantly higher than the income for R_{E0} owners, with a mean difference of €410 ha^{-1} per year ($H = 21.207$) (Table VIII). The moderate increase in annual income with respect to the annual ratio of timber harvesting ($\rho = 0.341$ at $p < 0.01$) would additionally suggest that these marketable forestlands were previously harvested for selling and, hence, the remarkable rate of forest products for self-consumption.

Finally, the annual rate of forest reinvestment barely rose in holdings with the smallest forest production size ($\rho = -0.226$). On the one hand, R_{E1} and R_{E2} owners managed forest landholdings that differed significantly in size, with over 3.2 ha more in favour of the R_{E1} group; on the other hand, these two types of landowner had productive forest holdings significantly larger than the R_{E4} and R_{E5} groups ($H = 21.459$). Meanwhile, 53.6% of R_{E1} and R_{E2} owners managed landholdings with more than 3.51 ha of productive forestland, and 58.4% of the R_{E4} and R_{E5} groups had forestlands ranging 1 to 1.7 ha. According to these results and to other previous cases, owners with occupations linked to agriculture (R_{E4} and R_{E5} groups) were certainly more likely to manage small fragmented holdings to intensify their agricultural production. The agricultural practice and its important relationship with land fragmentation was stressed by Butler et al. (2004) and Marey et al. (2006), as mentioned in the above sections.

Quantifying forest management

The PERSONAL group seemed to have no influence on the three forest practices analysed in Mariña Oriental. Nevertheless, the fraction of personal time devoted to the landholding affected the expenditure on forest plantation. Thus, the annual amount of personal labour-days used for forestry rose slightly in proportion to annual investment in planting forestlands ($\rho = 0.225$). On average, the P_{E5} and P_{E6} landowners spent annually on this practice €74 ha^{-1} more than the P_{E1}, P_{E3} and P_{E4} groups. The lowest investment in plantation was carried out by the P_{E2} owners, with an average of €125 ha^{-1} per year. Family aid noticeably supported the forest plantation pattern, as suggested in previous studies (Marey, 2003; Karppinen, 2005). The annual ratio of planting forestlands and its expenditure significantly differed according to the amount of labour devoted annually to forestry by family members ($H = 9.527$ and 9.003, respectively). Table IX shows that F_{M6} owners planted more forestlands and invested more on this forest activity annually than the remaining landowners. However, differences were statistically significant only between the F_{M3} and F_{M5} groups.

This behaviour may be clarified on the basis of three key factors: the labour-days devoted to forestry by the owner annually, his or her training in forestry, and the availability of machinery on the holding. On the one hand, the annual fraction of personal time for land management increased in the holdings that belonged to landowners trained in forestry ($D = 0.209$). None of the P_{E1}, P_{E2} or P_{E3} owners was trained in this subject, compared with 17% of the remaining owners ($\chi^2 = 10.113$). On the other hand, the family labour force on the holding was based on

Table IX. Homogeneous FAMILY subgroups with regard to annual ratio (%) and expenditure (€ ha^{-1} per year) on plantation, and income (€ ha^{-1} per year) and stumpage price per unit (€ t^{-1}) from timber sales.

FAMILY	F_{M1}	F_{M2}	F_{M3}	F_{M4}	F_{M5}	F_{M6}	*p*
% of interviewed landowners	43.0	11.6	8.1	14.0	17.4	5.9	
PLANT							
Absent planter	1.51	2.35	0.34	0.74	1.52		0.532
Family planter	1.51	2.35			1.52	4.43	0.142
PEXP							
New planter	184.09	185.07	69.16	171.52	238.30		0.260
Family planter	184.09	185.07		171.52	238.30	370.18	0.121
TINCOME							
New wood seller	193.22	154.54	62.86	145.30	107.47		0.659
Family wood seller	193.22	154.54		145.30		362.35	0.133
TPRICE							
New timber industrialist	3.53	4.68	2.14	3.30	3.73		0.733
Family timber industrialist						10.56	1.000

the availability of equipment. For each F_{M1} and F_{M2} owner who had machinery on his or her holding, there were two F_{M5} and F_{M6} owners who had these logistic resources as support for forest management ($\chi^2 = 11.158$). Finally, the annual amounts of personal and family labour were interrelated ($\chi^2 = 101.468$). On average, the relatives of P_{E4} and P_{E5} owners spent annually 11–50 labour-days on forestry, while P_{E1} and P_{E2} owners received less than 11 family labour-days per year, and P_{E3} and P_{E6} owners benefited annually from an amount of family support which was slightly less than the amount of labour contributed by the owner.

As expected, in this study the owner profile was a key factor in clarifying this behaviour. Thus, retired and active farmers received important support from their relatives and devoted a high fraction of personal labour-days to forestry on the holding. Conversely, professionals who did not work at their property usually relied on professional assistance to make forest management viable. Two-thirds of the landowners who spent more than 11 labour-days per year on forestry, both personally and in family labour, were retired and active farmers. Over 46% of the owners who annually devoted less than 11 personal and family labour-days to forestry were active workers outside agriculture. Under these circumstances, the inheritance-to-bequeath pattern may indicate not only that owners worked their land themselves, but also that owners received family support on land management. Again, it was observed that an emphasis solely on economic criteria did not determine a more active forest commitment or management, as suggested by Karppinen (1998) and Ingemarson et al. (2006).

Farming occupation, specifically former farming, may be the reason why owners who managed both inherited and purchased land spent more personal time on managing forestlands. Thus, the amount of labour-days spent annually by the landowner on managing forestlands was positively linked to the pattern of land acquisition ($D = 0.296$). While 60% of the P_{E4}, P_{E5} and P_{E6} owners were characterized by managing both types of land, 67% of the owners in the remaining groups owned fully inherited land ($\chi^2 = 16.724$). As suggested by the results obtained for the future pattern of land transmission, P_{E1}, P_{E2} and P_{E3} owners were more interested in selling their land in the short to mid-term, compared with the remaining population of owners, who tried to pass some or all of their land on to future generations ($\chi^2 = 18.287$).

To complete the above hypothesis about forest capitalization over marginal land, it was observed that the fraction of landowners who converted former meadows into woodlands was significantly different according to the group of personal labour force considered ($\chi^2 = 11.833$). As expected, all P_{E6} owners and more than one-third of the owners included in the P_{E4} and P_{E5} groups made this land-use change on their holding, compared with 14% of the owners in the remaining groups. Retired farmers were investing in agricultural marginal land by planting, a forest practice in which family aid was an important support. P_{E5} and P_{E6} owners spent annually two and three times more on holding improvement, respectively, than the P_{E1} group. Table X shows the significant mean differences in the annual investment in holding improvement based on the PERSONAL group ($H = 13.278$). Therefore, investment intensity and the landowner's commitment to forest management were clearly associated, as reported by many authors (Löyland et al., 1995; Zhang & Flick, 2001; Arano et al., 2004; Kline et al., 2002; Conway et al., 2003).

Such a personal commitment to land capitalization, together with the relationship obtained for personal and family time used for forestry, may also explain the fact that significant differences were tested in the mean annual income from land sales according to the amount of family labour force devoted annually to the holding ($H = 15.083$). The

Table X. Homogeneous PERSONAL subgroups with regard to investment in holding improvement (€ ha^{-1} per year), and income (€ ha^{-1} per year) and stumpage price per unit (€ t^{-1}) from timber sales.

PERSONAL	P_{E1}	P_{E2}	P_{E3}	P_{E4}	P_{E5}	P_{E6}	*p*
% of interviewed landowners	30.2	10.5	12.8	31.4	11.6	3.5	
INVEST							
Non-investor	12.37	0.00	8.54	5.07	24.98		0.390
Planter investor	12.37		8.54	5.07	24.98	38.79	0.107
TINCOME							
Non-wood seller	144.78	47.50	198.45	147.09		162.31	0.567
Wood seller	144.78		198.45	147.09	352.08	162.31	0.219
TPRICE							
Non-timber industrialist	3.14	1.88	4.54	3.43		2.12	0.716
Timber industrialist			4.54		9.76		0.073

F_{M6} landowners showed mean annual returns from this type of land transactions that were significantly lower than non-timber income of the owners included in the F_{M1} and F_{M5} groups. On average, the F_{M6} landowners received almost €190 and 310 ha^{-1} per year less than the F_{M1} and F_{M5} groups, respectively. In particular, 75% and 25% of the F_{M6} owners did not benefit from non-timber income or valued them below €381.8 ha^{-1} per year, respectively. In contrast, 16.7% and 33.3% of the F_{M1} and F_{M5} groups, respectively, obtained income from land sales above this economic figure.

In addition, it was shown that the owner's labour in forestry effectively depended on his or her interest in timber production, in line with other studies on timber market conditions and NIPFOs' land decisions (Pattanayak et al., 2002; Li & Zhang, 2004). Thus, the labour-days spent annually by the owner on managing forestland increased slightly with respect to the stumpage price per unit fixed in previous harvests ($\rho = 0.225$). A multiple comparison analysis showed that the mean annual income and unitary price from timber sales differed significantly according to the groups of personal and family labour-days devoted to forestry. As shown in Table X, P_{E5} owners annually received timber income at significantly higher stumpage prices per unit than the owners in the P_{E1} and P_{E2} groups ($H = 11.509$ and 16.877, respectively). With regard to the amount of family labour force in forestry, Table IX shows notable results for F_{M6} landowners, whose annual income and unitary price from timber sales were significantly higher than the income and unitary price received by the rest of the groups, excluding the F_{M2} group ($H = 8.356$ and 10.017, respectively). Therefore, it was confirmed that interest in timber production, in addition to favourable market conditions, increased not only the owner's involvement in forest management, but also the commitment of the owner's relatives to forestry.

Completing the importance of timber production in forest management in the study area, the likelihood that the landowner would change the current productive forest species and would enlarge woodlands in the future was positively correlated with the amount of personal labour force on the holding ($D = 0.163$ and 0.185, respectively). For each landowner in the P_{E1}, P_{E2} and P_{E3} groups who tried to replace the productive forest species and increase woodland in the short to mid-term, there were almost four and two owners in the other groups, respectively. However, differences in the future intention of changing the current productive forest species among groups of personal labour-days spent on land management were significant ($\chi^2 = 11.377$).

Machinery availability on the holding

The availability of agricultural and forestry machinery on the holding seemed to be moderately and positively related to the annual silviculture ratio in the region ($\rho = 0.373$). Owners in the M_{A1} group treated 2.5% more forestlands annually than the remaining owners ($H = 11.854$). Under this circumstance, some of the equipment available, such as chainsaws, pruning-saws or hand-weeders, could be used for forest improvement activities, despite the agricultural purpose of the equipment available in the great majority of the holdings in Mariña Oriental.

In addition to logistic support on the holding, family labour force used in forest management seemed to affect the silvicultural practices. Thus, the amount of family labour-days devoted annually to forestry showed significant differences on the basis of the availability of equipment ($\chi^2 = 11.158$). As mentioned in previous sections, the holdings of the owners who received annually more family support for forestry were generally better equipped. Thus, 42% of the M_{A1} owners benefited from more than 11 family labour-days per year, compared with 29% of the M_{A0} group. In fact, 29.1% of the owners who had agricultural and forestry machinery received more than 51 family labour-days per year, in contrast to the M_{A0} group, where 12.9% of them received this fraction of family labour on the holding.

Such an important commitment to forest improvement may explain why these M_{A1} owners were more interested in changing their current productive forest species in the short to mid-term. In the study region, the future intention of replacing the current productive forest species increased in accordance with the logistic resources for forest activities ($D = 0.222$). The weak and positive relation observed between this future intention and the annual ratio and expenditure on silviculture corroborated the premise ($\rho = 0.238$ and 0.216, respectively, at $p < 0.05$), and verified that forest expenditure may influence NIPFOs' land management (Gunter et al., 2001; Zhang & Flick, 2001; Kline et al., 2002; Arano et al., 2004; Li & Zhang, 2004). Owners who intended to replace their main productive species treated annually four times more forestland ($H = 4.809$), and invested annually in this practice almost twice as much as those who did not intend to replace it ($H = 3.833$). Such owners are interested in eucalyptus, a fast growing forest species that is highly productive and easy to manage. On average, for each M_{A0} owner who intended to change his or her current productive forest species in the next productive cycle, three M_{A1} owners intended to do so ($\chi^2 = 4.341$).

Once again, the owner profile allowed clarification of the reason behind this forest management guideline. Thus, the availability of machinery on the holding was higher in the holdings that belonged to owners actively engaged in agricultural practice ($D=0.312$). Whereas 34.5% of the M_{A1} owners were active farmers, 6.5% of the M_{A0} owners were active farmers ($\chi^2=8.478$). More specifically, the M_{A0} group included almost twice the number of landowners not related to agriculture than the M_{A1} group, but both groups included a similar fraction of retired farmers, over 54.1% ($\chi^2=12.935$). Therefore, it was verified that the equipment available on the large majority of the studied holdings presented a primarily agricultural purpose. To detail further the characterization of landowners, significant differences in the owner's mean age and educational level were tested according to MACHINERY group. As expected, more than half of the owners included in the M_{A1} group were 40–65 years old, as opposed to 64.5% of the owners in the M_{A0} group, who were over 65 years old ($H=3.487$). Moreover, 48.4% and 32.3% of the M_{A0} owners had no formal education or primary studies, respectively, compared with 30.9% and 56.4% of the owners in the M_{A1} group ($\chi^2=14.839$).

The likelihood of being trained in forestry and participating in professional bodies also increased with the availability of logistic resources on the holding ($D=0.192$ and 0.433, respectively). None of the M_{A0} owners had specific forest training, as opposed to 13% of the owners in the M_{A1} group ($\chi^2=4.295$). With regard to professional associations, only 6% of the M_{A0} owners were members of this type of group, as opposed to almost 50.9% of the owners in the other groups ($\chi^2=16.128$). As mentioned above, forest training and association membership, as well as equipment in the study region, were mainly focused on agriculture. Therefore, it is not surprising that M_{A1} owners were better trained and more organized into professional groups. Corroborating Hodges and Cubbage's (1990) findings, technology users would effectively seem to be more likely to participate in social groups.

With regard to the family unit, the mean annual income per household varied significantly according to the availability of equipment on the holding. On average, the M_{A1} group received almost €4300 per year more than the M_{A0} group ($H=3.291$). In particular, 77% of the M_{A0} owners earned less than €18,000 per year, compared with 76% of the M_{A1} group who exceeded this threshold. Moreover, there was a moderate positive correlation between the annual rate of forest reinvestment and the availability of machinery on the holding ($\rho=0.400$). The owners in the M_{A1} group received annually twice the forest reinvestment as the M_{A0} group ($H=13.631$), possibly because of their farming occupation, as previously stated. Over 54.8% of M_{A0} owners did not benefit from forests for self-consumption, whereas 12.7% and 67.3% of the M_{A1} landowners did not take into account this type of forest product or valued them below €152.4 ha^{-1} per year, respectively.

Professional advice in forestry

Hiring professional assistance in forestry was an important factor in continuing and making forest management viable in the area, as pointed out by other authors (Hardie & Parks, 1996; Gunter et al., 2001; Zhang & Flick, 2001). The annual amount of professional labour force on the holding increased with the annual ratio of forestlands planted ($\rho=0.408$). Consequently, this type of forest assistance had an effect on expenditure on plantation. The number of professional labour-days hired annually on the holding rose moderately in accordance with annual plantation expenditure ($\rho=0.402$). The P_{R5} and P_{R6} groups included the landowners who planted annually the largest amount of forestlands in Mariña Oriental, differing significantly from the remaining population of owners, except for the P_{R4} group ($H=23.670$). In addition, the P_{R5} and P_{R6} groups were also characterized by expending the largest economic amounts on this forest activity annually. In this case, P_{R6} landowners showed mean annual investments in planting forestlands that were significantly different from the rest of the groups, again excluding the P_{R4} group, whereas in the P_{R5} group, such differences were observed among all groups ($H=23.701$). Table XI shows the homogeneous subgroups of landowners formed from these analyses.

In addition, the technical assistance of professional foresters hired annually on the holding increased slightly and moderately, respectively, with the annual ratio of silvicultural treatment in forestlands and woodland harvesting ($\rho=0.251$ and 0.302, respectively). These two forest practices differed significantly depending on the annual amount of professional labour devoted to forestry. On the one hand, *post hoc* analyses showed that P_{R5} landowners were the most active silviculturists in Mariña Oriental, treating annually a ratio of forestland nearly four times higher than the P_{R1} and P_{R3} groups ($H=11.541$). On the other hand, the most remarkable behaviour of timber harvesting was also carried out by P_{R5} owners. On average, these landowners harvested annually almost five times more woodland than the P_{R1} group ($H=9.499$).

Annual investments in holding improvement (buildings or infrastructure) and forestland improvement (silviculture) increased slightly with the professional labour force on the holding ($\rho = 0.308$ and 0.313, respectively). The P_{R5} and P_{R6} owners were characterized by allocating the largest investment to new forest buildings or infrastructure, spending a mean of €30 ha^{-1} per year. However, significant differences were observed between the P_{R3} and P_{R5} owners, with a mean difference in annual investment in holding improvement of €24.9 ha^{-1} per year ($H = 19.907$). Moreover, P_{R5} and P_{R6} owners showed the greatest expenditures on treating their forestlands, and assigned to this activity an average of €61.7 and 141.7 ha^{-1} per year, respectively. In this case, annual expenditure on silviculture varied significantly between the owners in the P_{R5} group and the owners who annually hired less 10 than professional labour-days, i.e. P_{R1}, P_{R2} and P_{R3} landowners ($H = 13.599$). On the basis of this finding, it was observed that the fraction of owners who tried to replace their current productive forest species varied significantly in accordance with the professional labour force hired annually in forestry ($\chi^2 = 9.847$). As already suggested, noticeable ratios and investments in silviculture might entail an interest in changing the productive forest cycle in the short to mid-term. For each P_{R1} and P_{R2} owner who considered this change in the future, more than two P_{R5} and P_{R6} owners tried to replace their current productive forest species.

In Mariña Oriental, large investments in forestry required great economic compensation to encourage owners to put them into practice, as mentioned in previous sections. This may mean that significant mean differences were observed in the economic amount granted per subsidy between P_{R5} landowners and landowners in the P_{R1} and P_{R3} groups ($H = 6.806$). As mean values, the P_{R5} owners received in compensation €12 ha^{-1} per year more than P_{R1} and P_{R3} owners. Even though 11.3% of P_{R4} and P_{R5} owners benefited from more than €50.2 ha^{-1} per year, none of the P_{R1} and P_{R3} groups received economic aid above this threshold. Conversely, none of the owners included in the P_{R2} or P_{R6} groups applied for this type of public measure. Thus, it was corroborated that public subsidies were important tools for stimulating forest management. The role of public subsidies in forestry has received considerable attention in studies devoted to NIPFOs' land management (Löyland et al., 1995; Hardie & Parks, 1996; Zhang & Flick, 2001; Bolkesjø & Baardsen, 2002; Kline et al., 2002; Arano et al., 2004).

Profiling the owner who relied on professional assistance, there were significant differences in the landowner's main occupation according to PROFESS group ($\chi^2 = 36.601$). As expected, the largest proportion of owners who worked outside their property was included in the P_{R5} and P_{R6} groups (44%), while P_{R3} and P_{R4} owners were principally retired farmers (64%). The P_{R1} and P_{R2} groups embraced a similar fraction of active farmers and professionals unrelated to agriculture (over 31% in each category), but retiree was clearly the most prevalent primary occupation (44%). In accordance with the management guidelines found in the region, it was shown that landowners who did not work at their property were effectively rather involved in forestry. In line with several authors (Hodges & Cubbage, 1990; Zhang & Mehmood, 2001; Finley, 2002; Kittredge, 2005; Potter-Witter, 2005), this study tested whether professional labour was a determining factor in stimulating forest management among absentees. Such a landowner categorization may also clarify the slight decrease in the annual rate of forest reinvestments with the increase in the annual amount of professional forest labour on the

Table XI. Homogeneous PROFESS subgroups with regard to annual ratio (%) and expenditure (€ ha^{-1} per year) on plantation and size of productive forest holding (ha).

PROFESS	P_{R1}	P_{R2}	P_{R3}	P_{R4}	P_{R5}	P_{R6}	p
% of interviewed landowners	39.5	5.8	22.1	11.6	18.6	2.4	
PLANT							
Non-professional forester	0.75	0.13	0.82	1.84			0.776
Forester	0.75		0.82	1.84	3.93		0.150
Professional forester					3.93	6.16	0.521
PEXP							
Non-professional forester	142.30	62.36	153.58	162.35			0.825
Forester			153.58	162.35	385.91		0.062
Professional forester					385.91	482.64	0.844
SIZE							
Small landowner	3.84	1.97	4.23	4.94	7.38		0.084
Large landowner				4.94	7.38	10.67	0.056

holding ($\rho = -0.289$). On average, without statistically significant results, P_{R1}, P_{R2} and P_{R3} owners benefited annually from forest reinvestments twice as much as the remaining population of landowners. As observed throughout this study, the landowner status as an active farmer may be the main conditioning factor for this high self-consumption from forests.

In addition, owners who were more willing to rely on professional foresters were characterized by having sold timber at the best stumpage price per unit. Pairwise comparison analyses revealed that forest returns obtained by owners who hired more than 51 professional labour-days per year in forestry were significantly different from the returns obtained by owners who hired forest assistance up to 5 labour-days per year ($H = 7.036$). Thus, P_{R5} and P_{R6} landowners sold timber from previous harvests at a unitary price that was twice as high as the economic value fixed by the P_{R1} and P_{R2} groups ($H = 9.739$). The technical advice of professional foresters received by the P_{R5} and P_{R6} groups during timber harvesting may be the reason for such profitable timber sales. Moreover, better deals may explain why the landowners in these groups were more interested in enlarging their woodlands in the near future, as mentioned earlier in this article. The future intention of enlarging the woodland increased with the annual professional labour-days on the holding ($D = 0.308$). For each P_{R1} and P_{R2} owner who showed this intention, three P_{R5} and P_{R6} owners intended to enlarge their woodlands ($\chi^2 = 12.387$). Once again, favourable market conditions, particularly attractive timber prices, in addition to professional support on forest management, seemed to encourage owner involvement in forestry, as suggested by the results reported by Munn and Rucker (1994) and Löyland et al. (1995).

Finally, the number of professional labour-days hired annually in forestry was weakly and positively correlated with the production size of the forest holding, but weakly and negatively correlated with its degree of fragmentation ($\rho = 0.277$ and -0.246, respectively), as expected because of the parallelism observed between holding size and land management intensity (Kuuluvainen & Salo, 1991; Prestemon & Wear, 2000; Zhang & Mehmood, 2001; Arano et al., 2004; Potter-Witter, 2005). On the one hand, P_{R5} owners managed productive forest holdings significantly larger than the holdings included in the P_{R2} and P_{R3} groups ($H = 13.131$). The mean difference in the size of productive forestland differentiated two significant landowner profiles according to the professional labour force devoted to the holding (Table XI). On the other hand, the lowest degree of land fragmentation, i.e. the largest productive forest plots, were included in the P_{R5} and P_{R6} groups, with two plots per hectare of productive forestland; in contrast, the most fragmented lands were managed by P_{R1} and P_{R3} owners, with four plots per unit of productive forestland ($H = 10.939$).

Conclusions and implications

As a first step to promote policies that support NIPFOs' land planning and management, the present study has identified and explained the characteristics of the family unit that may determine how and why landowners make forest decisions, i.e. how and why landowners plant and develop silvicultural practices in their forestlands and harvest their woodlands. Moreover, the study searched for a possible relationship or distinction between the variables linked to the family unit and other factors related to landowner profile, forest property, land-use changes, forest economics, market conditions and/or policy measures. Within this framework, the study was carried out based on data obtained from a personal questionnaire completed in 2004 by 103 NIPFOs, each of them responsible for more than 1 ha of productive forestland in the Mariña Oriental region, located in northern Galicia (northern Spain).

For the 1999–2003 period, the results suggested that: (1) the pattern of land acquisition and the amount of family labour devoted to forestry were key factors in planting forestlands; (2) forest improvement treatments were associated with the availability of machinery on the holding; and (3) the dependency rate of forest reinvestments for self-consumption was linked to woodland harvesting. In addition, the amount of professional assistance hired on the holding was a determining factor in developing the three forest activities. Within the forest guidelines observed in the region, the results suggested that personal, family and professional commitment to land seemed to be significantly influenced by favourable timber market conditions. Active forest managers appeared to be interested in timber production, because these managers had received from previous harvests a high timber income at attractive stumpage price per unit.

Landowners who managed both inherited and purchased land were more likely to plant forestlands, and were identified with retired farmers who converted former meadows into woodlands by means of public subsidies. These landowners generally managed the land themselves, relying on forest training and family labour force in forestry. Land investment and management basically responded to emotional values, i.e. inheritance-to-bequeath: these landowners took care of the holding and intended to pass it on to future generations, although they did

not receive regular income from it. Landowners who had agricultural and forestry machinery on the holding and landowners who clearly depended on forest products for self-consumption stood out by being far more active silviculturists and harvesters, respectively. They were mainly profiled as active farmers who were trained in forestry and organized into professional groups. Because of their status as farmers, these landowners were more likely to manage the land themselves, and devoted an important fraction of their labour to forestry. As in the case of retired farmers, self-employed silviculturists and harvesters received important family aid in the accomplishment of the different forest practices on the holding.

However, it was necessary to distinguish a group of landowners who were clearly differentiated from the previous two profiles. Such owners did not earn their living from agriculture; rather, they were also seeking other sources of family income through forest investment and management on the basis of forest subsidies. These owners were managers of large and less fragmented forest holdings, who did not use forest products for self-consumption and did not spend much personal and family time on their land. These landowners worked closely with professional foresters to continue with their holdings and make land management viable, contributing significantly to the planting, silvicultural and harvesting patterns of the region.

The findings of this survey may provide important guidance on how and where to focus policy efforts on NIPFOs' land decision making and management. In accordance with the results, public programmes must be adapted to different landowner profiles and family prospects. Therefore, it would be particularly important to differentiate between farmers who display a remarkable emotional link to land and devote more time to forestry, and professionals outside agriculture, who are less attached to land ownership and generally turn to forest assistance. Nowadays, bridging the gap between agriculture and forestry is clearly a key step towards promoting a suitable service of forest assistance that improves farm forestry by means of information, training, technology and market access, and specialization. By means of close forest extension, such forest services could guide NIPFOs' land practices towards economically viable, socially attractive and environmentally sustainable forest management within the framework of rural development.

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Land-use and land-base patterns in non-industrial private forests: Factors affecting forest management in Northern Spain

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Planting, silviculture and harvesting practices

ABSTRACT

There is increasing worldwide interest in land-use allocation and management within the sphere of rural planning and development. The study of land-use patterns mainly focuses on understanding the practices and values of individuals involved, and no debate of this issue would be complete without taking into account non-industrial private forest (NIPF) ownership as a key component in most rural areas worldwide. This paper empirically explores and assesses NIPF owners' management in terms of analysing dynamics in farming and forestry practices (past conversions from forestland to meadow and from marginal meadow to woodland, and intentions to change the current productive forest species and to extend the area of woodland) and landholding attributes (size and degree of parcellation in productive forestland). Logistic regression models were also used to investigate the probabilities and influencing factors involved in transforming marginal meadows to woodland, and attempts on the part of NIPF owners to change the current productive forest species and increase productive forestland. For this, a total of 103 NIPF owners in Northern Spain were interviewed in person, in March 2004, about their commitment to and involvement in land management during 1999–2003. The models correctly explained 73.3%, 83.7% and 73.3% of the variability in having converted marginal meadow in woodland and of future intentions to change the productive forest species and increase the area of productive forestland, respectively. The results of the study indicate that forest management mainly responds to investment and increasing the productivity of the land as a capital asset, which is directly influenced by the size and degree of parcellation of the holding, and directly or indirectly related to the owner's interest in timber production. The results may be used by forest professionals, researchers and policymakers in order to design and execute successful forest policies related to land management and planning.

1. Introduction

The study of global land-use changes cuts across several academic disciplines and fields of inquiry, with the overall aim of achieving sustainable development (Bičík et al., 2001). Having seen the consequences of centuries of forest overexploitation and clear changes in the socio-economic structure of many rural areas, land-use allocation and management have recently become of concern within the sphere of rural planning and development worldwide. Thus, as Wiersum et al. (2002) have stated, land-use choices can have a profound influence upon the development of rural areas, and landowners' strategies and preferred rural development options vary under different rural conditions. Regional land-use studies have therefore made possible to compare the importance and the structure of the 'driving forces' of land-use changes at different spatial levels (Bičík et al., 2001), by modelling and predicting changes in land use and management.

According to Madsen and Andriansen (2004), the study of land-use patterns and dynamics mainly focus on understanding the practices and values of individuals involved, where 'practices' are understood as actions related to land use carried out by individuals, and 'values' as traditions, thoughts, and beliefs. Understanding land use therefore requires an understanding of landowners and how they make decisions (Koontz, 2001). Given a set of biophysical parameters, individuals choose a specific type of land use on the basis of the potential benefits, either tangible or non-tangible, while also taking into account personal aims and prospects, available means and resources, and possible constraints (Jansen and Di Gregorio, 2003). In addition, institutional, legal, socio-economic and cultural settings also influence an individual's decisions as regards land-use and management (Cihlar and Jansen, 2001). Changes in land use are clearly influenced by land tenure regimes, and hence, by the type of land management carried out (Marey-Pérez et al., 2006).

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Of particular concern within the wide range of literature related to land-use dynamics are changes in the use and management of forestland, because of the important consequences for the future availability of timber, wildlife habitats, and other benefits provided by forests (Kline and Alig, 2001; Marey-Pérez and Rodríguez-Vicente, 2008). Considering forestland tenure regimes, no debate of land-use dynamics would be complete without taking into account non-industrial private forest ownership as a key component in most rural areas worldwide. The nature of non-industrial private forest ownership differs notably from country to country and it is difficult to define the meaning of this term (Herbohn, 2001). According to the latter author, this type of forest ownership consists of a single or small number of planting blocks, non-professional management and often a lack of silvicultural skills, with little planning for future marketing. In other words, non-industrial private forest (NIPF) owners are individual landowners, not juristic landowners, whose forests constitute a part of their total land-use system of the holding and whose management aims are not solely centred on industrial timber production. NIPF owners own and manage land for a wide variety of purposes, and thus the 'practices' and 'values' are equally as diverse. They are heterogeneous by nature; some NIPF owners carry out intensive management, like industrial owners, while others may have a complete disregard for forest management for any purpose, productive or protective (Siry et al., 2005; Arano and Munn, 2006). As a result, collaborative and coordinated approaches among researchers and policymakers are essential, firstly, to improve knowledge about which and how holding characteristics and land-use patterns affect the decisions made by NIPF owners and the intensity of land investments, and secondly, to develop and execute successful forest policies in relation to land management and planning.

To help to understand NIPF owners' management objectives, motivations and behaviour, this study was specifically aimed at the analysis of NIPF owners' management in terms of empirical analysis of dynamics in farming and forestry practices, represented as past conversions from forestland to meadow and from marginal meadow to woodland, intentions to extend the area of woodland and to change the current productive forest species, and landholding attributes, represented as the size and degree of parcellation of productive forestland, by interviewing NIPF landowners in an area in Northern Spain. Thus, we examined possible statistical relationships or differences between these variables and other factors related to the landowner profile, family unit, and forest economics. In order to complete the results, we moreover included the three practices traditionally used to predict forest management behaviour of NIPF owners in the relevant literature, i.e. planting and silviculture in forestlands (Hyberg and Holthausen, 1989; Löyland et al., 1995; Hardie and Parks, 1996; Gunter et al., 2001; Zhang and Flick, 2001; Zhang and Mehmood, 2001; Kline et al., 2002; Arano et al., 2004; Ross-Davis et al., 2005), and timber harvesting in woodlands (Hyberg and Holthausen, 1989; Kuuluvainen and Salo, 1991; Löyland et al., 1995; Kuuluvainen et al., 1996; Prestemon and Wear, 2000; Zhang and Mehmood, 2001; Bølskejo and Baardsen, 2002; Conway et al., 2003; Størdal et al., 2008), and empirically examined these as regards the dynamics of farming and forestry practices and the characteristics linked to the landholding.

Within the extensive literature on land management behaviour of NIPF owners, we focused on past conversion of forestland to meadow and marginal meadow to woodland, given the agricultural background of the great majority of these landowners (Marey-Pérez and Rodríguez-Vicente, 2008). The abandonment of farms due to lack of generational replacement, together with favourable market conditions for timber production, may be important factors in the conversion of agrarian land to forestland for maintaining the productivity of the land and increasing the returns to complement household income (Gunter et al., 2001; Marey-Pérez et al., 2004). Furthermore, we consider proposals to replace the current productive forest species and to increase the extent of woodland within holdings. Favourable market conditions for certain types of industrial timber, the greater productivity or minor silvicultural requirements of particular forest species, profitable previous harvests and resulting timber sales may motivate NIPF owners to break with the usual patterns of forest management (Binkley, 1981; Boyd, 1984; Kuuluvainen and Salo, 1991; Bolkesjø and Baardsen, 2002), and to replace the current forest species or increase the area of productive woodland.

As regards land holding attributes, most of the existing literature identifies land size and the degree of parcellation as the most relevant factors affecting forest management. Owners who manage larger areas of forestland are more likely to invest in land with forest plantations, as capital (Boyd, 1984; Löyland et al., 1995; Hardie and Parks, 1996; Zhang and Pearse, 1997; Arano et al., 2004). Furthermore, larger productive forest holdings are also more suitable for carrying out forest improvement treatments and timber harvesting (Binkley, 1981; Hyberg and Holthausen, 1989; Kuuluvainen and Salo, 1991; Löyland et al., 1995; Kuuluvainen et al., 1996). Land parcellation may lead to some structural difficulties for forest investment and management, due to the small size of tracts, and hence, an increase in management costs and a decline in productive yields may be expected (Healy, 1985; Conway et al., 2003; Potter-Witter, 2005).

Characterization of land decision-making and management by NIPF owners in this way will provide more information about why certain land-use practices are carried out, and which can then be used to restructure and adjust territorial land-base. Forest professionals, researchers and policy makers may therefore benefit from further efforts as regards land management and planning by taking advantage of opportunities to overcome the obstacles that most NIPF landowners face, in order to satisfy their interests and prospects as regards land, in accordance with current demands for sustainable development.

2. Materials and methods

2.1. Study area and data collection

In an update and expansion of an earlier study by Marey-Pérez (2003), which explored individual private ownership and forest management in the Autonomous Community of Galicia (Northern Spain), data for the present study was collected in personal interviews with randomly selected NIPF landowners in the Mariña Oriental region, in Northeast Galicia, Spain (Fig. 1). In order to understand the selection of the area of study, it is first necessary to characterize clearly and concisely the characteristics of Galician forests. The particular climatic conditions in Galicia enable the region to be a leader in terms of the Spanish forestry sector. Some 9.5% of woodland in Spain is in Galicia, and this land holds 19.7% of the total volume of Spanish timber (Prada et al., 2005). According to the III National Forest Inventory (MMA, 1998), the total forest area in Galicia is more than 2 million hectares, equivalent to 69% of the territory; more than 1,405,000 ha of this is woodland, i.e. 48% of the Galician territory or almost 69% of the Galician forestland.

However, the main attribute that characterizes forestry in Galicia is without a doubt, the ownership system. Private ownership, whether individual or collective, constitutes the main type of forest ownership in Galicia, and corresponds to more than 1,994,000 ha, i.e. almost 98% of Galician forest; only 2.2% of Galician forest is publicly owned, the state or autonomous governments or other public bodies. In general, individual private property in the region occupies the most productive land, so that around 81.5% of the woodland in Galicia is under this type of regime (Marey-Pérez, 2003). Thus, 67.9% of private forest in Galicia is managed by more than 672,000 individual private owners, who each own a mean forested area of less than 2 ha, which may be typically subdivided into 10 plots. The remaining private forests (29.9%) correspond to communal forests – in Galician called *Montes Veciñais en Man Común*, a communal form of private land tenure (Marey-Pérez and Rodríguez-Vicente, 2008) – which are currently managed by 2835 collectives of private owners.

The Mariña Oriental region was therefore chosen for study since it is a forest region typical of much of Northern Spain, and particularly within Galicia, where forest covers most of the land (53%), and forest activity is

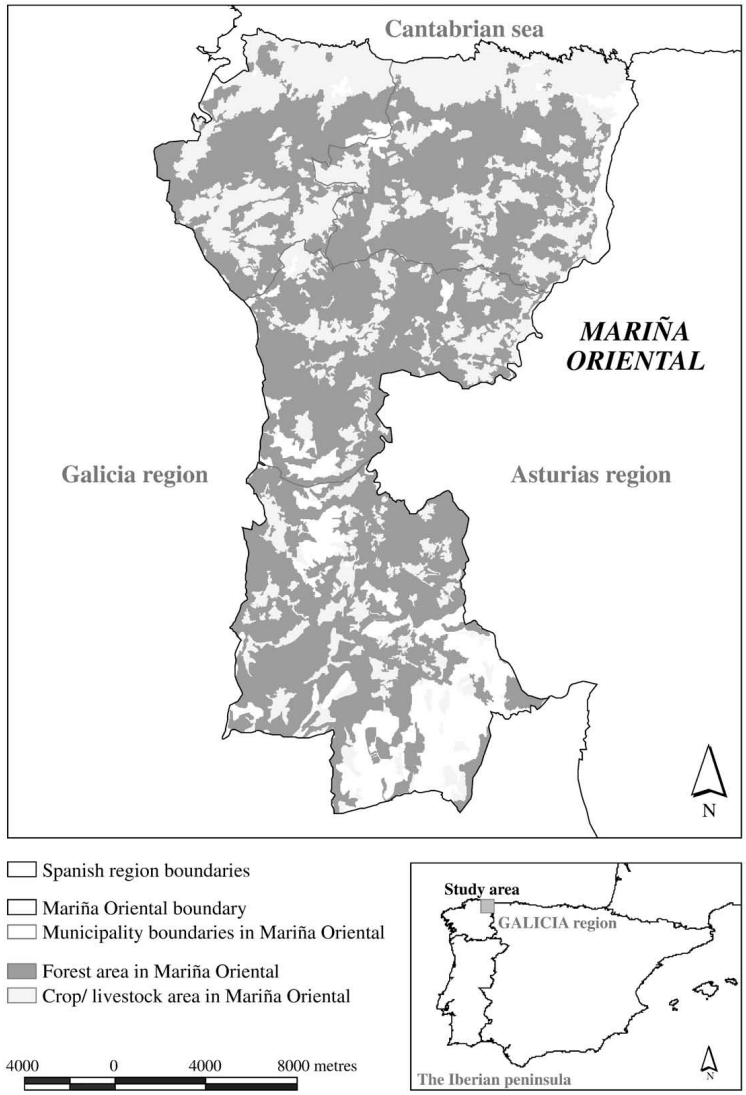

Fig. 1. Location of Mariña Oriental region in Galicia, Northern Spain.

increasing (over 46% of the forest is woodland managed for timber production). Thus, land use for forestry purposes increased by 8.5% between 1957 and 2001, mainly to the detriment of agrarian and scrub land, although the most important changes in land use involve forest stand composition (Marey-Pérez, 2003). Pure forest stands have increased considerably during this period (by about 300%), probably

because of the singular expansion of the forest species *Eucalyptus globulus* Labill. in the region; cover of the latter species is thought to have increased to more than 63% in the area between 1957 and 2001 (Marey-Pérez, 2003). The large expansion of productive forest stands (for timber production) in the Mariña Oriental and throughout the rest of Galicia, originates from the important changes that took place in the agro-forestry system during the 1950s, as mass rural emigration hindered the development of a competitive and intensive agricultural sector, causing instability at socio-economic and land use levels (Etxezarreta, 1979). As in other European countries, production ceased on a large number of farms, thus transforming land management and land patterns themselves: farm-level changes in land use are widely acknowledged as a response to decreasing agricultural economic viability (Marey-Pérez et al., 2004). The lack of farm labour led to much land becoming abandoned and progressively occupied by scrubland and native woodland; in order to counteract this tendency, the Spanish government's forest policy – begun in the late nineteenth century and reaching a peak in the mid-twentieth century – encouraged an increase in forest plantations destined principally for the fibre and chipboard industries, in an attempt to tackle the problem of low production, scarce profitability and deforestation of state woodlands (Marey-Pérez et al., 2004; Marey-Pérez and Rodríguez-Vicente, 2008). Posteriorly, European Council Regulation no. 2080/1992 of 30 June 1992, instituting a community aid scheme for forestry measures in agriculture, again favoured the establishment of large forest plantations in Galicia, especially during the period 1993 to 1997, when grant-aided afforestation constituted an important choice for private landowners who wished to improve the productivity of marginal lands through tree plantations, mainly with *Pinus* spp. and *Eucalyptus* spp.

At present in the Mariña Oriental 3043 NIPF owners manage more than 90% of the forested area in the region. The addresses of NIPF owners and attributes of their holdings, such as location, land-use and size, were identified from the Land Register (Cadastre). In accordance with Council Regulation (CEE) no. 571/88 of 29 February 1988, on organizing European Union surveys of farm structure, the sampling framework firstly consisted of all individual forest landowners living in the region who owned at least 1 ha of productive forestland, a sampling scheme proposed by Marey-Pérez (2003). This excluded many forest owners who probably would not have the necessary information to account for their management goals and practices. As a result of migratory phenomena in Galicia during the 20th century (Beiras-Torrado, 1975), a high percentage of the NIPF owners did not actually reside in Mariña Oriental. This forced us to review the population census and to reclassify landowners into non-resident and resident. From 750 NIPF owners who manage more than 1 ha of productive forestland in the region, 333 were classified as permanent residents, who together own 1154 ha of woodland, i.e. 42% of all productive forestland in the area, including plots smaller than 1 ha.

The large number of variables included in the cadastral database revealed a high degree of heterogeneity in the study population, which is why stratification was considered a key factor in characterizing and subsequently validating the results. The information in the cadastral database indicated that the variable designated 'productive forest area per landowner' was the most suitable for determining the minimal number of NIPF owners to interview, and their subsequent stratification. The classification of NIPF owners for determining the number of strata and the cut-off points was based on data on timber harvesting in Mariña Oriental. The size of productive forestland that enabled NIPF owners to fell the equivalent of the mean annual harvest per plot in the region defines the landowner stratification (Marey-Pérez, 2003). This was established as 3.5 ha of productive forestland, considering a weighted rotation age of 15 years for the two main forest species in the region, *E. globulus* Labill. and *Pinus pinaster* Ait. ssp. *atlantica*.

We opted to use a questionnaire and statistical sampling within the subjective methodology of analysis, in which the sample size was designed to achieve a 5% sampling error at the 95% confidence level. A priori, the error level was set at 3% for quantitative answers (mean estimation) and at 6% for qualitative answers (proportion estimation). In order to obtain comprehensive, reliable results, we attempted to enlarge the landowner sample in order to interview as many owners as possible, while minimizing the economic costs involved. Within the stratified methods, a self-weighting sample size was accordingly determined and allocated by means of Neyman's formula of minimum variance (Sukhatme, 1953).

The results showed that an initial estimation of 3% (mean estimation) would require a total of 101 questionnaires, whereas an initial estimation of 4% (proportion estimation) would require 99 questionnaires. From 333 NIPF owners, each responsible for more than 1 ha of productive forestland and permanently resident in Mariña Oriental, the self-weighting sample size was finally formed by 103 NIPF owners who had to be contacted and interviewed in person (Table 1). The NIPF landowners who were interviewed owned 12% of the forestland and 13% of the woodland (i.e., productive forestland) in the region. Thus, the error level was finally set at 4% for quantitative answers (mean estimation) and at 8% for qualitative answers (proportion estimation).

We considered a number of questionnaires before deciding on a final version that was divided into four sections, which sought information on owner profile, family unit, forest property and land-use changes, and forest economics during the period from 1999 to 2003. The definitive questionnaire was completed in two stages in March 2004. The first stage consisted of a telephone interview – between 20:00 and 22:00 h – inquiring as to the owner's willingness to participate in the study. If confirmed, the interviewer arranged for an interview in person within one or two days (the second stage). If the owner declined to be interviewed in person, the interviewer posed the questions included in the owner profile section. Each interview lasted an average of 36 min. The information was finally completed from the official data contained in the Land Register.

The analytical variables for the present study are based on the information obtained in the previous personal interviews, information that was redefined and coded in nominal, ordinal or binary variables that summarized the surveyed data and met the assumptions of the statistical analyses. For the formulation of ordinal variables, we applied simple statistical criteria by using SAS/STAT™ and STAT-GRAPHICS™ software. Firstly, we produced descriptive statistics and frequency histograms for the variables and then selected statistics of location and dispersion, i.e. the mean x and standard deviation σ, respectively (Cao-Abad, 2002). We then used the location measurement (x) as the centre of the variables considered for calculating the class intervals from the dispersion statistics (σ). The variables considered in the study are listed and described in Table 2, along with the percentage of interviewed owners for each category.

Given that forest decisions and/or practices of a representative NIPF owner are the result of a combination of individual decisions and/or practices regarding planting and silviculture treatments on forestland, as well as harvesting of woodland, these three individual forest practices were also included in the personal interviews and later defined as the following continuous variables in the present study:

1. PLANT. Forest planting, measured as the proportion of the entire forest area planted annually.
2. TREAT. Stand improvement treatments, measured as the proportion of the entire forest area in which silvicultural treatments are annually carried out. This includes activities such as the use of

Table 1
Classification of interviewed NIPF owners per stratum.

Stratum	Productive forestland (ha)	No.	%
A	1.00–1.70	22	21.4
B	1.71–3.50	28	27.2
C	3.50–7.00	31	30.1
D	>7.01	22	21.4
		103	100

fertilizers, application of insecticides, pesticides or herbicides, thinning of competing vegetation, and other management or improvement activities.

3. HARV. Timber harvesting, measured as the proportion of the entire wooded area harvested annually.

Table 2 also lists and describes the mean and standard deviation parameters observed for planting, silvicultural and harvesting practices during the five-year study period.

Finally, all of the economic variables analysed in the present study were adjusted to constant Euros for 2004 to control the inflation rate, and were summarized as mean annual euro amounts per-hectare-owned, with the exception of family incomes and the unit stumpage timber price. The relevant information was obtained from the Spanish consumer price index of the National Statistics Institute (INE, 2004).

2.2. Statistical analyses

Given that the study population was not suited to the Kolmogorov–Smirnov goodness-of-fit test for the normality K–S test or to the Levene test for homogeneity of variances, the statistical analyses conducted in this study were based on distribution-free tests, that is, non-parametric tests. The non-parametric procedure took into account the type of variables measured in the study, i.e. continuous, nominal/ordinal and binary variables, and was defined in order to provide a statistical explanation of the NIPF owners' management in terms of analysing past and future dynamics in farming and forestry practices, and landholding attributes. These dependent variables were empirically associated with other attributes linked to landowner profile, family unit, and forest economics, as well as to planting, silvicultural and harvesting management practices observed in the Mariña Oriental region. Thus, we first tested the strength and significance of the linear correlation among the variables, and subsequently contrasted the significant differences among them at a 95% confidence limit and a minimum level of statistical significance of 0.05.

We used Somers' D coefficient and its critical significance level, to measure the statistical relationship among nominal, ordinal and/or binary variables (by use of contingency tables). We subsequently computed and detected significant differences in the frequency distribution across nominal, ordinal and/or binary variables of the cross-tabulation using Pearson's chi-square statistic χ^2 and the two-tailed asymptotic significance.

Spearman's rho coefficient ρ was used to estimate the statistical association between the continuous variables and these measures against nominal, ordinal, and/or binary attributes at 0.01 and 0.05 significance levels. We also analysed the mean distribution across variables using the Kruskal–Wallis' H test, a non-parametric test of variance homogeneity equivalent to one-way ANOVA. Confirming this premise, we conducted pairwise comparisons using the Dunnett's T3 test to determine which categories (levels) of nominal/ordinal variables showed behaviour (means) significantly different from that of the continuous variables. Homogeneous subgroups of similar statistical behaviour were finally defined by Tukey's HSD procedure, after the significant differences were tested.

Finally, and to complete the investigation included in the present study, we modelled the relation between the variables MWOOD, CSPECIE and IFOREST as binary responses (1 = past change/intended changes); 0 = no past change/no intended changes) with respect to a combination of explanatory variables that enabled statistical characterization of these three management practices on the part of NIPF owners in the Mariña Oriental region. The variable FMEADOW was not used in the present model as it did not fulfil the balance between responses required to develop a statistically significant model.

On the basis of the binary nature of the three dependent variables, in the present study we opted to use logistic regression by backward step-wise selection procedure, a method based on an accumulative probability function whose main objective is to model how the presence or otherwise of diverse factors, and the value or levels of these, affect the probability of an occurrence (Ryan, 1997), i.e.:

$$P_i = E(Y = 1\, x_i) = \frac{1}{1 + e^{-(\beta_0 + \beta_i x_i)}} \quad (1)$$

where,

x_i, independent variables

$P(Y) = P$, the probability that the forest owner carries out the forestry activity, which takes a value of one when the NIPF owner has made the conversion from marginal meadow into woodland, attempted to change the current productive forest species or to enlarge his/her productive forestland in the future, and a value of zero when the NIPF owner has not developed or did not attempt to develop any of these practices

β_0, independent term in the logistic regression model

β_i, coefficients of the logistic regression model, significantly different from zero.

The estimates of the different regression coefficients were obtained by Maximum Likelihood Estimation (MLE). Testing of the statistical significance of each of the regression coefficients in the model was carried out by Wald's method, at a significance level of 0.05 (Hosmer and Lemeshow, 2000), i.e.:

$$\text{WALD} = \frac{\left(\hat{\beta}_1\right)^2}{\left(EE_{\hat{\beta}_1}\right)^2} \quad (2)$$

The previous statistic follows a chi-squared distribution with k degrees of freedom χ^{2k}, where:

$k = 1$, if the independent variable is quantitative

$k =$ number of categories $- 1$, if the independent variable is qualitative, whether nominal or ordinal.

The empirical model of participation of the NIPF owners in the three activities analysed was based on a function that includes regressor variables – related to the profile of the owner, the family unit, the forest land-holding, the forest economy, and the three forest management activities considered (plantation, silviculture and harvesting) – significant at a level of 0.05. The definition and descriptive statistics of these independent regressor variables are shown in Table 2.

3. Results and discussion

3.1. Past trends and future allocations in land-use

3.1.1. Past conversion from forestland to meadow

None of the three forest management practices analysed in Mariña Oriental appeared to be significantly affected by the past change from forestland to meadow. Nevertheless, descriptive statistics revealed that the F_{M0} group appears to include the most active forest managers in the region. The F_{M0} group annually planted and carried out forest improvement treatments seven times more often and in twice the area of forestland, respectively, than F_{M1} owners. In addition, F_{M0} owners also actively harvested woodland, at an annual rate five times higher than the F_{M1} group. The landowner status as an active farmer and the production requirements and priorities for land management clarify the reason why the F_{M1} owners transformed forestland into agricultural land (meadows), as well as explaining the lower involvement of these owners in forestry, although not significantly different from that of the F_{M0} owners. Thus, Beach et al. (2005) affirmed that land allocation between forestry and other uses is dependent on market factors such as the expected rates of return to alternative type of land use, among other

Table 2
Definition of study variables for the statistical analyses.

Variable	Code	Definition	% of interviewed NIPF owners	PLANT		TREAT		HARV	
				$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ
Landowner profile									
AGE ordinal	A_{G1}	Age of the owner, in years							
		1 if owner was less than 40 years old	4.6	2.44	3.65	0.50	0.88	0.86	1.51
	A_{G2}	2 if owner was 40–65 years old	44.2	1.57	2.24	1.35	4.03	5.83	8.31
	A_{G3}	3 if owner was more than 65 years old	51.2	1.49	2.95	0.78	1.67	1.79	2.42
EDUC ordinal	E_{D1}	Regulated education of the owner							
		1 if owner did not have studies	37.2	0.69	0.88	0.51	0.89	2.88	4.84
	E_{D2}	2 if owner had primary education	47.7	1.76	2.91	1.54	4.11	3.69	5.15
	E_{D3}	3 if owner had secondary education	9.3	4.17	4.58	0.90	0.89	5.80	13.35
	E_{D4}	4 if owner had tertiary education	5.8	1.54	1.83	0.20	0.32	2.74	4.59
OCCUP nominal	O_{C1}	Main primary occupation of the owner							
		1 if owner was a retired owner	51.2	1.42	2.65	0.66	1.54	2.21	3.10
	O_{C2}	2 if owner was an active farmer	24.4	1.23	2.15	1.01	1.31	4.99	6.76
	O_{C3}	3 if owner was a hired worker	9.3	0.99	1.06	0.65	0.68	6.14	13.19
	O_{C4}	4 if owner was a self-employee	3.5	3.86	3.95	0.53	0.82	0.30	0.29
	O_{C5}	5 if owner was an entrepreneur	4.6	2.83	2.75	6.29	12.44	6.84	9.88
	O_{C6}	6 if other	7.0	2.69	4.71	0.90	1.06	4.06	4.22
FARM binary	F_{R1}	Condition of the owner as an active farmer							
		1 if owner was an active farmer	24.4	1.23	2.15	1.01	1.31	4.99	6.76
	F_{R0}	0 if otherwise	75.6	1.68	2.81	1.02	3.30	3.06	5.87
ASSOC binary	A_{S1}	Participation of the owner in professional associations							
		1 if owner was a member of a professional association	33.7	1.74	2.24	1.04	1.31	3.58	4.97
	A_{S0}	0 if otherwise	66.3	1.49	2.87	1.01	3.49	3.51	6.67
TRAINING binary	T_{R1}	Forestry training of the owner							
		1 if owner participated in a forestry course	8.1	1.94	2.66	1.16	1.38	8.33	13.60
	T_{R0}	0 if otherwise	91.9	1.54	2.68	1.01	3.03	3.11	4.93
IMARKET binary	I_{M1}	Specific training in market (timber prices, supply–demand, etc)							
		1 if owner had market information	33.7	1.79	3.14	1.25	3.55	4.89	5.76
	I_{M0}	0 if otherwise	66.3	1.15	1.22	0.57	0.72	2.84	6.22
TECHNIC nominal	T_{E1}	Knowledge and use of production criteria for timber harvesting							
		1 if owner did not know about and did not take into account rotation age	8.1	1.08	1.65	0.46	0.74	0.00	0.00
	T_{E2}	2 if owner knew about and did not take into account rotation age	81.4	1.62	2.78	1.17	3.22	3.07	4.50
	T_{E3}	3 if owner knew about and took into account rotation age	10.5	1.55	2.48	0.29	0.40	9.84	12.86
Family unit									
INHERIT nominal	I_{H1}	Acquisition of the forest holding							
		1 if owner inherited lands	51.2	1.36	2.79	0.87	1.69	3.83	5.25
	I_{H2}	2 if owner inherited and bought lands	45.3	1.92	2.60	1.25	3.98	3.42	7.18
	I_{H3}	3 if owner bought lands	3.5	0.25	0.33	0.26	0.26	0.64	1.11
BEQUEST nominal	B_{E1}	Intention of bequeathing the forest holding							
		1 if owner intended to bequeath lands to heirs	94.2	1.56	2.69	0.75	1.36	3.63	6.26
	B_{E2}	2 if owner intended to bequeath some lands to heirs and sell the remainder	2.3	1.60	1.39	0.85	1.02	1.70	0.33
	B_{E3}	3 if owner intended to sell lands	3.5	1.94	3.31	8.33	14.39	2.14	3.70
HOUSEHOLD ordinal	H_{H1}	Annual net family income in Euros during 1999–2003							
		1 if net household income was less than 6000	10.5	0.64	1.11	0.38	0.48	2.29	2.97
	H_{H2}	2 if net household income was between 6000 and 9000	17.4	0.72	0.64	0.62	1.03	1.39	2.28
	H_{H3}	3 if net household income was between 9001 and 18,000	36.0	2.00	3.60	0.92	1.89	3.44	7.08
	H_{H4}	4 if net household income was between 18,001 and 30,000	19.8	1.25	1.92	0.60	0.61	4.98	7.98
	H_{H5}	5 if net household income was more than 30,000	16.3	2.53	2.78	2.60	6.54	5.08	5.28
REINVEST ordinal	R_{E0}	Annual reinvestment for household consumption in Euros during 1999–2003, per unit of forest area							
		0 if owner did not obtain reinvestments	27.9	1.40	2.08	1.49	5.07	4.42	8.83
	R_{E1}	1 if reinvestment was less than 71.0	32.5	2.52	3.70	1.11	1.99	3.32	3.55
	R_{E2}	2 if reinvestment was between 71.0 and 152.4	23.3	0.84	0.88	0.48	0.54	2.34	4.07
	R_{E3}	3 if reinvestment was between 152.5 and 233.7	10.5	1.46	3.03	1.07	1.25	2.23	3.76
	R_{E4}	4 if reinvestment was between 233.8 and 315.0	3.5	0.20	0.14	0.06	0.03	4.20	3.97
	R_{E5}	5 if reinvestment was more than 315.0	2.3	0.37	0.08	0.68	0.26	8.40	7.94
PERSONAL ordinal	P_{E1}	Personal labour-days spent annually on forestry during 1999–2003							
		1 if personal labour was less than 2	30.2	2.25	4.04	1.07	2.01	2.79	3.98
	P_{E2}	2 if personal labour was between 2 and 5	10.5	0.75	1.28	0.52	0.71	1.77	3.47
	P_{E3}	3 if personal labour was between 6 and 10	12.8	1.22	1.69	2.99	7.40	3.15	3.51
	P_{E4}	4 if personal labour was between 11 and 50	31.4	1.16	1.16	0.43	0.54	3.72	6.37
	P_{E5}	5 if personal labour was between 51 and 100	11.6	2.19	3.08	0.49	0.52	7.87	11.78
	P_{E6}	6 if personal labour was more than 100	3.5	1.11	1.28	2.01	1.76	0.49	0.85
FAMILY ordinal	F_{M1}	Family labour-days spent annually on forestry during 1999–2003							
		1 if family labour was less than 2	43.0	1.51	2.19	1.43	4.13	4.14	7.07
	F_{M2}	2 if family labour was between 2 and 5	11.6	2.35	4.91	1.16	2.98	2.04	2.35
	F_{M3}	3 if family labour was between 6 and 10	8.1	0.34	0.55	0.27	0.23	1.55	3.51
	F_{M4}	4 if family labour was between 11 and 50	14.0	0.74	0.69	0.48	0.53	3.22	6.22
	F_{M5}	5 if family labour was between 51 and 100	17.4	1.52	1.39	0.78	1.00	3.97	6.37
	F_{M6}	6 if family labour was more than 100	5.9	4.43	5.32	0.74	0.99	4.23	6.92
MACHINERY binary	M_{A1}	Logistic resources available for forestry activities							
		1 if owner had agricultural and forestry machinery	64.0	1.71	2.52	1.30	3.42	4.09	6.83
	M_{A0}	0 if otherwise	36.0	1.32	2.93	0.53	1.71	2.54	4.51
PROFESS ordinal	P_{R1}	Professional labour-days spent annually on forestry during 1999–2003							

Table 2 (*continued*)

Variable	Code	Definition	% of interviewed NIPF owners	PLANT		TREAT		HARV	
				$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ
		1 if professional labour was less than 2	39.5	0.75	0.89	0.61	0.92	1.60	3.03
	P_{R2}	2 if professional labour was between 2 and 5	5.8	0.13	0.18	0.23	0.42	2.77	3.96
	P_{R3}	3 if professional labour was between 6 and 10	22.1	0.82	0.85	0.29	0.36	4.15	6.19
	P_{R4}	4 if professional labour was between 11 and 50	11.6	1.84	2.45	0.49	0.53	3.34	5.07
	P_{R5}	5 if professional labour was between 51 and 100	18.6	3.93	4.67	3.27	6.26	7.08	10.04
	P_{R6}	6 if professional labour was more than 100	2.4	6.16	2.44	1.56	2.21	4.85	6.41
Forest property and land-use changes									
FMEADOW binary	F_{M1}	Past conversion of forestland into meadow during 1999–2003							
		1 if owner made this land-use change	2.3	0.23	0.11	0.45	0.59	0.79	1.11
	F_{M0}	0 if otherwise	97.7	1.60	2.69	1.03	2.96	3.60	6.17
MWOOD binary	M_W1	Past conversion of marginal meadow into woodland during 1999–2003							
		1 if owner made this land-use change	27.9	1.56	1.91	1.87	5.00	1.95	2.80
	M_{W0}	0 if otherwise	72.1	1.58	2.92	0.69	1.46	4.15	6.91
CSPECIE binary	C_{S1}	Future intention of changing the current productive forest species							
		1 if owner had this future purpose	22.1	1.92	3.39	2.46	5.63	4.76	9.23
	C_{S0}	0 if otherwise	77.9	1.47	2.44	0.61	1.28	3.18	4.94
IFOREST binary	I_{F1}	Future intention of increasing the productive forestland							
		1 if owner had this future purpose	44.2	1.98	2.87	1.48	4.03	5.22	8.02
	I_{F0}	0 if otherwise	55.8	1.25	2.47	0.66	1.56	2.20	3.59
PLOT ordinal	P_{L1}	Number of plots per hectare of productive forestland in ownership							
		1 if fragmentation degree was smaller than 1.52	14.0	3.21	4.44	3.54	7.25	7.88	10.41
	P_{L2}	2 if fragmentation degree ranged between 1.52 and 3.40	39.5	1.89	2.78	0.88	1.08	2.32	4.23
	P_{L3}	3 if fragmentation degree ranged between 3.41 and 5.29	27.9	1.02	1.67	0.38	0.47	4.86	6.33
	P_{L4}	4 if fragmentation degree was larger than 5.29	18.6	0.50	0.56	0.38	0.97	0.85	1.66
SIZE ordinal	S_{I1}	Area of productive forestland in ownership, in hectares							
		1 if ownership sized between 1.00 and 1.70	20.9	0.17	0.27	0.46	0.93	2.90	6.61
	S_{I2}	2 if ownership sized between 1.71 and 3.50	23.3	0.33	0.28	0.32	0.50	5.12	9.66
	S_{I3}	3 if ownership sized between 3.51–7.00	31.4	1.09	0.82	0.65	0.95	2.59	3.46
	S_{I4}	4 if ownership sized more than 7.00	24.4	4.58	4.00	2.65	5.53	3.77	3.67
Forest economics									
INVEST ordinal	I_{V0}	Annual investment in holding improvement in Euros during 1999–2003, per unit of forest area							
		0 if owner did not invest in the forest holding	74.1	0.91	1.46	0.47	0.83	3.15	5.30
	I_{V1}	1 if owner invested less than 39.7	14.1	4.51	4.97	1.84	2.62	3.47	3.48
	I_{V2}	2 if owner invested more than 39.7	11.8	2.31	2.58	3.54	7.60	6.34	11.57
PEXP ordinal	E_{P0}	Annual expenditure on plantation in Euros during 1999–2003, per unit of forest area							
		0 if owner did not spend on planting forestlands	4.7	0.00	0.00	0.04	0.05	1.53	3.06
	E_{P1}	1 if owner spent less than 127.0	58.8	0.53	0.64	0.41	0.86	2.34	4.34
	E_{P2}	2 if owner spent between 127.0 and 250.0	24.7	2.25	1.81	1.03	0.74	4.17	5.02
	E_{P3}	3 if owner spent between 250.1 and 400.0	7.1	1.74	1.08	0.80	0.81	11.73	15.18
	E_{P4}	4 if owner spent between more than 400.0	4.7	10.42	4.52	9.23	11.24	2.98	2.63
TEXP ordinal	E_{T0}	Annual expenditure on silviculture treatments in Euros during 1999–2003, per unit of forest area							
		0 if owner did not spend on forestland improvement	12.0	1.04	2.46	0.05	0.08	1.77	2.80
	E_{T1}	1 if owner spent less than 90.7	61.4	0.86	1.27	0.48	0.86	3.23	5.35
	E_{T2}	2 if owner spent between 90.7 and 221.7	19.3	2.69	2.93	1.18	0.83	3.51	4.54
	E_{T3}	3 if owner spent more than 221.7	7.3	4.93	6.38	3.08	3.40	9.74	14.62
REQUEST binary	R_{Q1}	Formal application for a forest management subsidy during 1999–2003							
		1 if owner applied for economic aid	20.9	2.91	4.33	2.64	6.02	2.84	2.97
	R_{Q0}	0 if otherwise	79.1	1.22	1.91	0.59	0.90	3.71	6.71
SUB ordinal	S_{U0}	Annual forest subsidy in Euros during 1999–2003, per unit of forest area							
		0 if owner did not applied for economic aid or was not finally compensated	90.8	1.41	2.25	0.92	2.89	3.60	6.34
	S_{U1}	1 if owner received less than 25.0	2.3	0.81	0.12	0.39	0.09	0.66	0.94
	S_{U2}	2 if owner received between 25.0 and 50.1	2.3	2.14	0.33	0.12	0.09	1.36	1.93
	S_{U3}	3 if owner received between 50.2 and 75.2	2.3	8.56	10.41	4.90	6.59	6.75	4.60
	S_{U4}	4 if owner received more than 75.2	2.3	1.06	1.06	2.52	2.01	2.73	3.86
TINCOME ordinal	T_{I0}	Annual income from timber sales in Euros during 1999–2003, per unit of forest area							
		0 if owner did not receive timber income	45.1	0.61	0.99	0.56	1.02	0.00	0.00
	T_{I1}	1 if owner received less than 195.1	17.1	2.03	4.25	2.61	6.90	7.34	7.09
	T_{I2}	2 if owner received between 195.1 and 425.2	18.3	3.20	3.54	0.78	0.95	3.64	3.34
	T_{I3}	3 if owner received more than 425.2	19.5	1.76	2.24	0.77	0.96	8.18	9.46
TPRICE ordinal	T_{P0}	Stumpage price in Euros during 1999–2003, per ton							
		0 if owner did not sell timber	45.1	0.61	0.99	0.56	1.02	0.00	0.00
	T_{P1}	1 if stumpage price per unit was less than 48.9	39.0	2.42	3.64	1.73	4.61	5.90	5.56
	T_{P2}	2 if stumpage price per unit was between 48.9 and 74.3	11.0	1.83	2.53	0.39	0.56	6.46	7.04
	T_{P3}	3 if stumpage price per unit was more than 74.3	4.9	2.61	3.54	0.44	0.40	8.17	12.17
NTINCOME ordinal	nT_{I0}	Annual income from land sales in Euros during 1999–2003, per unit of forest area							
		0 if owner did not receive non-timber income	33.7	1.69	2.73	0.57	0.91	0.81	0.92
	nT_{I1}	1 if owner received less than 381.8	50.6	1.37	2.75	1.33	4.07	2.14	3.13
	nT_{I2}	2 if owner received more than 381.8	15.7	2.11	2.64	1.06	1.25	8.86	5.79

Mean and standard deviation (%) for annual rates of planting, silvicultural and harvesting practices.

factors. As might be expected, all F_{M1} owners were active farmers, compared with 22.6% of the F_{M0} group ($\chi^2 = 6.338$); 52.4% of F_{M0} owners were retired farmers.

Because of their close association with the land, farmers actively manage their properties themselves and generally dedicate more time to forestry than NIPF owners who are not farmers and therefore work

outside the property (Zhang and Mehmood, 2001). This involvement with the land would confer these landowners, especially retired farmers, with know-how in land management that may explain why the knowledge and use of production criteria for timber harvesting varied significantly according to the landowner's past choice of converting forestland to meadow ($\chi^2 = 4.870$). Some 92.9% of the F_{M0} owners had some knowledge of the productive requirements of the forest species cultivated, in comparison with half of the F_{M1} owners; however, only 10.7% of the F_{M0} owners carried out silvicultural practices in accordance with the productive cycle of the forest species existing in woodland, whereas no F_{M1} owners did so. The descriptive statistics show that 75.1% of owners who were aware of the most suitable rotation age were farmers, mainly retired farmers (57.4%), whereas 71.4% of the owners who had no knowledge of this criterion were mainly active farmers and professionals outside agriculture (42.9% and 28.5%, respectively).

Wear and Parks (1994) maintain that harvesting age considered as optimal by the landowner depends on current and expected market conditions for all of the potential forest products. In this way, the owner can decide whether or not to harvest timber commercially on the basis of market perspectives. In the region, more than 30% of the owners who harvested below/above the rotation age of their productive forest species imitated the harvesting pattern of adjoining landowners or tried to augment their family income. Nevertheless, forest management practices that consider the suitable rotation age of the productive forest species generate high-quality timber products and, therefore, the timber is of higher value. In Mariña Oriental, the unitary price that timber was sold from previous harvests increased slightly when the landowner had relevant knowledge in this field and applied this forest criterion ($\rho = 0.337$ at $P < 0.01$). As expected, owners who did not know about and did not take into account rotation age sold timber at a significantly lower stumpage price per unit than the remainder ($H = 9.941$). Some 44.4% of the landowners who knew about and took into account rotation age fixed a timber selling price above 48.9 €/t, in comparison with 13.6% of the owners who knew about but did not take productive forest requirements into account.

We also found significant differences in the annual family income among FMEADOW groups ($H = 2.804$). Thus, the F_{M0} group earned almost twice the amount earned by F_{M1} owners per year. The status of active farmers may explain why the annual unitary amount of forest products for personal use also slightly increased with the owner's likelihood of converting forestland into meadow ($\rho = 0.214$ at $P < 0.05$). The F_{M1} owners actively benefited from forest products for their own use, with unitary reinvestment of 218 €/ha per year, which was more than three times higher the unitary amounts reinvested by F_{M0} landowners ($H = 3.881$). As described by Dewees (1992), Kurttila et al. (2001) and Marey-Pérez et al. (2004), while some owners are less dependent on forestry because of the increased proportion of other types of income, farmers may become more dependent on forestry as a source of revenue because of reduced development of the agricultural income. In Mariña Oriental, the annual unitary amount of forest reinvestment increased slightly when the landowner was actively involved in agriculture ($\rho = 0.304$ at $P < 0.01$). Active farmers made annual forest reinvestments twice as often as the remaining occupational groups ($H = 7.840$), with unitary forest reinvestments valued at between 71 and 233.7 €/ha per year. In particular, 33.8% of the landowners not involved in agriculture did not use the timber themselves and a similar percentage took advantage of forest products valued less than 71 €/ha and year within the household.

Moreover, conversion of forestland to meadows appeared to be significantly linked to the size of the productive forest holding ($H = 3.259$). Thus, the F_{M0} group managed holdings three times larger in productive forestland than the F_{M1} owners. This may be linked to the owner's involvement in agrarian practices; farmers are generally more likely to manage small forest land-bases because of their full-time commitment to agriculture. Additionally, and as indicated further below, farmers are generally more likely to manage more highly parcelled forestland. In this case, current land parcellation would arise from the previous demand for improving and increasing agrarian productivity, as indicated by Butler et al. (2004), Marey-Pérez et al. (2006) and Marey-Pérez and Rodríguez-Vicente (2008). Active and retired farmers managed holdings with the largest number of plots per unit of productive forestland in the region, an average of 3.5 plots. Conversely, hired workers and entrepreneurs managed the least parcelled landholdings, over 2.4 plots per unit of productive forestland.

3.1.2. Past conversion from marginal meadow to woodland

Past conversion from marginal meadow to woodland was weakly and positively correlated with the annual rate of improvement treatments ($\rho = 0.231$ at $P < 0.05$). The owners in the M_{W1} group annually carried out silvicultural treatments in almost three times more forestland than the M_{W0} group ($H = 4.534$). The landowner's occupation, specifically agrarian occupation, may again explain the pattern of forest management. As expected, the likelihood of converting former meadows into woodlands was negatively correlated with the status of the landowner as an active farmer ($D = -0.233$). For each M_{W1} owner who was an active farmer, there were almost four in the M_{W0} group ($\chi^2 = 4.667$). In particular, more than 62% and 29% of the landowners who considered this land-use change within their holding were retired farmers and professionals not involved in agriculture, respectively.

The previous results corroborate the hypothesis regarding capitalization of marginal land by means of investment in forestry on the part of owners not involved in agriculture who worked on their property part-time, and also retirees and older landowners (Karppinen, 1998; Gunter et al., 2001; Marey-Pérez et al., 2004). Land capitalization may therefore largely result in improved land productivity and ensure a complementary source of household income. These findings support the statement of Beach et al. (2005), i.e. that an increase in forest income with respect to agricultural income may tend to increase the effort placed in forest management. In fact, the proposed increase in woodland areas in the near future arise in light of past conversion from marginal meadow to productive forestland ($D = 0.280$). Some 66.7% of M_{W1} owners wanted to extend their productive woodland in the short/mid-term, as did 35.5% of the remaining groups ($\chi^2 = 6.822$). As indicated in the following sections, the main reason for this land management pattern could be attributed to previous harvests and resulting timber sales, i.e. to the landowner's interest in timber production.

The M_{W1} owners were the most active forest managers in the study area, and moreover we observed a clear relationship between the intensity of land investment and the landowner's commitment to forestry. Thus, the annual number of personal working days devoted to forestry differed significantly on the basis of the MWOOD group ($\chi^2 = 11.833$). Almost 59% of M_{W1} owners annually spent more than 10 working days on forestry, and more specifically, 39% of them worked more than 50 days per year. On the contrary, 58% of M_{W0} owners devoted less than 10 working days to forestry per year. As Löyland et al. (1995) reported, the landowner's occupation outside the property may mean that he/she has less time to work the land and therefore, is less likely to carry out forest practices him/herself. More precisely, and as previously suggested, devoting more time to working on the property may result in a greater degree of knowledge, which may enable landowners to manage the land themselves and take a more active role in forestry. Indeed, the annual number of personal working days on the holding tended to be higher when the landowner was trained in forestry ($D = 0.209$). All trained landowners worked more than 50 days on the holding per year, with 14.3% of them working more than 100 days per year; 58.3% of owners without this type of training worked less than 50 days on the holding per year ($\chi^2 = 10.113$). Furthermore, the landowner's knowledge and use of productive forest requirements in timber harvesting differed significantly as a function of the past conversion from marginal meadow to woodland ($\chi^2 = 4.824$). Three M_{W1} owners knew about and

applied suitable productive forest measures in previous timber harvests to each M_{W0} landowner.

The key role of public forestry subsidies was shown by the large proportion of owners who converted marginal meadows to woodland by use of such funding. In Indiana (USA), Ross-Davis et al. (2005) found that a shift in land use (afforestation) occurred on marginal agrarian land, and that public incentives appeared to encourage this shift. In Mariña Oriental, M_{W1} landowners appeared to apply for forestry grants to carry out the change in land use. Over 14% of M_{W0} owners applied for public subsidies to make forest management viable, compared with 33% of the M_{W1} group ($\chi^2 = 3.095$). As regards the unitary amounts finally granted per subsidy, M_{W1} owners annually received three times as much as the M_{W0} group (not significantly different). Hyberg and Holthausen (1989), Hardie and Parks (1996), Zhang and Flick (2001), and Kline et al. (2002), amongst others, have demonstrated that forest planting is positively correlated with the availability of public subsidies.

In accordance with the previous statement, the annual unitary investment in new forest buildings and infrastructures increased slightly with the likelihood of applying for public subsidies and with the annual unitary amount of public subsidies ($\rho = 0.334$ and 0.297, respectively, at $P<0.01$). In applying for such subsidies, there were four owners who invested annually in new forest buildings or infrastructures for every owner who did not invest in holding improvement ($\chi^2 = 10.808$). As regards the economic value of the subsidies, the unitary amount annually received by the owners who invested more than 39.7 €/ha per year was significantly higher than the unitary annual subsidy obtained by the owners who did not invest in holding improvement, i.e. over 25.6 €/ha per year more of public funding ($H = 8.112$). Moreover, annual unitary expenditure on planting was weakly and positively correlated with the likelihood of applying for public subsidies and the annual unitary amount granted per forest subsidy ($\rho = 0.244$ and 0.246, respectively, at $P<0.05$). Some 70.9% of the owners who spent more than 250 €/ha per year on forest planting applied for public forestry subsidies to make land management viable, compared with less than 20% of the remaining groups ($\chi^2 = 8.368$). As regards the unitary amount granted per subsidy, those owners who spent more than 400 €/ha per year on planting expenditures received almost three times as much per year as the owners who spent between 127 and 400 €/ha per year (not significantly different); none of the owners who did not invest in planting benefited from public subsidies in forestry. These findings suggest that public payments in forestry appear to play a key role in motivating this land management practice in the area.

The results of the logistic regression model for estimating the past transformation of the abandoned meadow to woodland are shown in Table 3. For a statistical significance of 1%, the fitted model correctly predicted 73.3% of the overall observations. The continuous variable TREAT, represented as the percentage of forestland under silvicultural improvement treatments as a proportion of the total forest, and the binary variable ASSOC, represented as the status of the owner as a member of an agroforestry association, proved to have a significant positive effect on carrying out this practice in the study region. The status of the owner as an active farmer (FARM variable) also proved to be a significant factor in this past change in land use, although with a negative sign.

These results show that those owners who actively carry out silvicultural practices every year were more inclined to have previously transformed abandoned land to woodland than those owners who had not done so, as previously mentioned. The owners who were members of agroforestry associations were almost 39% more likely to have carried out this type of transformation in their land that those who were not members of any professional group. Finally, and also discussed in this section, retired farmers or owners whose professional occupation was not related to agricultural were more likely to carry out this type of land use change than active farmers; active farmers were almost 3% less likely to have transformed abandoned land to woodland than the other professional groups.

Table 3
Parameter estimates of the logistic regression model that examines the factors affecting NIPF landowners' past decision to convert marginal meadow into woodland.

Variable	Coefficient	Wald	*P*-value	Standard error
TREAT	1.170	1.505	0.045	0.128
FARM	−0.097	6.677	0.010	0.904
ASSOC	3.212	3.495	0.050	0.624
Constant	0.338	10.878	0.001	0.329
−2 Log likelihood	101.836			
Model chi-square	11.534[a]			
Nagelkerke R^2	0.183			
Obs. with MWOOD = 1	27.0			
Obs. with MWOOD = 0	73.0			
Overall % correct	73.3			

[a] $P \leq 0.01$.

3.1.3. Future interest in changing the current productive forest species

Future plans to change the current productive forest species in the next productive cycle increased slightly with the annual rate of carrying out silvicultural treatments ($\rho = 0.238$ at $P<0.05$). Thus, C_{S1} owners annually treated four times more forestland than the remaining owners ($H = 4.809$). There was also a small positive correlation between this future land use and the annual expenditure on silviculture per unit of forest area ($\rho = 0.216$ at $P<0.05$). The C_{S1} group invested almost twice as much per year and per unit of forest area as C_{S0} owners in forest improvement treatments ($H = 3.833$). The fact that 80% of C_{S1} owners attempted to change the current productive forest species to *E. globulus* Labill. – a fast-growing forest species that is highly productive and easy to manage – may indirectly corroborate the findings of other studies, i.e. that forest expenditure significantly influences decision-making and intensity of land management by NIPF owners (Newman and Wear, 1993; Hardie and Parks, 1996; Gunter et al., 2001; Zhang and Flick, 2001; Kline et al., 2002; Arano et al., 2004).

Moreover, owners who intended to replace their current productive forest species spent greater unitary amounts per year on planting forestland. On average, C_{S1} owners annually invested almost 70 €/ha more in plantations than the C_{S0} group ($H = 2.726$). More specifically, about 66% of C_{S0} owners did not make any investment, or spent less than 127 €/ha per year on this forest practice. On the contrary, all C_{S1} owners planted forestland, and particularly, 54.4% of them annually spent more than 127 €/ha on planting. In addition, C_{S1} landowners appeared more likely to extend the area of woodland in the near future, despite the high annual unitary expenditure involved in planting and maintaining forestland. Thus, plans to change the current forest species in the next productive cycle and extend woodlands in the short/mid-term were positively correlated ($D = 0.367$). Some 79% of C_{S1} owners intended to extend the area of woodland within the holding, whereas the proportion was less than 35% in the C_{S0} group ($\chi^2 = 11.949$). Contrary to other authors who have shown that forestry costs negatively affects forestry practice choice and intensity (Newman and Wear, 1993; Gunter et al., 2001; Zhang and Flick, 2001; Kline et al., 2002; Arano et al., 2004), the large amounts of money invested in forestry did not appear therefore to reduce the intensity of forest management in the study region, although this may be associated with profitable timber sales, as explained below.

The profiles of the C_{S1} landowners revealed that the interest in changing the current productive forest species increased with the owner's involvement in professionals associations and the machinery availability within the holding ($D = 0.207$ and 0.222, respectively). For each C_{S0} owner who was a member of an agroforestry body and had machinery available within the holding, there were almost two owners in the C_{S1} group ($\chi^2 = 3.902$ and 4.341, respectively). As indicated by Finley (2002) and Kittredge (2005), the degree of participation in professional associations is linked to the owner's primary occupation. Only 14.6% of non-agricultural professionals were members of associations, compared with 22.7% and 76.2% of retired and active farmers, respectively ($\chi^2 = 24.687$). Available equipment on most holdings studied also indicated involvement in agriculture. Some 72.5% of active

and retired farmers had appropriate equipment on their holdings, compared with 59.4% of the remaining landowners ($\chi^2 = 12.935$). Descriptive statistics showed that for each C_{S1} owner who was a retired farmer, there were almost two in the C_{S0} group; C_{S1} owners were mainly active farmers (36.8%) and professionals outside agriculture (26.4%).

The owner's involvement in agriculture may also explain the positive relationship between the annual number of personal working days devoted to forestry and the intention to change the current productive forest species ($D = 0.163$). Some 55% of C_{S0} owners spent less than 10 working days per year on forestry, compared with a similar fraction of C_{S1} owners who annually worked more than 50 days on the holding ($\chi^2 = 11.377$). The major commitment to forestry on the part of the landowners who devote more time within the holding may also explain why this type of owner was more interested in changing the current productive forest species in the next productive cycle. In accordance with the findings of Zhang and Mehmood (2001), agriculturists generally have more time to devote to forest management, because of their involvement in practices related to the land. Moreover, we also found significant differences in the professional labour-forces hired annually within the holding per CSPECIE group ($\chi^2 = 9.847$). The 69% of the C_{S0} owners hired workers for less than 10 working days per year, a similar percentage to that corresponding to C_{S1} owners, who hired forest professionals for more than 10 per year. Therefore, a major personal and professional commitment of C_{S1} owners to their holding may also be the motive for changing the current productive forest species in the next productive cycle for other less demanding productive forest species.

The landowner's main occupation outside agriculture may explain why they rely on a professional labour-force to make forestry practices. We observed significant differences in the landowner's main occupation according to the annual number of professional working days spent on forestry ($\chi^2 = 36.601$). The 44% of landowners who worked outside their property hired foresters for more than 50 working days per year. Furthermore, 78% of active and retired farmers hired professional labour for less time, and more specifically, 67% of them hired forest workers for less than 5 working days per year. Absentee landowners usually have no time to devote to their forestland because they are fully occupied with other labour activities (Finley, 2002). Therefore, hiring professional assistance in forestry appears be a key factor in maintaining and making forest management viable, especially on the part of absentee landowners. Studies involving the role of technical guidance in forest adoption and management include those by Hodges and Cubbage (1990), Löyland et al. (1995), Hardie and Parks (1996), Gunter et al. (2001), and Zhang and Flick (2001).

The results of the logistic model for estimation of the intention to change the current productive forest species in the next productive cycle are shown in Table 4. The statistical significance of the fitted model was 1% and the model correctly predicted 83.7% of the total observations. In the model, the fraction of forestland under silvicultural improvement treatments as a proportion of the total forest (TREAT variable), the status of the owner as a member of an agroforestry association (ASSOC variable), and the number of personal work days dedicated annually to forestry (PERSONAL variable) were the variables that had a positive and significant effect on the future intention of the owner to change the current forest productive species in their woodland, as previously suggested. The knowledge and application of technical–silvicultural criteria by the owner (TECHNIC variable), the size of the forest holding (SIZE variable), and the unitary price of the standing timber (TPRICE variable) were also positive and significant factors to be included in the regression model created.

Thus, the most dynamic NIPF owners from a silvicultural point of view were more inclined to change the current productive forest species in their woodland in the next productive cycle than less active forest silviculturalists. The NIPF owners who formed part of an agroforestry association were approximately 10% more likely to carry out this change in the future than those who were not members of such groups. Because of their greater dedication to forestry activity, the NIPF owners who annually dedicated more than 10 work days on their holdings were almost 2% more likely to want to replace the productive forest species than those owners who dedicated less than 10 work days a year to forestry.

Table 4
Parameter estimates of the logistic regression model that examines the factors affecting NIPF landowners' future intention to change the current productive forest species in the next productive forest cycle.

Variable	Coefficient	Wald	*P*-value	Standard error
TREAT	1.555	4.694	0.030	0.204
ASSOC	3.697	4.025	0.045	0.652
TECHNIC	0.228	3.066	0.050	0.844
PERSONAL	1.340	1.927	0.036	0.211
SIZE	0.483	4.554	0.033	0.341
TPRICE	2.896	5.162	0.023	0.468
Constant	2.142	0.163	0.042	1.887
−2 Log likelihood	90.830			
Model chi-square	11.591[a]			
Nagelkerke R^2	0.356			
Obs. with CSPECIE = 1	22.0			
Obs. with CSPECIE = 0	78.0			
Overall % correct	83.7			

[a] $P \leq 0.01$.

Moreover, the owners who knew and applied technical–silvicultural criteria for forest management in previous rotations were 2% more likely to carry out the change in the future than those who had no knowledge of these criteria or who were aware of them but did not put them into practice. As regards the productive forest area, the NIPF owners who managed more than 3.50 ha were approximately 3% more likely to carry out this change in the next productive cycle than owners of less than 3.50 ha of productive forestland. Finally, the owners in the study region who sold timber from previous harvests, independently of the unitary price for standing timber, were 10% more likely to carry out this change in the future than the owners who did not sell any timber.

3.1.4. Future interest in extending the area of woodland

The annual rate of timber harvesting increased slightly in relation to the landowners' future intention to extend the area of woodland within the holding in the short/mid-term ($\rho = 0.242$ at $P < 0.05$). The I_{F1} group included many more active land managers in the area, who harvested more area of woodland per year than I_{F0} owners ($H = 4.972$). In addition, the annual rate of carrying out forest improvement treatments also differed significantly depending on the IFOREST group considered ($H = 2.954$). On average, landowners who aimed to extend their woodland in the near future annually treated almost 1% more forestland than the remaining owners.

Extending woodland in the short/mid-term was weakly and positively correlated with annual investments in plantation and forest improvement treatments per unit of forest area ($\rho = 0.278$ and 0.292, respectively, at $P < 0.01$). Thus, I_{F1} owners spent 97 € and 38 €/ha per year more on planting and silviculture, respectively, than the I_{F0} group ($H = 6.495$ and 6.976, respectively). Furthermore, annual unitary investments in holding improvement increased slightly in relation to the aim to extend the area of woodland ($\rho = 0.234$ at $P < 0.05$). The I_{F1} owners spent three times a year more on unitary investment in new forest buildings and infrastructures than the remaining owners ($H = 4.608$). The largest investment in forestry by the I_{F1} owners appeared to be aimed at capitalizing on former land dedicated to agriculture, a finding that is corroborated by the fact that the landowner's intention to extend the area of woodland in the near future was significantly correlated with past conversion of the land from marginal meadow to woodland ($D = 0.280$). The proportion of I_{F1} owners who carried out this type of conversion within the holding was almost three times that observed in the I_{F0} group ($\chi^2 = 6.822$). Despite the more active forestry activity and the greater amount spent on this, the fact that the I_{F1} owners aimed to increase the area of woodland shows that in the study region large amounts of money invested

in forestry do not appear to reduce the intensity of management by those owners more actively involved in forestry, but rather that (as previously suggested for the future intention of replacing the productive forest species) this may be explained by the economic interests of the owners in producing timber according to a silvicultural regime involving lower economic and labour costs.

Once again, knowledge of the landowner's primary occupation is a key factor in understanding the pattern of forest management observed in the study region. The degree of landowner's involvement in associations and the number of personal working days devoted annually to the holding increased in accordance with the aim to extend the woodland area ($D=0.211$ and 0.185, respectively). Some 25% of I_{F0} owners were members of professional organizations related to forestry, in contrast to 45% from the I_{F1} group ($\chi^2=3.697$). With respect to personal time devoted to forestry, 60% of I_{F0} owners spent less than 10 working days a year within the holding, compared with 55% of I_{F1} owners who spent more than this amount of time on forestry activities. The annual number of days that forestry workers were hired for also increased on the basis of the landowner's aim to extend the area of woodland ($D=0.308$). For each I_{F0} owner who sought professional assistance for more than 50 working days per year, there were three in the I_{F1} group ($\chi^2=12.387$). Two profiles of active forest managers were clearly differentiated in the region, retired farmers and professionals who did not earn their living from agriculture; both types of forest managers were more likely than other owners to invest in marginal agrarian land for profitable use. The greater use of personal and professional labour forces in forestry activities corresponding to I_{F1} owners, in addition to their greater involvement and greater economic spending on the activity may explain why forest owners who intend to increase the amount of productive forestland also appeared to be more interested in replacing the current productive species in their woodlands. Thus, future intentions to extend woodland and replace the current forest species were positively related ($D=0.367$). For each I_{F0} owner who aimed to change his/her forest productive cycle, there were five I_{F1} landowners ($\chi^2=11.949$).

The agrarian link may explain exactly why the pattern of land acquisition was positively correlated with the future intention to extend the area of woodland within the holding ($D=0.187$). Some 60% of I_{F0} owners inherited their holding; a similar proportion in the I_{F1} group managed holdings that comprised a combination of inherited and purchased land. The owner's main occupation varied significantly according to the pattern of land acquisition ($\chi^2=22.191$). Thus, retired farmers represented a specific group with holdings principally acquired by purchase and inheritance. In brief, retired farmers are more likely to make land transactions because of their desire to improve and increase the former agrarian productivity, and hence a more significant land mobility (Marey-Pérez et al., 2004). The relationships between land tenure and forest management have been explored by Conway et al. (2003), Ross-Davis et al. (2005), and Marey-Pérez et al. (2006).

The main reason for extending the areas of woodland, despite the associated economic and labour costs for NIPF owners, may be explained, as suggested in the present study, by previous harvests and resulting timber sales, i.e. the interest in timber production (Hardie and Parks, 1996; Bolkesjø and Baardsen, 2002; Kline et al., 2002). Firstly, the annual rate of harvesting woodland increased greatly in proportion to the annual unitary timber income and stumpage price per unit from previous harvests in the region ($\rho=0.809$ and 0.781, respectively, at $P<0.01$). Secondly, it was found that the mean unitary annual income and unitary stumpage price from timber sales differed significantly among IFOREST groups ($H=3.118$ and 3.104, respectively). Thus, and emphasizing the first statement in this paragraph, the I_{F1} owners benefited greatly from forests, and received over 100 €/ha per year as timber-related income at almost twice the selling price per unit than the I_{F0} owners. This indicates that favourable market conditions for timber production, especially attractive timber prices, appeared to motivate involvement of NIPF owners in land management in the study area. Binkley (1981), Boyd (1984), Kuuluvainen and Salo (1991), Kuuluvainen et al. (1996), Bolkesjø and Baardsen (2002), Pattanayak et al. (2002), and Bolkesjø et al. (2007) have all shown that timber price (for roundwood, pulpwood and sawtimber) positively affects harvest choice and intensity or volume, and timber supply.

The annual unitary investment in holding improvement also increased slightly in relation to the unitary stumpage price from previous harvests ($\rho=0.232$ at $P<0.05$). The unitary price at which landowners who made annual investments in holding improvement sold the timber was almost double the unitary selling price fixed by owners who did not invest in new forest buildings or infrastructures ($H=4.774$). Also, the annual unitary timber income from previous harvests increased moderately with the annual expenditure per unit of forest area associated with planting ($\rho=0.417$ at $P<0.01$). Landowners who spent more than 127 €/ha per year on forest planting obtained three times more annual unitary income from forests than landowners who spent less than this amount or did not invest in planting ($H=10.694$). More specifically, the unitary stumpage price from preceding harvests increased slightly with the annual unitary expenditure on planting ($\rho=0.343$ at $P<0.01$). In this case, owners who spent between 127 and 250 €/ha per year and the owners who spent more than 400 €/ha per year on planting sold timber at twice the unitary selling price fixed by the remaining groups of owners. Finally, the annual expenditure per unit of forest area associated with silviculture increased slightly in relation to the annual unitary income from timber harvests ($\rho=0.252$ at $P<0.05$). Landowners who spent more than 90.7 €/ha per year on carrying out forest stand treatments earned twice the annual unitary amount from the timber as landowners who spent less than this amount or did not invest in silviculture.

The landowner's intention to extend the wooded land-base also appeared to be related to the pattern of land parcellation in the region. Thus, the number of plots per unit of productive forestland varied significantly as regards the intended land use ($H=2.861$). On average, productive forest holdings belonging to I_{F0} owners were slightly more parcelled than the land-base belonging to the I_{F1} group; some 63.2% of the I_{F1} group owned holdings of less than 3.4 plots per hectare of productive forestland, compared with 54.2% of I_{F0} owners who managed more than 3.4 plots per hectare of productive forestland. Therefore, taking into account the land management pattern of I_{F0} owners, land parcellation may lead to some structural difficulties for forest investment and management, due to the small size of plots, and thus an increase in management costs and a decline in productive yields may be expected (Healy, 1985; Conway et al., 2003; Potter-Witter, 2005).

The results of the logistic regression model for future intention to increase the woodland in the short-medium term are shown in Table 5. This model correctly classified 73.3% of the overall observations for a significance level of 1%. As discussed in this section, the binary variable ASSOC, which indicates the status of the owner as a member of a professional agroforestry association, and the ordinal variable PROFESS, which represents the number of professional work days contracted annually by the NIPF owner were two of the regressor variables included in the present model. The third significant attribute as regards the probability that the owners would continue increasing the extent of the productive forestland was the ordinal variable TINCOME, which categorizes the annual amount of forest income per unit of forest area proceeding from the sale of timber. These three independent variables had a significant positive effect on the future intention of the owner to increase the area of productive forestland in the short-medium term.

Thus, those owners who participated in an agroforesty association were almost 40% more likely to keep increasing the size of their woodlands in the near future than those who were not members of

Table 5
Parameter estimates of the logistic regression model that examines the factors affecting NIPF landowners' future intention to enlarge the area of woodland within the holding in the short/mid-term.

Variable	Coefficient	Wald	*P*-value	Standard error
ASSOC	2.368	2.899	0.039	0.510
PROFESS	1.492	6.666	0.010	0.155
TINCOME	1.681	2.8230	0.041	0.309
Constant	0.121	13.421	0.000	0.576
−2 Log likelihood	118.056			
Model chi-square	3.874[a]			
Nagelkerke R^2	0.238			
Obs. With IFOREST = 1	44.0			
Obs. with IFOREST = 0	56.0			
Overall % correct	73.3			

[a] $P \leq 0.01$.

such bodies. Moreover, those NIPF owners who contracted more than 5 professional work days for forestry activities were 10% more likely to have this intention than those owners who contracted less than 5 professional work days annually. Finally, those owners who received more than 195.1 € per year and unit of forest area from the sale of timber were almost 30% more likely to increase the area of productive forest than those owners who received less than this amount or who did not sell any timber.

3.2. Territorial structure of the ownership

3.2.1. Degree of parcellation of productive forestland

As Kendra (2003) stated, forestland is becoming increasingly parcelled, in contrast to the larger-scale management recommended by policymakers and land planners. Land parcellation is directly reflected in owners' decisions and practices regarding land, which generally reduces the likelihood and intensity of management (Conway et al., 2003; Potter-Witter, 2005). Indeed, the annual rates of planting and silviculture decreased slightly when the degree of parcellation of productive forestland increased ($\rho = -0.293$ and -0.312, respectively, at $P<0.01$). A similar trend was also observed in the timber harvesting practice; the amount of woodland harvested per year decreased slightly when the number of plots per unit of productive forestland increased ($\rho = -0.216$ at $P<0.05$). Post-hoc analyses confirmed this result, and showed that these three practices were also significantly different per PLOT group (Table 6). The P_{L1} owners were the most active planters in the area, and planted significantly more forestland per year than the P_{L4} owners ($H = 10.027$). In addition, the P_{L1} group also included the most active silviculturalists in the study area, who were significantly more active than the remaining owner groups ($H = 9.763$). Finally, the annual rate of timber harvesting by the P_{L1} group was significantly higher than the observed in the P_{L2} and P_{L4} groups, on average five times higher ($H = 13.057$).

Some aspects of the forest owner's profile again identified the owners in terms of the degree of parcellation of the forest property and enabled a more detailed understanding of the type of forest management that the owners carried out. Thus, we also observed that the number of plots per unit of productive forestland increased slightly in accordance with the landowner's age ($\rho = 0.257$ at $P<0.05$), and furthermore, decreased slightly with the level of formal education and primary occupation ($\rho = -0.236$ and -0.265, respectively, at $P<0.05$). On average, the P_{L1} and P_{L2} groups were more than eight years younger than P_{L3} and P_{L4} owners ($H = 6.697$). All owners younger than 40 years old were included in the P_{L2} group, whereas 61.5% of P_{L3} and P_{L4} owners were older than 65 years old; 66.7% of P_{L1} owners were 40–65 years old. On the other hand, 16.7% of P_{L1} owners had not received any formal education, as compared with 50.2% of P_{L2} and P_{L4} owners; almost 67% of P_{L3} landowners had received primary education (although the differences were not significant). Finally, there were almost three non agricultural professionals in the P_{L1} and P_{L2} groups to one in each of the remaining owner groups (although again the differences were not significant). The availability of agroforestry machinery also differed significantly among PLOT groups ($\chi^2 = 9.381$). Over 31.3% of P_{L1} owners had suitable agricultural and forestry machinery for land management, whereas 70.8% of the remaining groups did not have such resources available. Taking into account the agrarian profile of a large proportion of the owners included in P_{L3} and P_{L4}, this appears to confirm that agricultural productivity may be an important factor in land parcellation in the study area.

The number of plots per unit of productive forestland also decreased slightly in relation to the increase in the annual earning per household ($\rho = -0.250$ at $P<0.05$). As Table 6 shows, the family income annually earned by P_{L4} owners was significantly lower than that earned by the remaining owners ($H = 8.788$). No P_{L4} landowner received more than 18,000 € in annual family income, in comparison with 44.8% of the remaining groups, who received more than this amount. Taking into account the more active forest management on the part of P_{L1} landowners, these results may support, although indirectly, those obtained by other authors who have reported that higher investments in forest are made by those owners with higher income per household (Hardie and Parks, 1996; Gunter et al., 2001; Mahapatra and Mitchell, 2001; Arano et al., 2004; Ross-Davis et al., 2005). However, the statistical analysis revealed that the annual income of the family units in the study was not a significant factor in the activities related to planting, silviculture and harvesting, or in the money annually invested in holding improvement or silviculture. Only the annual unitary expenditure on forest plantation increased slightly in relation to annual household income ($\rho = 0.220$ at $P<0.05$),

Table 6
Homogeneous PLOT subgroups with regard to annual rates of planting, silviculture and harvesting (%), family income (€/year), expenditures on planting and silviculture (€/ha per year), and the size of productive forest holding (ha).

PLOT		P_{L1}	P_{L2}	P_{L3}	P_{L4}	*P*-value
% of interviewed landowners		14.0	39.5	27.9	18.6	
PLANT	Small planter		1.89	1.02	0.50	0.363
	Large planter	3.21	1.89	1.02		0.054
TREAT	Small silviculturalist		0.88	0.38	0.38	0.947
	Large silviculturalist	3.54				1.000
HARV	Small harvester		2.32	4.86	0.85	0.160
	Large harvester	7.88		4.86		0.394
HOUSEHOLD	Farmer traditionalist		18,781.63	17,786.20	10,245.38	0.051
	New professional	20,997.86	18,781.63	17,786.20		0.759
PEXP	Non-planter		240.22	156.09	120.65	0.226
	Planter	299.42	240.22	156.09		0.105
TEXP	Non-silviculturalist		97.88	67.52	51.98	0.698
	Silviculturalist	168.19	97.88	67.52		0.088
SIZE	Small landowner		5.25	3.44	3.39	0.404
	Large landowner	7.87	5.25			0.130

although the mean values were not statistically significant; landowners whose income exceeded 9000 € per year invested almost 100 €/ha per year more in planting their forestland than those groups with household earnings below this figure.

The annual unitary investment in holding improvement increased slightly as the degree of parcellation of the productive forestland decreased ($\rho = -0.216$ at $P<0.05$). More than 85% of P_{L3} and P_{L4} owners did not invest in their holding for annual development of new forest buildings or infrastructures, in comparison with 62% of P_{L1} and P_{L2} owners. On average, the P_{L1} and P_{L2} groups annually invested twice as much in their holdings per unit of forest area as the remaining owners ($H = 7.840$). In the same way, annual unitary expenditure on planting and developing silviculture decreased slightly in those holdings with a larger number of plots per unit of productive forestland ($\rho = -0.238$ and -0.266, respectively, at $P<0.05$). Indeed, more parcelled holdings cannot be managed for forestry as efficiently as larger ones, and there are fewer investment and management options available. In this case, P_{L1} owners were the most active in terms of planting and carrying out silvicultural practices in forestland, and were significantly more active than the remaining owners ($H = 7.560$ and 8.471, respectively). The P_{L1} and P_{L2} owners allocated twice as much money annually per unit of forest area to these practices as the P_{L3} and P_{L4} groups (Table 6). On the basis of these findings and the characterization of the landowners, retired farmers and also non-agricultural professionals appear more likely to invest in land in order to increase its value and its returns.

Active forest managers appeared to resort to professional assistance for carrying out land management practices. Thus, the annual number of days that forestry workers were hired moderately and slightly increased with the annual rates of forest planting and timber harvesting, respectively ($\rho = 0.408$ and 0.302, respectively, at $P<0.01$), as well as slightly in relation to the annual rate of silviculture ($\rho = 0.251$ at $P<0.05$). These relationships explain why the annual number of days that forestry workers were hired was higher in the less parcelled productive forest holdings ($\rho = -0.246$ at $P<0.05$). Some 37% of P_{L1} and P_{L2} owners hired workers for more than 50 working days per year, while 80% of the P_{L3} and P_{L4} groups hired professional labour for less than 10 days per year. Taking into account that 71.4% of the non-agrarian professionals were included in the P_{L1} and P_{L2} groups, it can again be deduced that forestry was generally less feasible for managers with occupations outside the property, thereby forcing landowners to make use of professional assistance in order to develop forestry.

The relationship between the degree of land parcellation and the intensity of land management may explain the significant differences in the productive possibilities from studied landholdings according to the number of plots per unit of productive forestland. Even though there was no statistical evidence regarding the annual unitary income from timber sales, the unitary stumpage price fixed from previous harvests differed significantly among PLOT groups ($H = 6.275$). A multiple comparison analysis showed that the P_{L1} and P_{L3} owners sold timber at significantly higher stumpage prices per unit (twice as high) than the P_{L2} and P_{L4} owners. According to Cubbage (2003), technical advice provided by professional foresters may explain this result, as this type of assistance in timber harvesting and marketing may increase the landowner's net revenues from timber sales. Furthermore, Boyd (1984) and Hyberg and Holthausen (1989) reported that provision of technical assistance tends to increase the likelihood that NIPF owners will harvest their timber. Thus in the study region, the annual rate of timber harvesting increased slightly with respect to the landowner's knowledge of timber market information ($\rho = 0.274$ at $P<0.05$), and moreover, the stumpage price per unit from previous harvests increased slightly in accordance with this type of information ($\rho = 0.282$ at $P<0.05$). On average, the annual rate of timber harvesting by owners who had access to information about the timber market was twice that observed for the remaining owners ($H = 6.391$), fixing the unitary price of the timber at more than 2 €/t ($H = 6.442$).

Finally, larger areas of productive forestland were closely linked to a lower degree of land parcellation. Thus, the number of plots per unit of productive forestland increased slightly on those holdings consisting of smaller areas of productive forestland ($\rho = -0.316$ at $P<0.01$). The post-hoc analyses showed that the P_{L1} group was characterized as owning the largest productive forest holdings in the region, which were significantly larger than those owned by the P_{L3} and P_{L4} groups ($H = 9.553$). Some 64.3% of P_{L1} and P_{L2} owners managed productive forest holdings larger than 3.5 ha, and more specifically, 41.2% of them owned more than 7 ha of productive forestland. On the contrary, 45.8% and 62.5% of P_{L3} and P_{L4} owners, respectively, owned productive forest holdings smaller than 3.5 ha, and a third of them managed less than 1.7 ha of productive forestland. These significant differences classified the owner population as shown in Table 6.

3.2.2. Land-base of productive forestland

As Royer (1980) stated, 'if there has been one factor most often associated with differences in landowner responses in surveys, it has been the size of landholdings'. In Mariña Oriental, the size of productive forest holding was found to be a key factor in making forest management viable, as found in other studies of NIPF owner land decisions (Binkley, 1981; Boyd, 1984; Hodges and Cubbage, 1990; Löyland et al., 1995; Hardie and Parks, 1996; Zhang and Pearse, 1997). Thus, the annual rates of planting and silviculture in forestland increased greatly and slightly, respectively, according to the size of productive forest holding ($\rho = 0.802$ and 0.355, respectively, at $P<0.01$). In addition, the annual rate of harvesting woodland increased slightly in relation to this landholding attribute ($\rho = 0.255$ at $P<0.05$). The S_{I4} landowners were the most active planters in the region, and differed significantly from the remaining owners ($H = 56.330$). The rate of carrying out silvicultural practices was significantly higher in the S_{I4} group than in the S_{I2} group ($H = 11.787$). These variables distinguished two significant subgroups of planters and silviculturalists in the area (Table 7). Finally, the S_{I2} group harvested significantly more woodland per year (>2% more) than the remaining groups ($H = 7.058$).

The size of the productive forest holding increased slightly in those landowner groups who had received a higher level of formal education ($\rho = 0.294$ at $P<0.01$). For each S_{I3} and S_{I4} owner who had not received any formal education, there were three in the S_{I1} and S_{I2} groups; the fraction of owners educated to tertiary-level in the S_{I4} group was twice as high as in the remaining groups ($\chi^2 = 16.198$). The fact that the level of education was positively correlated with the owner's primary occupation completed the previous results ($D = 0.406$). All owners educated to tertiary level and half of the owners educated to secondary level worked in areas outside of agriculture, whereas 75% and 44% of the owners who had not received any formal education or only primary education, respectively, were retired farmers ($\chi^2 = 39.148$). Thus, 52.4% of the professionals not related to agriculture managed productive forest holdings larger than 3.5 ha, whereas a similar fraction of the active and retired farmers (57%) managed smaller productive forest holdings, probably because they were more likely to be involved in managing agrarian land.

A better level of education would generally improve prospects and success within the labour market, which should be reflected in the annual earnings of the owners. As indicated in Table 7, the annual income of S_{I4} owners was significantly higher than that of the S_{I3} owners, a mean difference higher than 8300 €/year ($H = 11.272$). Some 33.3% of S_{I4} owners earned more than 30,000 €/year in family income, in contrast to 11.3% of the remaining owner groups. Therefore, Nagubadi et al.'s (1996) findings were corroborated in the study region: landowners with a higher income were more likely to manage larger forest holdings. As already mentioned, involvement in agriculture may also explain why annual unitary reinvestment in forest activities increased slightly in those holdings of smaller size of productive forestland ($\rho = -0.226$ at $P<0.05$). As seen in Table 7, the S_{I1} owners annually took advantage of unitary forest reinvestments

Table 7
Homogeneous SIZE subgroups with regard to annual rates of planting, silviculture and harvesting (%), family income (€/year) and forest reinvestment for household consumption (€/ha per year), expenditures on plantation and silviculture (€/ha per year), income (€/ha per year) and stumpage price (€/t) from timber sales, and the degree of parcellation of the productive forest holding (no. plot/ha).

SIZE		S_{I1}	S_{I2}	S_{I3}	S_{I4}	*P*-value
% of interviewed landowners		20.9	23.3	31.4	24.4	
PLANT	Small planter	0.17	0.33	1.09		0.463
	Large planter				4.58	1.000
TREAT	Small silviculturalist	0.46	0.32	0.65	2.65	0.065
	Large silviculturalist	0.46		0.65		0.982
HOUSEHOLD	Farmer traditionalist	19,891.83	14,319.11	13,784.32		0.193
	New professional	19,891.83	14,319.11		22,130.,12	0.057
REINVEST	Non-forest consumer		94.73	58.20	33.03	0.055
	Forest consumer	108.19	94.73	58.20		0.164
PEXP	Non-planter	95.25	148.80	183.50		0.339
	Planter				371.06	1.000
TEXP	Non-silviculturalist	40.67	69.52	67.09		0.658
	Silviculturalist		69.52	67.09	108.23	0.360
TINCOME	Non-wood seller	86.98	132.04	231.10		0.152
	Wood seller		132.04	231.10	301.66	0.066
TPRICE	Non-timber industrialist	2.25	3.41	4.35		0.336
	Timber industrialist		3.41	4.35	5.92	0.192
PLOT	Small landowner		3.20	3.71	2.43	0.101
	Large landowner	4.30	3.20	3.71		0.197

three times as often as the S_{I4} group ($H=6.811$). In fact, landowner status as an active farmer could be the main factor that explains the significant differences in the likelihood that the owner will convert forestland into meadow according to the SIZE group ($\chi^2=7.735$). None of the S_{I2}, S_{I3} and S_{I4} owners converted forestland into meadow, in comparison with 11% of S_{I1} owners.

Large holdings required larger annual inputs of money to improve them, as expected due to the relationship between land size and intensity of management (Hyberg and Holthausen, 1989; Kuuluvainen and Salo, 1991; Prestemon and Wear, 2000; Zhang and Mehmood, 2001; Arano et al., 2004; Potter-Witter, 2005; Arano and Munn, 2006). The annual unitary investment in holding improvement increased slightly with the size of the productive forest holding ($\rho=0.216$ at $P<0.05$). The S_{I4} owners spent per unit of forest area twice as much per year on new forest buildings and infrastructures as the remaining owners ($H=7.638$). Furthermore, annual unitary expenditures on planting and forest improvement treatments moderately and slightly increased as holding size increased, respectively ($\rho=0.524$ and 0.369, respectively, at $P<0.01$). Larger holdings would therefore be more likely to be managed, and more specifically, to be planted and improved, as found by Boyd (1984), Löyland et al. (1995), Arano et al. (2004) and Potter-Witter (2005). The S_{I4} owners invested per unit of forest area significantly more per year in planting and silviculture than the remaining owners ($H=23.997$ and 10.217, respectively). The significant differences found in annual unitary expenditure on planting and silviculture enabled classification of landowners as shown in Table 7.

The landowners appeared to resort to public subventions in forestry to implement these activities and to pay off their corresponding expenditures, as previously mentioned. We found that the likelihood of a landowner applying for public subventions significantly differed according to the size of the productive forest holding ($\chi^2=12.851$). None of the S_{I2} owners and 11.1% of the S_{I1} group applied for subventions, compared with 30.4% of the remaining owner population. As regards the annual unitary amount granted per subsidy, the S_{I3} and S_{I4} owners annually received twice as much as the S_{I1} group, although the difference was not significant. Owners of large landholdings also appeared to be actively supported in technical guidance in forestry. The number of days that forestry workers were hired for per year increased slightly in accordance with the size of productive forestland ($\rho=0.277$ at $P<0.01$). Over 45% of S_{I1} and S_{I2} owners hired forestry workers for fewer than 5 days a year; a similar percentage of S_{I4} owners annually hired workers for more than 50 days, and 22.2% of S_{I3} owners hired workers for between 11 and 100 days a year ($\chi^2=23.103$). Therefore, large landowners were more likely to rely on professional assistance for forest management, in accordance with the findings of Nagubadi et al. (1996), Zhang and Mehmood (2001) and Van Gossum et al. (2005). As mentioned throughout this study, the main reason for contacting forest professionals was linked to the landowner's primary occupation.

Larger productive forest holdings were characterized by higher timber income at a higher unitary stumpage price, probably because of the greater likelihood of being harvested and obtaining a higher timber volume to negotiate a better price at a lower harvesting cost. The positive significance of the size of the landowners' property on timber harvesting has been analysed in several studies (Binkley, 1981; Boyd, 1984; Kuuluvainen and Salo, 1991; Löyland et al., 1995; Prestemon and Wear, 2000; Conway et al., 2003; Potter-Witter, 2005; Bolkesjø et al., 2007; Størdal et al., 2008). Thus, the annual unitary timber income and timber selling price per unit increased slightly in relation to the size of the productive forest holding ($\rho=0.372$ and 0.285, respectively, at $P<0.01$). As Table 7 shows, the S_{I4} owners annually obtained a significantly larger unitary income from timber sales at significantly higher unitary stumpage prices than the other owners ($H=13.802$ and 9.958, respectively). Taking into account the guidelines for forest management observed in the area, attractive timber prices, in addition to professional support in forest management may motivate landowners to become involved in forestry, as also pointed out by Munn and Rucker (1994) and Löyland et al. (1995).

Finally, larger land-bases of productive forestland were generally characterized by a lower degree of parcellation, as already stated. Thus, the number of plots per unit of productive forestland decreased slightly in those holdings comprising a large area of productive forestland ($\rho=-0.316$ at $P<0.01$). As expected, the S_{I4} group owned productive forest holdings that were significantly less parcelled than those owned by the S_{I1} group ($H=13.027$). Some 66.6% of S_{I1} and S_{I2} owners managed holdings comprising more than 3.4 productive forest plots per hectare, compared with 73% of the owners in S_{I3} and S_{I4} groups whose holdings comprised less than 1.52 plots per hectare of productive forestland. On average, the S_{I1} group owned holdings with two plots per unit of productive forestland more than S_{I4} owners, and one plot more per unit of productive forestland than S_{I2} and S_{I3} groups (Table 7). This finding, together with the previous characterization of the landowners, appears confirm that owners involved in farming were certainly more likely to manage small and parcelled holdings to intensify their agrarian production.

4. Conclusions and implications

As a prior step in developing and executing successful forest measures in land management and planning policy, the main objective of the present study was to examine structural attributes of the forest holding, as well as past changes and future intentions for land use, in relation to individual forest management in the Mariña Oriental region, in Northeast Galicia (Northern Spain) for the 1999–2003 period. The data used was obtained, in 2004, by personal interviews with 103 NIPF owners, each responsible for more than 1 ha of productive forestland in the study area.

On the basis of the results obtained, three main types of NIPF owners were identified: retired farmers who maintained forestry activity as their only link with the agrarian sector, and who were actively involved in carrying out the work themselves; active full-time farmers who viewed their forestry activities as an extra source of income, and finally, owners occupied in other professional sectors (outside of agrarian activities) who own forestland, but which is largely managed by contracted personnel. Secondly, the correlation and dependency analyses revealed that the greatest and most efficient forest activity was associated with three key parameters: larger areas of productive forestland in the property, less-divided forestland and greater availability of time to dedicate to forestry activities, whether by the owners themselves or by contracted workers.

As regards past changes and future intentions for land use, conversion of forestland into meadow responded to the demand for increasing agrarian land-base, and this past land-use change was significantly related to the landowner's occupation as an active farmer. In the region, owners who were farmers generally managed smaller productive forest land-bases, because of their full-time commitment to agriculture, and more parcelled productive forest holdings, probably because of their aim to improve and increase the overall agrarian productivity, in contrast to the remaining landowner population. Furthermore, both past transformation of marginal meadow to woodland and the future intention to increase the area of productive forestland in the short-medium term clearly depends on past experience. Thus, those NIPF owners who had profited by selling timber from previous harvests (high annual unitary income from timber sales at better unitary stumpage prices), had either increased the area of woodland on their properties or intended to do so in the near future. Retired farmers and non-agricultural professionals were the owners most likely to carry out this type of land-use conversion through use of public subsidies. Finally, the intention to change the productive forest species in the next productive cycle was also linked to the forest profitability. Thus, those NIPF owners who devoted more time to forestry work, either themselves or through contracted workers, and who invested more money in the activity were more inclined to improve the profitability of their land. The profile that included this type of owner mainly corresponds to active farmers, who because they do not have more land to reforest because the land is required for livestock purposes, aim to improve the profitability of the forestland by the type of change mentioned.

In summary, the main conclusions of the present study are that the NIPF owners in the Mariña Oriental appear to respond clearly to timber markets, as other authors have concluded in other regions, with the particular characteristic of "a moral responsibility" of looking after the land or using it for productive purposes — in contrast with the alternative of the decapitalization of abandoned farm land. The forest area and its configuration (number of plots per unit of land) are also important factors in motivating NIPF owners to initiate or continue forestry activities, with the so-called economies of size being particularly important, as also found in other studies.

Forest professionals, researchers and policymakers should take into account the existence of different profiles of private forest owners and managers, and therefore, the existence of different types of land holdings and land management practices, in making decisions and developing programmes involving sustainable land planning and forest resources. The present study demonstrates that it is essential to reinforce the role of the associations and of the technicians and/or professional forestry workers in forest planning and management, given the importance of this in initiating and continuing forest activity, by providing information and training, generating and professionalizing the work, and finally producing timber and other forest products and services. In addition, the land-base of productive forestland must necessarily be improved or restructured, either by direct land planning measures (agroforestry land consolidation) or by indirect forest cooperation measures (landowner involvement in management-related associations). Consequently, public programmes aimed at ensuring the continuity of private forest management and that may improve holding profitability and viability should be designed and executed. Such public programmes should involve the use of economic incentives, training and practical tools, and professional assistance specifically aimed at NIPF owners. To maximize and make forestry competitive within rural development, further and continuous research is required in order to discover and test plausible means of encouraging NIPF owners to invest appropriately in a land-base in keeping with their personal and family circumstances or needs.

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Analysis of individual private forestry in northern Spain according to economic factors related to management

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ABSTRACT

In addition to being motivated by profit, the management decisions taken by non-industrial private forest (NIPF) owners involve other considerations beyond timber, such as non-timber goods and services, as well as factors that affect the level of timber output from the land. Ensuring and improving forest profitability to make NIPF management viable is one of the main challenges faced by this type of landowner. This study empirically explores and assesses management by NIPF owners, through analysing attributes of forest economics (investment in holdings, expenditure on planting and silviculture, public subsidies, along with timber and non-timber incomes). With the aim of predicting outcomes, a multiple regression model was also constructed to investigate and quantify the relationship between socioeconomic and holding factors, and the planting activities carried out by NIPF owners. For this, 103 resident forest landowners in a forest region in northern Spain were interviewed in person, during March 2004, about their commitment to and involvement in land management during the period 1999–2003. The results mainly revealed that attractive forest returns and favourable market conditions for timber production are significant factors for investment in and development of forestry, with personal and family conditions also being important factors in explaining the type of land management carried out. In particular, the multiple linear regression model for forest planting activity correctly explained 84.5% of the variability observed in the study population, indicating that both the investments in and

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the incomes from forestry play an important role in the activity, as does the size of the holding. The findings may be of interest in promoting public measures related to timber markets and economic incentives for forest management, which will allow landowners to develop economically viable practices, as well as enabling fulfilment of social and environmental demands for sustainable forestry and rural development.

Introduction

The need to consider environmental issues as well as incorporating social and economic criteria in forest decision-making and management has been recognized and accepted as a paradigm for rural development in recent times, a salient theme in forestry throughout the world today. Sustainable forest planning guidelines are particularly complex for non-industrial private forest (NIPF) owners because their objectives are much more diverse than those of other types of private landowner, given that they are heterogeneous by nature (Arano and Munn, 2006). As pointed out by Alig et al. (1990), NIPF owners and their holdings are diverse both within and across regions, where intentions vary widely and often change over time. Furthermore, many of them do not cite timber production as one of their primary aims.

The situation is particularly complex within regions where this type of private forest ownership predominates and contributes significantly to rural development. In many rural areas, NIPF land management generates numerous benefits that complement the economy, contributes to social welfare and improves the natural environment (Marey-Pérez and Rodríguez-Vicente, 2008). Thus, in addition to being motivated by profit, the decisions made by NIPF owners with regard to production are affected by other considerations beyond timber, such as non-timber goods and services, as well as factors that affect the level of timber outputs from the land (Newman and Wear, 1993). Therefore, the balance among forest productivity, management and monitoring, and profitability is more complex to model and forecast for NIPF ownership than for other types of land tenure.

Two basic theoretical models have been used to analyse and model the types of NIPF land management within the extensive literature concerning this type of private individual ownership: *utility maximization* and *profit maximization*. In the utility maximization approach, NIPF owners select from among timber and non-timber options that forests offer to maximize perceived utility for themselves (financial and non-financial benefits from the land), whereas the profit maximization assumption views the landowner as a firm or commercial entity and the forest as a unit of production, usually of timber products (Alig et al., 1990). Studies of NIPF owners commonly profile and model them as utility-maximizers of forests, given that non-timber products may be of equal or greater importance to NIPF owners than timber products (Binkley, 1981; Boyd, 1984; Pattanayak et al., 2002; Conway et al., 2003; Potter-Witter, 2005).

In a more globalized economy, the current and future competitiveness of the forest management practices carried out by many NIPF owners are nevertheless threatened, as forest practices that are socially acceptable and environmentally respectful may not be economically profitable. Moreover, high investment in silvicultural treatments is required throughout the productive cycle and there is a long delay between planting and timber harvesting in the rotation of forest species. This means that landowners cannot generate a constant economic cash-flow, which would encourage and ensure continuous management and monitoring, as in other agrarian practices. Factors such as the long-term nature of any profits, lack of professionalism, the use of forestry practices that are based on family requirements, as well as the increasing proportion of landowners (who do not earn their living from agriculture as they have more profitable primary occupations), and market competition based on low prices but high costs (Bolkesjø and Baardsen, 2002; Marey-Pérez et al., 2004) all contribute to destabilizing the economic sustainability of forest management, and hence, social and environmental sustainability in rural areas.

The present study attempts to mitigate the general concern in scientific and political fields about land management practices by NIPF owners, through empirical analysis and discussion of the following key issues:

1. Forestry as an 'economic activity' (*profit* model) that supports and matches the NIPF economy, that is, forest decision-making and management based on the economic balance of total forest production, taking into account the benefits from production for own consumption, intermediate expenditure, depreciation and taxes, plus subsidies, repaid with added interest and at certain risk, and
2. Forestry as a 'moral norm' (*utility* model) in which the land is managed and maintained within the NIPF heritage, that is, forest decision-making and management based on a close personal links between the landowner and his/her property, as well as family assets that will be passed on to future generations.

The aim of the study was therefore to explore management by NIPF owners by empirical analysis of variables concerning the *balance sheet*, *and the profit and loss account in forestry*, represented as investment in holding, expenditure on planting and silviculture, public subsidies, along with timber- and non-timber-related incomes, by targeting surveyed resident NIPF owners in an area in northern Spain. However, according to Karppinen (1998), forest management, as a voluntary action, is primarily driven by the motivations of the landowner, i.e. their values and goals. Thus, analysis of the economy of NIPF forest management practices would not be complete without analysis of the agroforestry system and the landowners' personal goals and circumstances. We therefore explored possible statistical relationships or distinctions between these economic variables and other factors related to the landowner profile, family unit, forest property, and land-use changes. In order to complete the results, we moreover included the three practices traditionally used to predict forest management behaviour of NIPF owners in the relevant literature, i.e. planting and silviculture on forestland and timber harvesting on woodland (Löyland et al., 1995; Hardie and Parks, 1996; Kuuluvainen et al., 1996; Prestemon and Wear, 2000; Zhang and Flick, 2001; Kline et al., 2002; Conway et al., 2003; Arano et al., 2004; Potter-Witter, 2005; Ross-Davis et al., 2005; Størdal et al., 2008), and examined these empirically in relation to economic factors of relevance in forestry activities.

In summary, we used sociodemographic and territorial data to evaluate and therefore address the role of the forest economy in NIPF management behaviour, whilst considering the forest practices carried out by NIPF owners by modelling the role and weight of economic forest attributes, which are always and inseparably determined by the preferences and circumstances of the manager, the family unit, and the territorial system. Ensuring and improving forest profitability to make NIPF management viable is one of the main concerns in decision-making and practices carried out by this type of private owner. Characterizing land decision-making and management by NIPF owners in this way may allow policymakers to design suitable measures or tools to implement profitable forest practices under the current criteria of sustainability and within the framework of rural development. As Lillandt (2001) stated, individual landowners are not motivated to participate in forest practices without economic profitability.

After outlining the background information about NIPF land management behaviour and centering the research objective, the article is structured as follows. The second section describes the study area and explains the empirical data, variables, and methodological framework employed. The third section presents and discusses the study results. Finally, the conclusions and implications are drawn in the last section.

Materials and methods

Study area and data collection

Following the research initiated by Marey-Pérez (2003), concerning individual private land ownership and its forest management in the Autonomous Community of Galicia (northern Spain), data for this survey were collected by interviews in person with randomly selected NIPF owners within the Mariña Oriental area of northeast Galicia (Fig. 1). This area was chosen for the study as it is a forest

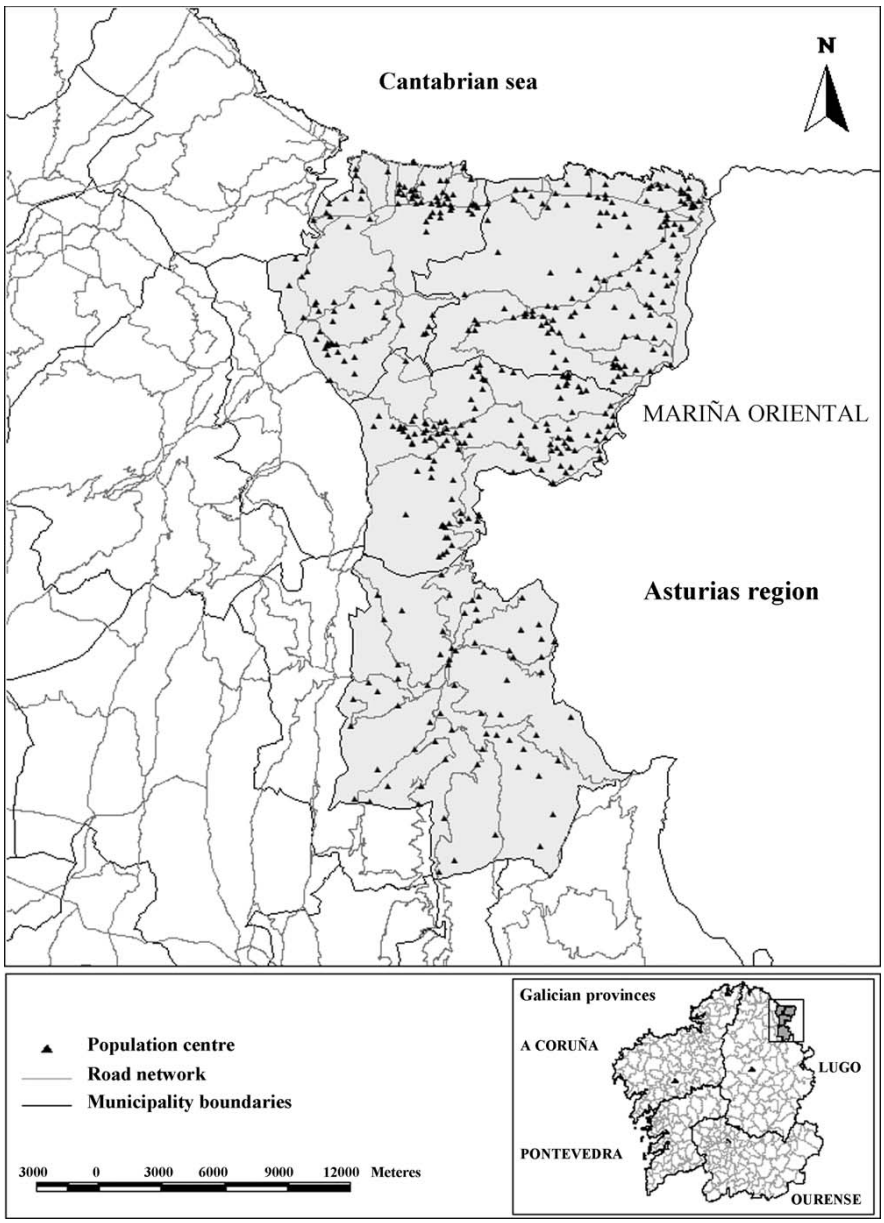

Fig. 1. Location of Mariña Oriental in Galicia, northern Spain.

region typical of much of northern Spain, where forest covers a large area (53%) and forest activity is increasingly popular (over 46% of the forests are woodlands managed for timber production). Forests are owned by 3043 NIPF owners who manage more than the 90% of the forested area in the region. *Eucalyptus globulus* Labill. (blue gum) and *Pinus pinaster* Ait. ssp. *atlantica* (maritime pine) are the main productive forest species in the area, and cover more than 71% of the forestland, with a mean timber yield of 26.4 m^3/ha per year, at a rotation age of 12 and 25 years respectively for blue gum and maritime pine; the timber is mainly used to produce fibre and chipboard (Marey-Pérez, 2003). These forest stands are generally intermingled with agrarian crops and native forest stands, especially *Quercus robur* L. (European oak), *Betula celtiberica* Rothm. and Vasc. (silver birch), and *Castanea sativa* Mill. (European chestnut).

The addresses of NIPF owners and the attributes of their landholdings, such as location, land-use and size, were obtained from the Land Register (cadastre). In agreement with the Council Regulation (CEE) n° 571/88 of 29 February 1988, on organizing European Union surveys of farm structure, the sampling framework firstly consisted of all individual forest landowners living in the area who owned at least 1 ha of productive forestland, a sampling scheme proposed by Marey-Pérez (2003). This excluded many landowners who probably would not have the necessary information to account for their forest management goals and practices, and especially, for forest economics. As a result of migratory phenomena in Galicia during the 20th century (Beiras-Torrado, 1975), a high percentage of these NIPF owners did not actually reside in Mariña Oriental (Marey-Pérez et al., 2004). This forced us to review the population census and reclassify landowners as non-resident and residents. From 750 NIPF owners who manage more than 1 ha of productive forestland in the region, 333 were registered as permanent residents who owned 1154 ha of woodland, i.e. 42% of all productive forestland in the area, including plots smaller than 1 ha. The definition of forest plot in this study follows that indicated in the Land Register (cadastre), i.e. a portion of land enclosed by a polygonal line, which pertaining to a single or various proprietors but indivisible within municipal terms, registers the interest in the land (rights, restrictions and responsibilities). The cadastre also includes a geometric description of the plots along with other details such as ownership or control of land, fiscal value, and the potential use of the land in terms of regional land plans.

The large number of variables included in the cadastral database revealed a high degree of heterogeneity in the study population, which is why stratification was considered a key factor in characterizing and subsequently validating the results, as well as for determining the bias in sample selection. The information in the cadastral database indicated that the variable designated 'productive forest area per landowner' was the most suitable for determining the minimal number of NIPF owners to interview, and their subsequent stratification. The classification of NIPF owners for determining the number of strata and the cut-off points was based on data on timber harvesting in Mariña Oriental. The size of productive forestland that enabled NIPF owners to harvest the equivalent of the mean annual harvest for the region defines the landowner stratification (Marey-Pérez, 2003). This was established as 3.5 ha of productive forestland, considering a weighted rotation age of 15 years for the two main forest species in the region, *Eucalyptus globulus* Labill. and *Pinus pinaster* Ait. ssp. *atlantica*. This stratification of the population (resident NIPF owners with more than 1 ha of productive forestland) established four strata in which the owners included were randomized to ensure the possibility of being selected in the population sample, as well as guaranteeing the representativeness of the sample relative to the initial population.

We opted to use a questionnaire and statistical sampling within the subjective methodology of analysis, in which the sample size was designed to achieve a 5% sampling error at the 95% confidence level. A priori, the error level was set at 3% for quantitative answers (mean estimation) and at 6% for qualitative answers (proportion estimation). In order to obtain comprehensive, reliable results, we attempted to enlarge the landowner sample in order to interview as many owners as possible, while minimizing the economic costs involved. Within the stratified methods, a self-weighting sample size was accordingly determined and allocated by means of Neyman's formula of minimum variance (Sukhatme, 1953).

The results showed that an initial estimate of 3% (mean estimate) required the completion of 101 questionnaires in total, whereas for an initial estimate of 4% (proportion estimate) completion of 99 questionnaires was required. From 333 NIPF owners, each were responsible for more than 1 ha

Table 1
Classification of NIPF owners interviewed per stratum.

Stratum	Productive forestland (ha)	No.	%
A	1.00–1.70	22	21.4
B	1.71–3.50	28	27.2
C	3.50–7.00	31	30.1
D	>7.01	22	21.4
		103	100

of productive forestland whilst being a permanent resident in Mariña Oriental; the self-weighting sample size was finally formed by 103 NIPF owners who were contacted and interviewed in person (Table 1). The NIPF landowners who were interviewed owned 12% of the forestland and 13% of the woodland (i.e., productive forestland) in the region. Thus, the error level was finally 4% for quantitative answers (mean estimate) and at 8% for qualitative answers (proportion estimate).

A variety of questionnaires were tested before deciding on a final version, which sought information on owner profile, family unit, forest property and land-use changes, and forest economics for the period 1999–2003. The survey was carried out in two stages during March 2004. The first stage consisted of a telephone interview conducted between 20:00 and 22:00 h, which inquired into the owner's willingness to participate in the study. If confirmed, the interviewer arranged for an interview in person within 1 or 2 days (the second stage). If the owner declined to be interviewed in person, the interviewer posed the questions included in the landowner-profile section. Each interview lasted an average of 36 min. Finally, data obtained from interviews was complemented with data from the Land Register.

The analytical variables considered in the present study were chosen in relation to the information obtained in the personal interviews; the information was redefined and coded into nominal, ordinal or binary variables that summarized data from the survey and met the assumptions of the statistical analyses. For the formulation of ordinal variables, we used SAS^{TM} software (version 9.1). Firstly, we produced descriptive statistics and frequency histograms for the variables and selected measures of location and dispersion, i.e. mean x and standard deviation σ, respectively (Cao-Abad, 2002). We then considered the measure of location (x) as the centre of the variables considered, and calculated the class intervals from the measure of dispersion (σ). Definition of the variables considered in the present study, divided into four main topics, along with the number of owners interviewed in each category, are shown in Table 2, along with the main descriptive statistics for the continuous variables used in the study (x; σ).Given that forest decisions and/or practices of a representative NIPF owner are the result of a combination of individual decisions and/or practices regarding planting and silviculture treatments on forestland, as well as harvesting of woodland, these three individual forest practices were also considered in the personal interviews and later defined as the following continuous variables in the study:

1. PLANT, forest planting, measured as the proportion of area planted annually in the entire forest area ($x = 1.57\%$; $\sigma = 2.66\%$).
2. TREAT, stand improvement treatments, measured as the proportion of the area in which silvicultural treatments are carried out annually within the entire forest area ($x = 1.02\%$; $\sigma = 2.93\%$). This includes activities such as the use of fertilizers, application of insecticides, pesticides and herbicides, thinning of competing vegetation, and other treatments to improve stands, and
3. HARV, timber harvesting, measured as the proportion of the area harvested annually in the entire wooded forest area ($x = 3.53\%$; $\sigma = 6.12\%$).

Finally, to control for the inflation rate, all the economic variables analysed in the study were made constant by adjusting euros for 2004 values, with the exception of family household income and the unitary stumpage timber price, which were summarized as mean annual amounts (euros); the remaining economic variables were redefined as mean annual amounts (euros) per hectare owned. The relevant information was obtained from the Spanish consumer price index formulated by the National Statistics Institute (INE, 2004).

Table 2
Definition of study variables for statistical analyses.

Variable (acronyms)	Definition
Landowner profile	
AGE (A_G) Ordinal	Age of the owner, in years (x = 64.24; σ = 13.63) [1 = <40 years old; 2 = 40–65 years old; 3 = >65 years old]
EDUC (E_D) Ordinal	Regulated education of the owner [1 = no studies; 2 = primary education; 3 = secondary education; 4 = tertiary education]
OCCUP (O_C) Nominal	Main primary occupation of the owner [1 = retired; 2 = active farmer; 3 = hired worker; 4 = self-employee; 5 = entrepreneur; 6 = other]
FARM (F_R) Binary	Condition of the owner as an active farmer [1 = active; 0 = otherwise]
ASSOC (A_S) Binary	Participation of the owner in professional associations [1 = participation; 0 = otherwise]
TRAINING (T_R) Binary	Forestry training of the owner [1 = training; 0 = otherwise]
IMARKET (I_M) Binary	Specific training in market (timber prices, supply-demand, etc.) [1 = training; 0 = otherwise]
TECHNIC (T_E) Nominal	Knowledge and use of production criteria for timber harvesting [1 = no knowledge, no use; 2 = knowledge, no use; 3 = knowledge, use]
Family unit	
INHERIT (I_H) Nominal	Acquisition of the forest holding [1 = inheritance; 2 = inheritance, purchase; 3 = purchase]
BEQUEST (B_E) Nominal	Intention of bequeathing the forest holding [1 = bequeath; 2 = bequeath, sale; 3 = sale]
HOUSEHOLD (H_H) Ordinal	Annual net family income in Euros during 1999–2003 (x = 17,224.94; σ = 10,339.69) [1 = <6000; 2 = 6000–9,000; 3 = 9001–18,000; 4 = 18,001–30,000; 5 = >30,000]
REINVEST (R_E) Ordinal	Annual reinvestment for household consumption in Euros during 1999–2003, per unit of forest area (x = 71.01; σ = 81.32) [0 = no reinvestments; 1 = <71.0; 2 = 71.0–152.4; 3 = 152.5–233.7; 4 = 233.8–315.0; 5 = >315.0]
PERSONAL (P_E) Ordinal	Personal labour-days spent annually on forestry during 1999–2003 [1 = <2; 2 = 2–5; 3 = 6–10; 4 = 11–50; 5 = 51–100; 6 = >100]
FAMILY (F_M) Ordinal	Family labour-days spent annually on forestry during 1999–2003 [1 = <2; 2 = 2–5; 3 = 6–10; 4 = 11–50; 5 = 51–100; 6 = >100]
MACHINERY (M_A) Binary	Logistic resources available for forestry activities [1 = machinery; 0 = otherwise]
PROFESS (P_R) Ordinal	Professional labour-days spent annually on forestry during 1999–2003 [1 = <2; 2 = 2–5; 3 = 6–10; 4 = 11–50; 5 = 51–100; 6 = >100]
Forest property and land-use changes	
FMEADOW (F_M) Binary	Past conversion of forestland into meadow during 1999–2003 [1 = change; 0 = otherwise]
MWOOD (M_W) Binary	Past conversion of marginal meadow into woodland during 1999–2003 [1 = change; 0 = otherwise]
CSPECIE (C_S) Binary	Future intention of changing the current productive forest species [1 = intention; 0 = otherwise]
IFOREST (I_F) Binary	Future intention of increasing the productive forestland species [1 = intention; 0 = otherwise]
PLOT (P_L) Ordinal	Number of plots per hectare of productive forestland in ownership (x = 3.40; σ = 1.88) [1 = <1.52; 2 = 1.52–3.40; 3 = 3.41–5.29; >5.29]
SIZE (S_I) Ordinal	Area of productive forestland in ownership, in hectares (x = 4.76; σ = 3.86) [1 = 1.00–1.70; 2 = 1.71–3.50; 3 = 3.51–7.00; 4 = >7.00]
Forest economics	
INVEST (I_V) Ordinal	Annual investment in holding improvement in Euros during 1999–2003, per unit of forest area (x = 10.35; σ = 24.56) [0 = no investment; 1 = <39.7; 2 = >39.7]
PEXP (E_P) Ordinal	Annual expenditure on plantation in Euros during 1999–2003, per unit of forest area (x = 193.48; σ = 176.28) [0 = no planting; 1 = <127.0; 2 = 127.0–250.0; 3 = 250.1–400.0; 4 = >400.0]
TEXP (E_T) Ordinal	Annual expenditure on silviculture treatments in Euros during 1999–2003, per unit of forest area (x = 71.83; σ = 81.76) [0 = no forestland improvement; 1 = <90.7; 2 = 90.7–221.7; 3 = >221.7]
REQUEST (R_Q) Binary	Formal application for a forest management subsidy during 1999–2003 [1 = subsidy; 0 = otherwise]
SUB (S_U) Ordinal	Annual forest subsidy in Euros during 1999–2003, per unit of forest area (x = 4.92; σ = 20.09) [0 = no application, no aid; 1 = <25.0; 25.0–50.1; 2 = 50.2–75.2; 4 = >75.2]
TINCOME (T_I) Ordinal	Annual income from timber sales in Euros during 1999–2003, per unit of forest area (x = 166.62; σ = 193.39) [0 = no timber sale; 1 = <195.1; 2 = 195.1–425.2; 3 = >425.2]
TPRICE (T_P) Ordinal	Stumpage price in Euros during 1999–2003, per ton (x = 3.99; σ = 4.25) [0 = no timber sale; 1 = <48.9; 2 = 48.9–74.3; 3 = >74.3]
NTINCOME (nT_I) Ordinal	Annual income from land sales in Euros during 1999–2003, per unit of forest area (x = 170.79; σ = 281.77) [0 = no non-timber income; 1 = <381.8; 2 = >381.8]

Statistical analyses

Given that the study population was not suited to the Kolmogorov–Smirnov goodness-of-fit test for the normality *K–S* test or to Levene's test for homogeneity of variances, the statistical analyses were based on distribution-free tests, i.e. non-parametric tests. The non-parametric approach considered the types of variables measured in the study, i.e. continuous, nominal/ordinal and binary variables, and was designed to provide a statistical explanation of the type of management carried out by resident NIPF owners in terms of analysing attributes related to forest economics. The study variables (forest economic attributes) were empirically associated with other attributes linked to landowner profiles, family unit, forest property, and land-use changes, as well as with planting, silvicultural and harvesting management practices observed in the Mariña Oriental region. Therefore, the strength and significance of the linear correlation among the variables was tested, where the observed significant differences were subsequently compared at the 95% confidence limit and a minimum level of statistical significance of 0.05.Somers' *D* coefficient and its critical significance level were applied to measure the statistical relationship among nominal, ordinal and/or binary variables by use of contingency tables (Table 3). Significant differences in frequency distribution across nominal, ordinal and/or binary variables of the cross-tabulation were computed and detected by use of Pearson's chi-square statistic χ^2 and two-tailed asymptotic significance (Table 4).

Spearman's rho coefficient ρ was used to estimate the statistical association between the continuous variables and the nominal, ordinal, and/or binary variables, at $P < 0.01$ and <0.05 (Table 3). The mean distribution across variables was analysed by use of the Kruskal–Wallis' *H*-test, a non-parametric test of variance homogeneity equivalent to one-way analysis of variance ANOVA (Table 4). In addition, pairwise comparisons were performed by use of Dunnett's T3 test to determine which categories (levels) of nominal/ordinal variables showed behaviour (means) that differed significantly from that of the continuous variables. After significant differences were tested, the post hoc analyses were completed with Tukey's honest significant difference (*HSD*) test, which was used to define homogeneous subgroups of nominal/ordinal variables that displayed similar statistical behaviour in relation to the continuous variables.

Finally, and to complete the investigation included in the present study, we modelled the relationship between the variables PLANT, TREAT and HARV as quantitative continuous responses with respect to a linear combination of continuous explanatory variables related to socioeconomics and forest holding (Table 2); this enabled statistical characterization of these three management practices by NIPF owners in Mariña Oriental region. On the basis of the quantitative continuous nature of the three dependent variables, we opted to use multiple linear regression, a predictive method where the main objective is to model how the presence or otherwise of diverse factors, and the value or levels of these, affects the proportion of the dependent variable, i.e.:

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k x_k + \epsilon \quad (1)$$

where Y is the dependent variable of the model, interpreted as a linear combination of a combined set of k explanatory variables; x_k comprises the explanatory regression variables; β_k comprises the partial regression coefficients (parameters); β_0 is the model constant; and ϵ comprises the model's residuals that the explanatory variables used in the model are not capable of explaining (the difference between the observed value of the dependent variable and the value predicted by the regression equation).

In the present study, a step-wise selection procedure, by use of the SAS^{TM} software (version 9.1), was applied to find the subset of original and statistically significant explanatory variables that best fitted the equation, in accordance with the criteria for statistical selection of bias minimization and fit maximization for Adjusted-R^2 (Neter et al., 1996). In other words, with the minimum possible number of independent variables, we sought the regression model that explained the greatest possible amount of variance in the dependent variables (PLANT, TREAT and HARV), and the measure of goodness-of-fit which contains a "penalty" for model complexity (Adjusted-R^2 takes into account the number of explanatory variables in the model and the number of observations the model is based on; therefore, the Adjusted-R^2 value gives a more useful measure of the success of the model than R^2 value).

In the step-wise selection procedure, each explanatory variable is sequentially entered – step-by-step – into the regression model and its validity is assessed by measuring the level of statistical

Table 3
Correlations among study variables (Somers' D and Spearman's ρ tests).

		INVEST (C)	PEXP (C)	TEXP (C)	REQUEST (B)	SUB (C)	TINCOME (C)	TPRICE (C)	NTINCOME (C)
Landowner land management practices									
PLANT (C)	ρ	0.415**	0.835**	0.566**	0.247*	0.207	0.448**	0.409**	0.037
TREAT (C)	ρ	0.413**	0.571**	0.686**	0.180	0.159	0.176	0.084	0.168
HARV (C)	ρ	0.184	0.354**	0.193	0.068	0.030	0.809**	0.781**	0.341**
Landowner profile									
AGE (C)	ρ	0.009	−0.091	−0.065	0.230*	0.196	−0.160	−0.083	0.037
EDUC (O)	$D\|\rho$	0.021	0.194	0.141	−0.027	0.010	0.088	0.052	−0.130
OCCUP (N)	$D\|\rho$	−0.004	0.235*	0.073	−0.147	−0.236*	0.095	0.042	−0.090
FARM (B)	$D\|\rho$	−0.023	−0.049	0.095	−0.159	−0.088	0.035	−0.003	0.179
ASSOC (B)	$D\|\rho$	0.150	0.112	0.086	−0.064	0.027	0.141	0.108	0.011
TRAINING (B)	$D\|\rho$	0.161	0.140	0.002	−0.045	0.059	0.120	0.101	0.096
IMARKET (B)	$D\|\rho$	0.086	0.015	0.024	−0.004	0.021	0.172	0.282*	0.032
TECHNIC (N)	$D\|\rho$	0.041	0.033	−0.089	0.103	0.072	0.265*	0.337**	0.081
Family unit									
INHERIT (N)	$D\|\rho$	0.246*	0.224*	0.013	0.203*	0.073	−0.097	−0.081	0.034
BEQUEST (N)	$D\|\rho$	0.082	−0.001	−0.054	−0.002	−0.079	−0.009	−0.056	0.045
HOUSEHOLD (C)	ρ	0.007	0.220*	0.166	−0.084	−0.022	0.151	0.120	0.105
REINVEST (C)	ρ	−0.024	0.031	0.097	−0.153	−0.005	−0.042	−0.042	0.502**
PERSONAL (O)	$D\|\rho$	0.094	0.225*	0.009	0.087	−0.005	0.177	0.225*	0.079
FAMILY (O)	$D\|\rho$	−0.058	0.109	0.037	−0.026	0.022	0.002	0.114	−0.004
MACHINERY (B)	$D\|\rho$	0.145	0.174	0.073	−0.089	0.070	0.172	0.162	0.203
PROFESS (O)	$D\|\rho$	0.308**	0.402**	0.313**	0.147	0.189	0.207	0.206	0.048
Forest property and land-use changes									
FMEADOW (B)	$D\|\rho$	0.242	−0.050	−0.070	−0.052	−0.049	−0.059	−0.059	−0.087
MWOOD (B)	$D\|\rho$	0.151	0.153	0.133	0.189	0.076	0.035	−0.030	−0.016
CSPECIE (B)	$D\|\rho$	0.093	0.180	0.216*	0.002	0.022	0.144	0.139	0.024
IFOREST (B)	$D\|\rho$	0.234*	0.278**	0.292**	0.172	0.049	0.196	0.196	0.083
PLOT (C)	ρ	−0.216*	−0.238*	−0.266*	−0.012	−0.002	−0.171	−0.101	−0.074
SIZE (C)	ρ	0.216*	0.524**	0.369**	0.208	0.101	0.372**	0.285**	−0.137
Forest economics									
INVEST (C)	ρ		0.474**	0.341**	0.334**	0.297**	0.209	0.232*	0.093
PEXP (C)	ρ	0.474**		0.799**	0.244**	0.246*	0.417**	0.343**	0.266*
TEXP (C)	ρ	0.341**	0.799**		0.093	0.142	0.252*	0.134	0.268*
REQUEST (B)	$D\|\rho$	0.334**	0.244*	0.093			0.053	−0.039	−0.004
SUB (C)	ρ	0.297**	0.246*	0.142			−0.007	−0.057	−0.080
TINCOME (C)	ρ	0.209	0.417**	0.252*	0.053	−0.007			0.083
TPRICE (C)	ρ	0.232*	0.343**	0.134	−0.039	−0.057			0.043
NTINCOME (C)	ρ	0.093	0.266*	0.268*	−0.004	−0.080	0.083	0.043	

Note: Variable subscripts indicate which typology of variable was used in the statistical analysis (C continuous; N nominal; O ordinal; B binary). Statistically significant coefficients: $^{**}P < 0.01$, $^{*}P < 0.05$.

Table 4
Significant differences among study variables (Pearson's χ^2 and Kruskal–Wallis' H tests).

		INVEST (O)	PEXP (O)	TEXP (O)	REQUEST (B)	SUB (O)	TINCOME (O)	TPRICE (O)	NTINCOME (O)
Landowner land management practices									
PLANT (C)	H	16.647*	44.154*	16.787*	5.165*	5.270*	18.843*	15.897*	1.414
TREAT (C)	H	14.471*	22.972*	29.402*	2.747*	5.883	3.192	4.708	1.857
HARV (C)	H	2.847	7.112*	2.397*	0.398	2.718	67.637*	66.328*	21.944*
Landowner profile									
AGE (C)	H	2.107	2.769	0.084	4.490*	5.162*	2.845	2.258	1.616
EDUC (O)	χ^2/H	4.463	13.030	2.550	2.621	5.461	6.987	8.165	2.981
OCCUP (N)	χ^2/H	4.410	30.986*	19.207	7.134	7.212	23.363*	20.178	10.379
FARM (B)	χ^2/H	0.136	5.160	4.950	2.184	2.711	1.071	5.783	3.041
ASSOC (B)	χ^2/H	1.866	2.293	0.908	0.360	6.209	5.889	1.070	4.589
TRAINING (B)	χ^2/H	7.642*	1.824	2.156	0.203	5.240	1.263	4.226	0.893
IMARKET (B)	χ^2/H	0.871	3.706	1.171	0.002	1.734	7.984*	6.635*	3.462
TECHNIC (N)	χ^2/H	3.980	18.982*	6.063	1.060	4.837	11.345*	17.207*	0.394
Family unit									
INHERIT (N)	χ^2/H	9.757*	13.780*	2.888	6.853*	6.921	8.547	4.650	1.926
BEQUEST (N)	χ^2/H	3.883	7.419	2.711	0.808	0.544	5.560	4.024	3.522
HOUSEHOLD (C)	H	0.071	9.038*	5.110*	0.599	1.765*	3.217	2.791	0.380
REINVEST (C)	H	0.054	4.123*	4.032*	1.992	4.994*	0.252	0.293	18.888*
PERSONAL (O)	χ^2/H	14.427	15.855	7.908	3.997	23.563	19.653	38.867*	6.854
FAMILY (O)	χ^2/H	8.751	37.273*	15.872	2.548	15.230	27.182*	27.779*	12.410
MACHINERY (B)	χ^2/H	3.445	0.597	0.980	0.696	6.974	2.254	1.943	3.043
PROFESS (O)	χ^2/H	30.016*	42.573*	27.407*	8.849	17.798	18.461	18.332	9.420
Forest property and land-use changes									
FMEADOW (B)	χ^2/H	4.807*	0.623	2.749	0.542	0.210	2.533	0.353	2.842
MWOOD (B)	χ^2/H	3.029	4.036	3.190	3.095*	7.238	1.454	1.139	1.558
CSPECIE (B)	χ^2/H	2.125	3.267	3.869	0.000	2.948	2.453	4.632	0.195
IFOREST (B)	χ^2/H	6.289*	9.550*	7.929*	2.644	4.176	5.744	4.008	2.043
PLOT (C)	H	4.544	8.333*	5.437	0.011	5.205*	4.119	8.624*	2.194
SIZE (C)	H	6.844*	19.627*	6.366*	3.672*	3.592	13.720*	14.683*	0.378
Forest economics									
INVEST (C)	H		21.154*	8.130*	8.188*	13.304*	4.607	2.603	0.848
PEXP (C)	H	21.000*		37.598*	4.463*	5.347	12.384*	10.061*	4.825*
TEXP (C)	H	10.567*	50.134*		1.923	2.712	2.026	1.401	5.108*
REQUEST (B)	χ^2/H	10.808*	8.368*	0.920			2.415	7.484	0.417
SUB (C)	H	8.112*	2.127	1.631			2.564	2.833	1.649
TINCOME (C)	H	4.536	10.694*	5.552	0.265	0.715			13.039*
TPRICE (C)	H	4.774*	7.701	1.257	0.177	0.830			9.538*
NTINCOME (C)	H	0.716	11.737*	9.849*	0.105	1.975	4.636*	1.356*	

Note: Variable subscripts indicate the type of variable used in the statistical analysis (C, continuous; N, nominal; O, ordinal; B, binary). *Statistically significant coefficient: *$P < 0.05$.

significance of the *F*-statistic. At each step, the regression algorithm selects the independent variable which yields the largest reduction in the unexplained variance of the dependent variable, i.e. the independent variable most highly correlated with the dependent variable. If adding an explanatory variable contributes to the regression model (the significance level associated with *F*-statistic is lower than 0.05, entry probability), then it is retained, but all other explanatory variables in the equation are then re-tested to check if they are still contributing to the success of the regression model; if they no longer contribute significantly they are removed (the significance level associated with *F*-statistics is higher than 0.10, exit probability). The regression algorithm finishes when no variables meet the entry or exit criteria of probability.

The global importance of the set of independent variables and the relative importance of each of them in the regression model were measured by means of the global *F*-test and the individual *t*-test, respectively, at $P < 0.05$. In order to detect high correlations between explanatory variables that could cause problems with regard to the success of the regression equation, the collinearity analysis was controlled with the tolerance criterion (a measure of the proportion of variance of a variable that does not depend on the remaining variables included in the model). In this way, an independent variable formed part of the regression model if the level of tolerance was higher than 0.0001 (the closer to zero the tolerance value is for an explanatory variable, the stronger the relationship between this and the other explanatory variables).

The selected reduced model was computed and subjected to residual analysis to ensure a reasonable degree of independency (Durbin–Watson's *DW*-test), homoscedasticity and normality (through graphics of standardized residuals plotted against predicted values, and a histogram of standardized residuals, respectively), and linearity (Adjusted-R^2 of the regression model) of residuals. Thus, the robustness of the regression equation was ensured.

Results and discussion

Investment in holding improvement

In the study region, management decisions in terms of planting and carrying out silvicultural practices in forestland were both influenced by the annual amount invested in improving the holding by means of new forest buildings and infrastructures. Thus, the investment annually devoted to holding improvement increased moderately with the annual rates of planting and carrying out forest stand improvements ($\rho = 0.415$ and 0.413, respectively, at $P < 0.01$). The post hoc analyses revealed that the two forest practices differed significantly according to the INVEST group ($H = 16.647$ and 14.471, respectively). In our analysis, I_{V1} landowners were the most active planters in the area, with a significantly higher annual rate of planting than the I_{V0} landowners. On the other hand, the I_{V2} owners were the most active in terms of silvicultural treatments, differing significantly from the I_{V0} group. The homogeneous subgroups of landowners according to these three variables are illustrated in Table 5.

The annual investment in holding improvement was moderately and positively correlated with the annual expenditure on planting ($\rho = 0.474$ at $P < 0.01$), whilst being weakly and positively correlated with the annual expenditure on silviculture ($\rho = 0.341$ at $P < 0.01$). In this case, I_{V0} owners spent significantly less per year on forest planting than the remaining population ($H = 21.000$). As regards the annual expenditure on silviculture, the mean expenditure on forest stand improvements differed significantly between the I_{V0} and I_{V2} groups ($H = 10.567$). The classification of the study population according to annual investment in holding improvement and annual expenditures on planting and silviculture which is summarized in Table 5.

The active involvement in forest management by I_{V1} and I_{V2} landowners may be explained by considering the landowner's primary occupation, production requirements and goals for land management. The I_{V2} group included a large proportion of retirees (60%), whereas professionals not involved in agriculture were mainly included in the I_{V1} group (41.7%); farming was the most common professional category among I_{V0} owners (50.8%). According to the management behaviour and expenditure on forestry observed in Mariña Oriental, we suggest that retirees, older landowners, and non-agrarian professionals who worked part-time on their properties invested in marginal land in order to maintain their productivity, as reported by Karppinen (1998), Gunter et al. (2001) and Marey-Pérez et al. (2004).

Table 5
Mean annual rates of planting and silviculture (%), expenditure on planting and silviculture (€/ha per year), amounts awarded through public subsidies (€/ha per year), and size of productive forest holding (ha) per homogeneous INVEST subgroup.

INVEST No. of interviewed landowners	I_{V0} 76	I_{V1} 15	I_{V2} 12	*P*-value
PLANT				
Non-investor	0.91		2.31	0.245
Planter investor		4.51		1.000
TREAT				
Non-investor	0.47	1.84		0.374
Silviculturalist investor		1.84	3.54	0.223
PEXP				
Non-investor	148.37			1.000
Planter investor		399.86	304.38	0.294
TEXP				
Non-investor	62.55	128.61		0.184
Silviculturalist investor		128.61	151.83	0.807
SUB				
Non-investor	0.66	9.95		0.361
Investor			26.21	1.000
SIZE				
Small investor	4.20		4.99	0.823
Large investor		7.50	4.99	0.148

In fact, the likelihood of converting former meadows into woodland was negatively correlated with the condition of the landowner as an active farmer ($D = -0.233$); more than 62% and 29% of the landowners who considered this type of land-use change within their holding were, respectively, retired farmers and non-agricultural professionals ($\chi^2 = 4.667$). Thus, significant differences in the likelihood of converting forestlands into meadows according to the INVEST group were observed ($\chi^2 = 4.807$). As expected, none of the I_{V2} owners and 5.6% of I_{V1} owners carried out this type of conversion on their holding, in contrast to the 50% of the I_{V0} group who opted for this procedure.

Because of their close association with the land, farmers tend to manage their property themselves and they generally have more time to dedicate to forestry (Zhang and Mehmood, 2001). In addition, spending more time working on the property may result in better forestry training, which would qualify landowners to manage the land and take a more active role in forest-related activities. In the Mariña Oriental area, the annual number of personal working days devoted to forestry is positively correlated with the landowner's training in forestry ($D = 0.209$). All trained owners worked for more than 50 days per year on forestry in the holdings; in contrast, 58.3% of owners who did not have any knowledge of forestry spent less than 50 working days per year on the holding ($\chi^2 = 10.113$). This pattern of personal forest management may explain the observed significant differences in the landowners' forest training according to the INVEST group ($\chi^2 = 7.642$). Some 30.0% of I_{V2} landowners were trained in forestry, in comparison with 6.3% of I_{V0} landowners and none of the I_{V1} group.

Annual investments in holding improvement increased slightly with the hired labour employed on the holding ($\rho = 0.308$ at $P < 0.01$). Whereas 77.8% of I_{V0} landowners hired forestry workers for less than 10 professional days per year, 70% and 41.7% of I_{V1} and I_{V2} owners, respectively, hired forestry workers for between 11 and 100 days per year ($\chi^2 = 30.016$). According to the previous landowner profile, the landowner's occupation outside the property may mean having less time available for working the land (Löyland et al., 1995; p. 226), and therefore, he/she is less likely to carry out forest practices him/herself.

In fact, we observed significant differences in the landowner's main occupation according to the annual amount of hired help obtained ($\chi^2 = 36.601$). Some 67% of retired and active farmers hired forestry workers for less than 5 days per year, in comparison with 44.5% of non-agricultural landowners who hired forestry workers for more than 50 days per year. Professional assistance in forestry proved to be an important factor in making forestry viable in the area, as suggested in other studies concerning

NIPF management (Löyland et al., 1995; Hardie and Parks, 1996; Zhang and Flick, 2001; Zhang and Mehmood, 2001).

The annual investment in holding improvement and the land acquisition pattern were positively and weakly correlated ($\rho = 0.246$ at $P < 0.05$). Whereas 72.5% of I_{V1} and I_{V2} owners managed inherited and purchased holdings, inheritance was the sole pattern of land acquisition for 60.3% of I_{V0} owners ($\chi^2 = 9.757$). This is probably associated with the landowner' condition as a retired farmer. In Mariña Oriental, retired farmers represented a specific group, with holdings that were mainly acquired through purchase and inheritance. Briefly, retired farmers are more likely to carry out land transactions in order to improve and increase their agricultural productivity, and hence display a higher degree of land mobility (Marey-Pérez et al., 2004). Thus, the main occupation of owners varied significantly on the basis of the land acquisition pattern ($\chi^2 = 22.191$). While 59.1% of the retired farmers managed inherited and purchased land, 25.8% of the remaining occupational groups managed inherited and purchased land.

The key role of public funding in forestry was supported considering that the annual investment in new forest buildings and infrastructures in the region increased slightly with the likelihood of applying for public subsidies and with the annual amount granted ($\rho = 0.334$ and 0.297, respectively, at $P < 0.01$). There were four I_{V1} and I_{V2} owners for every I_{V0} owner who applied for this type of subsidy ($\chi^2 = 10.808$). With regard to the amounts granted per subsidy, the mean amount received by the I_{V2} group was significantly higher than that received by the I_{V0} group ($H = 8.112$), as seen in Table 5.

The main reason for the land management behaviour in the region may be attributed to previous harvests and timber sales, i.e. to the owners' interest in timber production. Thus, the annual investment in holding improvement increased slightly in relation to the unitary stumpage price from previous harvests ($\rho = 0.232$ at $P < 0.05$). There were significant differences between the I_{V2} group and the I_{V0} and I_{V1} groups ($H = 4.774$); the price at which the I_{V1} and I_{V2} owners sold the timber was almost twice the price obtained by the I_{V0} owners. The interest in timber production may also explain why the owner's intention to extend the area of woodland within the holding increased slightly with the annual investment in holding improvement ($\rho = 0.234$ at $P < 0.05$). Over 50% and 80% of I_{V1} and I_{V2} owners, respectively, aimed to extend the area of woodland, compared with 38.1% of the I_{V0} group ($\chi^2 = 6.289$). According to this finding, large amounts of money invested in forestry do not appear to reduce the intensity of management in the region, but favourable market conditions for timber production, particularly attractive timber prices, appeared to motivate involvement in land management by NIPF owners, as explained in the following sections.

As expected, due to the relationship between the area of land and the intensity of land management (Kuuluvainen and Salo, 1991; Prestemon and Wear, 2000; Zhang and Mehmood, 2001; Arano et al., 2004; Potter-Witter, 2005; Arano and Munn, 2006), the annual investment in holding improvement decreased slightly with the degree of parcellation of the productive forestland ($\rho = -0.216$ at $P < 0.05$), and increased slightly with the size of the productive forest holding ($\rho = 0.216$ at $P < 0.05$). The number of plots per unit of productive forestland was greater than 3.4 for 55.5% of I_{V0} owners, and for 16.7% and 27.3% of I_{V1} and I_{V2} owners, respectively. This is probably associated with the agricultural occupation of the owner. As reported by Butler et al. (2004), Marey-Pérez et al. (2006) and Marey-Pérez and Rodríguez-Vicente (2008), the desire to improve and increase the current or former agricultural productivity may be one of the main predictors and reasons for dividing the land. With regard to the area of productive forest, the I_{V1} group also owned significantly larger landholdings than the I_{V0} landowners ($H = 6.844$), as illustrated in Table 5.

Expenditure on planting

The annual expenditure on planting appeared to affect all three forest management practices analysed in the region. Annual rates of planting and silviculture increased greatly and moderately, respectively, with annual expenditure on planting ($\rho = 0.835$ and 0.571, respectively, at $P < 0.01$). In addition, the annual rate of harvesting woodland increased slightly in relation to annual expenditure on planting ($\rho = 0.354$ at $P < 0.01$). Pairwise comparisons indicated that E_{P4} owners were significantly more active planters and silviculturalists than the other landowners in the area ($H = 44.154$ and 22.972, respectively). As regards timber harvesting, the E_{P3} owners were the most active harvesters in the

Table 6
Mean annual rates of planting, silviculture and harvesting (%), expenditure on silviculture (€/ha per year), income from land sales (€/ha per year), and size of productive forest holding (ha) per homogeneous PEXP subgroup.

PEXP	E_{P0}	E_{P1}	E_{P2}	E_{P3}	E_{P4}	*P*-value
No. of interviewed landowners	5	61	25	7	5	
PLANT						
Non-planter	0.00	0.53		1.74		0.150
Farm planter		0.53	2.25	1.74		0.159
New planter					10.42	1.000
TREAT						
Farm silviculturalist	0.04	0.41	1.03	0.80		0.935
New silviculturalist					9.23	1.000
HARV						
Non-harvester	1.53	2.34	4.17			0.914
Harvester			4.17	11.73	2.98	0.117
TEXP						
Retiree	0.00	32.40				0.977
Farmer		32.40	154.71			0.184
Absentee			154.71	259.47	265.26	0.273
NTINCOME						
Non-land seller	50.60	140.59	290.13		74.92	0.996
Land seller				404.22		1.000
SIZE						
Small landowner	2.29	3.67	6.60	3.79		0.108
Large landowner			6.60		11.11	0.083

region; there were significant differences in the mean rates of timber harvesting between the E_{P3} group and both the E_{P1} and E_{P2} groups ($H = 7.112$). The homogeneous subgroups of landowners according to the annual expenditure on planting and annual rates of the three forest management practices are shown in Table 6.

The amount designated annually to forest planting increased moderately in relation to the amount spent annually on holding improvements ($\rho = 0.474$ at $P < 0.01$). The E_{P2} and E_{P4} owners invested significantly more money in new forest buildings and infrastructure than the remaining owners, on average three times more a year than the amount invested by groups E_{P0}, E_{P1} and E_{P3} ($H = 21.154$). Furthermore, the annual expenditure on planting increased greatly according to the annual expenditure on silviculture ($\rho = 0.799$ at $P < 0.01$). As shown in Table 6, annual expenditure on silviculture by E_{P1} owners differed significantly from the remaining groups, excluding group E_{P0}; significant differences were also observed between E_{P0} owners and both E_{P3} and E_{P4} owners in terms of this variable ($H = 50.134$). As well as investments in holding improvements, high expenditure on forestry (planting and silviculture) did not appear to reduce the intensity of management in the region.

We found that the owner's primary occupation and the annual amount spent on planting forestlands were weakly and positively correlated ($\rho = 0.235$ at $P < 0.05$). All active farmers in the study population were included in groups E_{P0}, E_{P1} and E_{P2}, because they were more likely to manage agrarian land, whereas all E_{P3} and E_{P4} owners were retired farmers and non-agricultural professionals ($\chi^2 = 30.986$). This finding supports the idea that both retired farmers and professionals who did not earn their living from agriculture were more likely to invest in forestry in order to maintain the land as a capital asset. Moreover, the annual expenditure on the forest plantation increased slightly in relation to the annual household income ($\rho = 0.220$ at $P < 0.05$), and there were significant differences between E_{P0} and E_{P2} owners in this respect ($H = 9.038$). The E_{P2} and E_{P4} groups received almost 8500 €/year more in household income than the remaining population; the lowest income per family unit corresponded to the E_{P0} group, with a mean income of 9700 €/year. These results indirectly support those obtained by other authors who have pointed out that high forest investments are made by those owners with a larger income per household (Hardie and Parks, 1996; Gunter et al., 2001; Mahapatra and Mitchell, 2001; Arano et al., 2004; Ross-Davis et al., 2005).

Involvement in agriculture may be the main reason why the annual fraction of forest products for own consumption differed significantly according to annual expenditure on planting forestlands. The annual amount of forest products for household consumption by E_{P4} owners differed significantly from that observed for E_{P1} and E_{P2} groups ($H = 4.123$). The E_{P0}, E_{P1} and E_{P2} owners actively benefitted from forests for their own use, a mean benefit of 76.2 €/ha per year, which was more than two and eight times higher than the mean value obtained for E_{P3} and E_{P4} landowners, respectively. As described by Dewees (1992), Kurttila et al. (2001) and Marey-Pérez et al. (2004), although some owners are less dependent on forestry because of a higher proportion of other incomes, farmers may become more dependent on forestry as a source of revenue because of lower benefits obtained from agricultural activities. In Mariña Oriental, the annual amount of forest products for own consumption was slightly higher for landowners actively involved agriculture than for other owners ($\rho = 0.304$ at $P < 0.01$). Active farmers annually took advantage of forest products twice as often as the remaining occupational groups ($H = 7.840$).

The annual income from land sales and the annual expenditure on planting were weakly and positively correlated ($\rho = 0.266$ at $P < 0.05$). According to the land management behaviour observed in the area, the landowners could sometimes sell forestland that they were unable to manage and could invest in forestry as the remaining part of the holding. As seen in Table 6, the annual non-timber income of E_{P3} owners was significantly higher than the corresponding income of the remaining landowner population ($H = 11.737$). The likelihood of marketing forestland may explain the small positive relationship between the pattern of land acquisition and the annual expenditure on planting ($\rho = 0.224$ at $P < 0.05$). Whereas 79.2% of E_{P3} and E_{P4} owners managed holdings acquired through inheritance and purchase, 43.3% of the remaining landowner groups had holdings acquired through inheritance alone ($\chi^2 = 13.780$). Considering the owner profile of the E_{P3} group, improving and increasing agricultural productivity increased land mobility among retired farmers, as already explained.

The owner's primary occupation may also explain why the annual number of working days dedicated to forestry by both the owners themselves and by hired labour increased slightly and moderately, respectively, with annual expenditure on planting ($\rho = 0.225$ at $P < 0.05$ and 0.402, at $P < 0.01$, respectively). Forestry is generally less feasible for managers with occupations outside the property, which obliges them to hire forestry workers, whereas owners involved in agriculture are more likely to devote time to forestry, probably because of a greater attachment to the land. All E_{P0} owners spent less than 5 working days on forestry annually, while 44.5% of E_{P1} and E_{P2} owners and 66.7% of E_{P3} owners devoted between 11 and 100 working days annually; in contrast, 75% of E_{P4} owners dedicated less than 10 working days to forestry per year. With regard to hired labour, none of the E_{P0} owners hired forestry workers for more than 2 days per year, in comparison with all owners in the E_{P4} group who hired forestry workers for more than 50 days a year; 82% of E_{P1} owners and 48.8% of E_{P2} and E_{P3} owners hired labour for less than 10 days a year ($\chi^2 = 42.573$).

Family aid was also important with regard to the way in which the forestland was managed. Thus, the annual number of working days that the family spent on forestry differed significantly according to the annual expenditure on planting ($\chi^2 = 37.273$). All E_{P0} owners and 65.4% of E_{P1} and E_{P2} owners benefitted from a family labour-force working in forestry for less than 10 days per year, while 83.4% of E_{P3} owners annually benefitted from their families working on the holding for between 11 and 100 days; half of the E_{P4} owners had family assistance for less than 5 working days per year and the other half part-benefitted from a family labour-force working for more than 100 days per year. This may be explained by taking into account that the input of family labour on the holding depended to a certain extent on the availability of equipment, and moreover, that the annual inputs of personal and family labour were interrelated. Thus, for each owner who benefited from a family labour force for less than 5 days a year and had machinery on the holding, there were two owners who had these resources as support for forest management in the groups who benefitted from more than 50 annual days input from family labour-force ($x^2 = 11.158$). In relation to the second item, the relatives of owners who devoted between 11 and 100 days per year to working on the holding, worked for 11–50 labour-days on forestry per year, while owners who spent less than 5 personal days on forestry per year benefitted from fewer than 11 family labour-days per year. Owners who worked on the holding for between 6 and 10 labour-days or more than 100 days per year, benefited from family input that was slightly less than the input of labour by the owner ($\chi^2 = 101.468$).

As with the annual investment in new forest buildings or infrastructure within the holding, annual expenditure on planting was weakly and positively correlated with the likelihood of applying for public subsidies and the annual amount granted per forest subsidy ($\rho = 0.244$ and 0.246, respectively, at $P < 0.05$). Some 70.9% of E_{P3} and E_{P4} owners applied for subsidies in order to make land management viable, compared with less than 20% of the remaining owner groups ($\chi^2 = 8.368$). As regards the amount awarded per subsidy, E_{P4} owners annually received almost twice as much as the E_{P2} group, and almost four times more than E_{P1} and E_{P3} groups, although the differences were not significant; none of the E_{P0} finally benefitted from public subsidies in forestry. Hyberg and Holthausen (1989), Hardie and Parks (1996), Zhang and Flick (2001) and Kline et al. (2002), amongst others, have demonstrated that forest planting is positively correlated with the availability of public subsidies.

We observed that the annual timber income from previous harvests increased moderately with the annual expenditure on planting forestlands ($\rho = 0.417$ at $P < 0.01$), which corroborates the previous statement about land capitalization. There were significant differences between E_{P0} and E_{P2} groups ($H = 10.694$); E_{P2}, E_{P3} and E_{P4} landowners annually obtained three times more income from forests than E_{P0} and E_{P1} landowners. More specifically, the unitary stumpage price from preceding harvests increased slightly with the annual expenditure on planting ($\rho = 0.343$ at $P < 0.01$). In this case, E_{P2} and E_{P4} owners sold timber at twice the price obtained by the remaining groups. The attention given to timber production may also explain why the intention to extend the area of woodland within the holding increased weakly with the annual expenditure on planting ($\rho = 0.278$ at $P < 0.01$). Thus, 75% of E_{P4} owners intended to extend the area of woodland, compared with 58.4% of E_{P2} and E_{P3} owners; 33.5% of the landowners in groups E_{P0} and E_{P1} aimed to extend the area of woodland in the future ($\chi^2 = 9.550$).

Indeed, annual timber harvesting increased slightly with the intention to extend the woodland ($\rho = 0.242$ at $P < 0.05$). Landowners who intended to enlarge the area of woodland harvested twice as much timber annually as the remaining owner population ($H = 4.972$), where the income from timber was 100 €/ha per year more ($H = 3.118$), at almost twice the stumpage price per unit ($H = 3.104$). Forest management practices that include a suitable rotation age for productive forest species generate high quality timber products and, as a result, the timber is of higher value, as indicated in the following sections. This may explain why the E_{P2} and E_{P4} groups included the highest proportions of landowners who had knowledge about rotation and applied this criterion in Mariña Oriental. All E_{P4} owners knew about the forest requirements of their productive forest species and took them into account; 32.5% of E_{P2} and E_{P3} owners knew about the suitable rotation age of the productive forest species and applied this knowledge during previous harvests, compared with 6.4% of E_{P0} and E_{P1} groups ($\chi^2 = 18.982$).

The annual expenditure on planting forestlands decreased slightly with the degree of parcellation of the productive forestland ($\rho = -0.238$ at $P < 0.05$), and increased moderately with the size of the productive forestland ($\rho = 0.524$ at $P < 0.01$). The greatest number of plots per unit of productive forestland corresponded to the E_{P0} and E_{P1} groups, with a mean number of four plots per hectare of productive forestland; conversely, the remaining owner groups managed the least fragmented holdings, with over 2.4 plots per unit of productive forestland ($H = 8.333$). Productive forest holdings belonging to E_{P4} owners were significantly larger than those belonging to the remaining groups, excluding the E_{P2} group; the size of the productive forest holdings belonging to the E_{P2} owners was significantly different from that of the E_{P1} group ($H = 19.627$). These differences found in the size of the productive forestland and the annual plantation expenditure allowed us to classify landowners as in Table 6. Larger holdings would, therefore, be more likely to be managed, and more specifically to be planted, as discussed by Löyland et al. (1995), Arano et al. (2004) and Potter-Witter (2005).

Expenditure on silviculture

The annual expenditure on forest stand treatments was moderately and positively associated with annual rates of planting and silviculture in the region ($\rho = 0.566$ and 0.686, respectively, at $P < 0.01$). Post hoc analyses revealed significant differences in annual rates of planting between the E_{T1} group and E_{T2} or E_{T3} groups, and between E_{T0} and E_{T3} groups ($H = 16.787$). As regards forest stand treatments, E_{T3} owners differed significantly from the remaining study population, as the former carried out most silvicultural treatments per year in the region ($H = 29.402$). As regards timber harvesting,

Table 7
Mean annual rates of planting, silviculture and harvesting (%), amount of forest products for household consumption (€/ha per year), expenditure on planting (€/ha per year), income from land sales (€/ha per year), and size of productive forest holding (ha) per homogeneous TEXP subgroup.

TEXP No. of interviewed landowners	E_{T0} 12	E_{T1} 63	E_{T2} 20	E_{T3} 8	*P*-value
PLANT					
Farm planter	1.04	0.86	2.69		0.278
New planter			2.69	4.93	0.131
TREAT					
Farm silviculturalist	0.05	0.48	1.18		0.095
New silviculturalist				3.08	1.000
HARV					
Non-harvester	1.77	3.23	3.51		0.901
Harvester		3.23	3.51	9.74	0.056
REINVEST					
Non-forest consumer	38.15	68.79	65.18		0.767
Forest consumer		68.79	65.18	123.64	0.258
PEXP					
Retiree	98.46	126.05			0.960
Farmer			317.71		1.000
Absentee				583.92	1.000
NTINCOME					
Non-land seller	101.57	136.56	176.55		0.895
Land seller				460.43	1.000
SIZE					
Small landowner	2.98	4.16		6.11	0.127
Large landowner		4.16	7.06	6.11	0.177

significant differences were only observed between the E_{T3} and E_{T0} groups ($H = 2.397$). The homogeneous subgroups of landowners according to the annual expenditure on silviculture and the three forest management practices are shown in Table 7.

As the annual investments in holding improvement and forest planting increased, the annual investment in silviculture increased slightly and greatly, respectively ($\rho = 0.341$ and 0.799, respectively, at $P < 0.01$). The E_{T2} and E_{T3} owners annually invested three and two times more, respectively, in new forest buildings or infrastructures than the remaining groups ($H = 8.130$). As Table 7 shows, the E_{T2} and E_{T3} groups also spent significantly more on planting than the remaining groups ($H = 37.598$). The future intention to extend the area of woodland increased slightly with annual expenditure on stand forest treatments ($\rho = 0.292$ at $P < 0.01$), which again showed that large investments in forestry did not appear to decrease the level of management in Mariña Oriental. The number of E_{T2} and E_{T3} owners who intended to extend the area of productive forest in the near future was almost twice the number in the E_{T0} and E_{T1} groups ($\chi^2 = 7.929$).

The main reason for the previous finding may again be attributed to the landowner's interest in timber production as a motive for investing in the land. As with the annual expenditure on planting forestlands, the annual expenditure on carrying out silvicultural treatments increased weakly in relation to the annual income from timber harvests ($\rho = 0.252$ at $P < 0.05$). The E_{T2} and E_{T3} groups annually earned two times more income from selling timber than the remaining landowners. Moreover, the annual income from land sales increased slightly in those landowner groups who spent larger amounts per year on forest stand treatments ($\rho = 0.268$ at $P < 0.05$). The E_{T3} group received a significantly higher income from non-timber resources than the E_{T0} and E_{T1} groups ($H = 9.849$), as Table 7 shows. These results support that the landowners included in the study were able to sell forestland that they were not able to manage and to invest in forestry as the remainder of the holding.

The high degree of commitment to forest stand treatments explains why the likelihood of changing the current productive forest species increased slightly with the annual expenditure on silviculture

Table 3
Correlations among study variables (Somers' *D* and Spearman's ρ tests).

		INVEST (C)	PEXP (C)	TEXP (C)	REQUEST (B)	SUB (C)	TINCOME (C)	TPRICE (C)	NTINCOME (C)
Landowner land management practices									
PLANT (C)	ρ	0.415**	0.835**	0.566**	0.247*	0.207	0.448**	0.409**	0.037
TREAT (C)	ρ	0.413**	0.571**	0.686**	0.180	0.159	0.176	0.084	0.168
HARV (C)	ρ	0.184	0.354**	0.193	0.068	0.030	0.809**	0.781**	0.341**
Landowner profile									
AGE (C)	ρ	0.009	−0.091	−0.065	0.230*	0.196	−0.160	−0.083	0.037
EDUC (O)	D/ρ	0.021	0.194	0.141	−0.027	0.010	0.088	0.052	−0.130
OCCUP (N)	D/ρ	−0.004	0.235*	0.073	−0.147	−0.236*	0.095	0.042	−0.090
FARM (B)	D/ρ	−0.023	−0.049	0.095	−0.159	−0.088	0.035	−0.003	0.179
ASSOC (B)	D/ρ	0.150	0.112	0.086	−0.064	0.027	0.141	0.108	0.011
TRAINING (B)	D/ρ	0.161	0.140	0.002	−0.045	0.059	0.120	0.101	0.096
IMARKET (B)	D/ρ	0.086	0.015	0.024	−0.004	0.021	0.172	0.282*	0.032
TECHNIC (N)	D/ρ	0.041	0.033	−0.089	0.103	0.072	0.265*	0.337**	0.081
Family unit									
INHERIT (N)	D/ρ	0.246*	0.224*	0.013	0.203*	0.073	−0.097	−0.081	0.034
BEQUEST (N)	D/ρ	0.082	−0.001	−0.054	−0.002	−0.079	−0.009	−0.056	0.045
HOUSEHOLD (C)	ρ	0.007	0.220*	0.166	−0.084	−0.022	0.151	0.120	0.105
REINVEST (C)	ρ	−0.024	0.031	0.097	−0.153	−0.005	−0.042	−0.042	0.502**
PERSONAL (O)	D/ρ	0.094	0.225*	0.009	0.087	−0.005	0.177	0.225*	0.079
FAMILY (O)	D/ρ	−0.058	0.109	0.037	−0.026	0.022	0.002	0.114	−0.004
MACHINERY (B)	D/ρ	0.145	0.174	0.073	−0.089	0.070	0.172	0.162	0.203
PROFESS (O)	D/ρ	0.308**	0.402**	0.313**	0.147	0.189	0.207	0.206	0.048
Forest property and land-use changes									
FMEADOW (B)	D/ρ	0.242	−0.050	−0.070	−0.052	−0.049	−0.059	−0.059	−0.087
MWOOD (B)	D/ρ	0.151	0.153	0.133	0.189	0.076	0.035	−0.030	−0.016
CSPECIE (B)	D/ρ	0.093	0.180	0.216*	0.002	0.022	0.144	0.139	0.024
IFOREST (B)	D/ρ	0.234*	0.278**	0.292**	0.172	0.049	0.196	0.196	0.083
PLOT (C)	ρ	−0.216*	−0.238*	−0.266*	−0.012	−0.002	−0.171	−0.101	−0.074
SIZE (C)	ρ	0.216*	0.524**	0.369**	0.208	0.101	0.372**	0.285**	−0.137
Forest economics									
INVEST (C)	ρ		0.474**	0.341**	0.334**	0.297**	0.209	0.232*	0.093
PEXP (C)	ρ	0.474**		0.799**	0.244**	0.246*	0.417**	0.343**	0.266*
TEXP (C)	ρ	0.341**	0.799**		0.093	0.142	0.252*	0.134	0.268*
REQUEST (B)	D/ρ	0.334**	0.244*	0.093			0.053	−0.039	−0.004
SUB (C)	ρ	0.297**	0.246*	0.142			−0.007	−0.057	−0.080
TINCOME (C)	ρ	0.209	0.417**	0.252*	0.053	−0.007			0.083
TPRICE (C)	ρ	0.232*	0.343**	0.134	−0.039	−0.057			0.043
NTINCOME (C)	ρ	0.093	0.266*	0.268*	−0.004	−0.080	0.083	0.043	

Note: Variable subscripts indicate which typology of variable was used in the statistical analysis (C continuous; N nominal; O ordinal; B binary). Statistically significant coefficients: **$P < 0.01$, *$P < 0.05$.

Table 4
Significant differences among study variables (Pearson's χ^2 and Kruskal–Wallis' H tests).

		INVEST (O)	PEXP (O)	TEXP (O)	REQUEST (B)	SUB (O)	TINCOME (O)	TPRICE (O)	NTINCOME (O)
Landowner land management practices									
PLANT (C)	H	16.647*	44.154*	16.787*	5.165*	5.270*	18.843*	15.897*	1.414
TREAT (C)	H	14.471*	22.972*	29.402*	2.747*	5.883	3.192	4.708	1.857
HARV (C)	H	2.847	7.112*	2.397*	0.398	2.718	67.637*	66.328*	21.944*
Landowner profile									
AGE (C)	H	2.107	2.769	0.084	4.490*	5.162*	2.845	2.258	1.616
EDUC (O)	χ^2/H	4.463	13.030	2.550	2.621	5.461	6.987	8.165	2.981
OCCUP (N)	χ^2/H	4.410	30.986*	19.207	7.134	7.212	23.363*	20.178	10.379
FARM (B)	χ^2/H	0.136	5.160	4.950	2.184	2.711	1.071	5.783	3.041
ASSOC (B)	χ^2/H	1.866	2.293	0.908	0.360	6.209	5.889	1.070	4.589
TRAINING (B)	χ^2/H	7.642*	1.824	2.156	0.203	5.240	1.263	4.226	0.893
IMARKET (B)	χ^2/H	0.871	3.706	1.171	0.002	1.734	7.984*	6.635*	3.462
TECHNIC (N)	χ^2/H	3.980	18.982*	6.063	1.060	4.837	11.345*	17.207*	0.394
Family unit									
INHERIT (N)	χ^2/H	9.757*	13.780*	2.888	6.853*	6.921	8.547	4.650	1.926
BEQUEST (N)	χ^2/H	3.883	7.419	2.711	0.808	0.544	5.560	4.024	3.522
HOUSEHOLD (C)	H	0.071	9.038*	5.110*	0.599	1.765*	3.217	2.791	0.380
REINVEST (C)	H	0.054	4.123*	4.032*	1.992	4.994*	0.252	0.293	18.888*
PERSONAL (O)	χ^2/H	14.427	15.855	7.908	3.997	23.563	19.653	38.867*	6.854
FAMILY (O)	χ^2/H	8.751	37.273*	15.872	2.548	15.230	27.182*	27.779*	12.410
MACHINERY (B)	χ^2/H	3.445	0.597	0.980	0.696	6.974	2.254	1.943	3.043
PROFESS (O)	χ^2/H	30.016*	42.573*	27.407*	8.849	17.798	18.461	18.332	9.420
Forest property and land-use changes									
FMEADOW (B)	χ^2/H	4.807*	0.623	2.749	0.542	0.210	2.533	0.353	2.842
MWOOD (B)	χ^2/H	3.029	4.036	3.190	3.095*	7.238	1.454	1.139	1.558
CSPECIE (B)	χ^2/H	2.125	3.267	3.869	0.000	2.948	2.453	4.632	0.195
IFOREST (B)	χ^2/H	6.289*	9.550*	7.929*	2.644	4.176	5.744	4.008	2.043
PLOT (C)	H	4.544	8.333*	5.437	0.011	5.205*	4.119	8.624*	2.194
SIZE (C)	H	6.844*	19.627*	6.366*	3.672*	3.592	13.720*	14.683*	0.378
Forest economics									
INVEST (C)	H		21.154*	8.130*	8.188*	13.304*	4.607	2.603	0.848
PEXP (C)	H	21.000*		37.598*	4.463*	5.347	12.384*	10.061*	4.825*
TEXP (C)	H	10.567*	50.134*		1.923	2.712	2.026	1.401	5.108*
REQUEST (B)	χ^2/H	10.808*	8.368*	0.920			2.415	7.484	0.417
SUB (C)	H	8.112*	2.127	1.631			2.564	2.833	1.649
TINCOME (C)	H	4.536	10.694*	5.552	0.265	0.715			13.039*
TPRICE (C)	H	4.774*	7.701	1.257	0.177	0.830			9.538*
NTINCOME (C)	H	0.716	11.737*	9.849*	0.105	1.975	4.636*	1.356*	

Note: Variable subscripts indicate the type of variable used in the statistical analysis (C, continuous; N, nominal; O, ordinal; B, binary). *Statistically significant coefficient: *P* < 0.05.

Table 9
Mean annual rates of planting and harvesting (%), and expenditure on planting (€/ha per year) per homogeneous TINCOME subgroups. Mean values of annual rate of harvesting (%) per homogeneous TPRICE subgroup.

TINCOME No. of interviewed landowners	T_{I0} 46	T_{I1} 18	T_{I2} 19	T_{I3} 20	*P*-value
PLANT					
Non-planter	0.61	2.03		1.76	0.366
Planter		2.03	3.20	1.76	0.355
HARV					
Non-harvester	0.00		3.64		0.178
Harvester		7.34	3.64	8.18	0.058
PEXP					
Non-investor	124.29	214.15		252.05	0.104
Planter investor		214.15	270.65	252.05	0.737
TPRICE No. of interviewed landowners	T_{P0} 46	T_{P1} 40	T_{P2} 11	T_{P3} 6	P-value
HARV					
Non-harvester	0.0	5.90	6.46		0.053
Harvester		5.90	6.46	8.17	0.797

owners managed both inherited and purchased lands, as R_{Q0} owners; landowners who purchased their holdings were exclusively included in the R_{Q0} group ($\chi^2 = 6.853$). The likelihood of applying for subsidies also differed significantly depending on the owners' willingness to plant former agricultural land, i.e. to convert marginal meadows into woodland ($\chi^2 = 3.095$). Over 23.5% of R_{Q0} owners converted marginal meadows into woodland as a productive alternative within their holding, compared with 55.6% of R_{Q1} owners. Therefore, the landowner profile and the type of land management observed in the area supports that land capitalization, especially on the part of retirees, may largely correspond to the likelihood of obtaining public funding in order to improve land productivity and to ensure a complementary source of household income by means of forest investment.

Finally, the size and degree of parcellation of productive forestland differed significantly according to the likelihood of applying for public subsidies and the annual amount awarded per subsidy, respectively. On average, R_{Q1} owners managed almost 1 ha more than R_{Q0} owners ($H = 3.672$). As regards the degree of parcellation of productive forestland, there were significant differences between S_{U0} and S_{U3} owners ($H = 5.205$). The largest number of plots per unit of productive forestland corresponded to S_{U1} and S_{U4} groups, a mean of 4.5 plots; conversely S_{U0} owners managed the least parcelled holdings with over one plot per unit of productive forestland.

Income from timber sales

The annual rate of planting forestland in the region increased moderately in relation to the annual income from timber and unitary stumpage price from previous harvests ($\rho = 0.448$ and 0.409, respectively, at $P < 0.01$). Hyberg and Holthausen (1989), Newman and Wear (1993), Hardie and Parks (1996) and Kline et al. (2002), amongst others, have reported that stumpage, pulptimber and sawtimber prices have a significant and positive effect on the likelihood or intensity of planting. As Table 9 shows, the post hoc analyses revealed that the annual rate of planting by T_{I0} owners was significantly different from the rate of planting by T_{I2} owners ($H = 18.843$). With regard to the annual rate of planting on the basis of the unitary price of timber, this forestry activity differed significantly in the T_{P0} and T_{P1} groups ($H = 15.897$). In this case, T_{P1} and T_{P3} owners planted twice as much forestland per year as the T_{P0} and T_{P2} owners.

Furthermore, the annual rate of timber harvesting was strongly and positively correlated with the annual timber income and the unitary stumpage from previous harvests ($\rho = 0.809$ and 0.781, respectively, at $P < 0.01$). The T_{I3} and T_{P3} owners were the most likely to harvest woodland, although there were significant differences between the T_{I0} group and T_{I1} or T_{I3} groups ($H = 67.637$) and between

the T_{P0} group and T_{P1} or T_{P3} groups ($H = 66.328$). The homogeneous subgroups of landowners according to the annual rate of harvesting and the annual income or unitary stumpage price from timber are shown in Table 9. This finding indicates that market conditions for timber production play a significant role in forest management of the area. Binkley (1981), Boyd (1984), Kuuluvainen and Salo (1991), Kuuluvainen et al. (1996), Bolkesjø and Baardsen (2002), Pattanayak et al. (2002), and Bolkesjø et al. (2007), amongst others, have demonstrated that timber price – for roundwood, pulpwood and sawtimber – has a significant positive effect on harvest choice and intensity or volume, and timber supply.

The unitary stumpage price from previous harvests and the landowner's knowledge of timber market information were weakly and positively correlated ($\rho = 0.282$ at $P < 0.05$). Some 48.4% of T_{P0} and T_{P1} owners did not have any information with regard to timber markets, as compared with 33.3% and 18.9% of T_{P2} and T_{P3} owners, respectively ($\chi^2 = 6.635$). Moreover, significant differences in the availability of timber market information were observed according to the TINCOME group ($\chi^2 = 7.984$); 81.1% and 68.8% T_{I2} and T_{I3} owners, respectively, knew about timber market conditions, as compared with 48.4% of T_{I0} and T_{I1} owners. Also, the annual income and selling price from timber increased slightly when the landowner had some knowledge of appropriate rotation ages and applied this knowledge ($\rho = 0.265$ at $P < 0.05$ and 0.337 at $P < 0.01$, respectively). For every T_{I0} and T_{I1} owner there were two T_{I2} and T_{I3} owners who knew about and applied the suitable rotation age in previous timber harvests ($\chi^2 = 11.345$). As regards the unitary stumpage price, the T_{P2} and T_{P3} groups included the largest share of landowners who knew about and applied productive forest criteria (36.1%), compared with 7.4% of T_{I0} and T_{I1} owners ($\chi^2 = 17.207$). Wear and Parks (1994) concluded that the optimum harvest age depended on current and expected market conditions; the owner can thus decide whether or not to harvest timber commercially based on market perspectives.

The landowner's main occupation differed significantly depending on the annual timber income ($\chi^2 = 23.363$), differences that help clarify the type of land management behaviour previously described. The largest proportion of non-agricultural professionals was included in T_{I2} and T_{I3} groups (28.9%), while on the contrary, 35.7% of T_{I1} owners were active farmers; 56.8% and 46.7% of T_{I0} and T_{I2} owners, respectively, were retirees. The close relationship between the owner's occupation and his/her commitment to the land may also explain why the annual fraction of personal working days devoted to forestry increased slightly with the unitary stumpage price ($\rho = 0.225$ at $P < 0.05$). This supports the hypothesis that the landowner's forest labour depended on his/her interest in productive woodland, as suggested by Pattanayak et al. (2002). All T_{P3} and 66.6% of T_{P2} owners spent more than 11 working days per year on forestry, while 59.6% of T_{P0} and T_{P1} groups did not devote more than this time to forestry ($\chi^2 = 38.867$). In addition, family assistance in forestry also differed significantly according to the TINCOME and TPRICE groups ($\chi^2 = 27.182$ and 27.779, respectively). Firstly, some 46.2% of T_{I0} and T_{I1} owners benefitted from less than 5 family working days per year, compared with 40% and 62.5% of T_{I2} and T_{I3} owners, respectively, who benefitted from more than 100 family working days per year. Secondly, 76.4% of T_{P3} and T_{P2} owners benefitted from more than 50 family working days per year, compared with 27.4% of T_{P0} and T_{P1} groups.

The timber selling price and the annual investment in holding improvement were weakly and positively correlated ($\rho = 0.232$ at $P < 0.05$). On average, the T_{P3} owners annually invested five times more in new forest buildings and infrastructures than the T_{P0} group, and three times more than T_{P1} and T_{P2} owners, although the differences were not significant. The annual expenditure on planting moderately and slightly increased, respectively, with the annual income and unitary stumpage from timber harvests ($\rho = 0.417$ and 0.343, respectively, at $P < 0.01$). The T_{I2} and T_{I3} owners invested significantly more money in planting forestland than the T_{I0} group ($H = 12.384$), as Table 9 shows. With regard to the timber selling price, T_{P2} and T_{P3} owners spent half as much on planting as the remaining groups, whilst the differences between T_{P0} and T_{P1} owners were significant ($H = 10.061$). Moreover, the annual expenditure on silviculture increased slightly in relation to the annual income from timber sales ($\rho = 0.252$ at $P < 0.05$). The T_{I3} owners invested almost twice as much in forest stand treatments than the other owners, although the differences were not significant.

The mean annual income from land sales differed significantly according to the annual income from timber sales and the unitary stumpage price. Taking into account the guidelines for the forest practices and the levels of forest investments analysed in the area, this supports the previous statement about

Table 10
Mean annual rate of harvesting (%), expenditure on silviculture (€/ha per year), income (€/ha per year) and stumpage price (€/T) from timber sales, and amount of forest products for household consumption (€/ha per year) per homogeneous NTINCOME subgroup.

NTINCOME No. of interviewed landowners	nT_{I0} 35	nT_{I1} 52	nT_{I2} 16	*P*-value
HARV				
Non-harvester	0.81	2.14		0.361
Harvester			8.86	1.000
REINVEST				
Non-forest consumer	25.30			1.000
Forest consumer		87.94	120.95	0.312
TEXP				
Non-investor	48.76	67.13		0.693
Silviculturalist investor			123.68	1.000
TINCOME				
Non-wood seller	122.55	193.05		0.510
Wood seller			390.41	1.000
TPRICE				
Non-timber industrialist	2.94	4.15		0.559
Timber industrialist		4.15	6.32	0.164

the harvesting of forestland before selling and the investment in the remaining fraction of land within the holding. The incomes from non-timber resources were significantly higher in the T_{I3} and T_{P3} groups than in the T_{I0} and T_{P1} groups, respectively ($H = 4.636$ and 1.356, respectively). The T_{I3} owners annually sold forestland for twice as much per unit than that sold by T_{I1} and T_{I2} owners, and three times as much as that sold by T_{I0} group. With regard to the timber selling price, T_{P3} and T_{P2} owners annually received five times as much income from non-timber products as the remaining study population.

Larger productive forest holdings were characterized by higher timber income at a higher unitary stumpage price, probably because of a greater likelihood of the timber being harvested and taken advantage of; with a large volume of timber enabling negotiation of a better selling price with minimal harvesting cost. The positive significance of the size of the landowners' property on timber harvesting has been analysed in a few studies (Binkley, 1981; Boyd, 1984; Kuuluvainen and Salo, 1991; Löyland et al., 1995; Prestemon and Wear, 2000; Conway et al., 2003; Potter-Witter, 2005; Bolkesjø et al., 2007; Størdal et al., 2008). Thus, the annual timber income and timber selling price increased slightly in relation to the area of productive forestland ($\rho = 0.372$ and 0.285, respectively, at $P < 0.01$). The T_{I1} and T_{P1} owners managed significantly larger areas of productive forestland than T_{I0} and T_{P0} owners, respectively ($H = 13.720$ and 14.683, respectively). On average, T_{I0} and T_{P0} groups owned almost 2 ha less forestland than the other groups. In addition, the T_{P0} owners managed significantly more parcelled holdings than T_{P1} owners ($H = 8.624$).

Income from land sales

The annual income from land sales increased slightly with the annual rate of timber harvesting ($\rho = 0.341$ at $P < 0.01$). This suggests that marketable forestland was harvested before selling. Pairwise comparisons indicated that nT_{I2} owners were the most active harvesters in the area, and were significantly more active than the remaining owners ($H = 21.944$). The fact that annual expenditure on planting and silvicultural treatments increased slightly with annual non-timber incomes ($\rho = 0.266$ and 0.268, respectively, at $P < 0.05$) indicates that those owners who actively participated in the land market by means of selling forestland were also actively investing in forestry in the rest of the holding. Again, nT_{I2} owners spent significantly greater annual amounts on planting and silviculture than the other owners ($H = 4.825$ and 5.108, respectively). The classification of the study population according to annual income from land sales and annual rate of timber harvesting and annual expenditure on silviculture is summarized in Table 10.

Table 11
Coefficients of the multiple linear regression model for forest planting activities.

	Partial regression coefficients (parameters)		Significance test		Standardized partial regression coefficients	Collinearity test
	Value	Standard error	*t*	*P*-value		Tolerance
Constant	−1.096	0.209	−5.235	0.000		
PEXP	0.014	0.001	12.491	0.000	0.997	0.308
SIZE	0.224	0.037	6.017	0.000	0.324	0.677
TEXP	0.009	0.002	5.342	0.000	0.445	0.283
INVEST	0.002	0.001	3.212	0.002	0.208	0.469
TINCOME	0.001	0.001	2.674	0.009	0.129	0.839

The mean timber income and unitary stumpage price from previous harvests differed significantly according to the NTINCOME group, which supports the previous statement about forestland sales after harvesting. The nT_{I2} group annually received a significantly higher income from timber than the remaining groups ($H = 13.039$). With regard to the unitary stumpage price, nT_{I2} owners sold their timber at a significantly higher price than that obtained by nT_{I1} owners ($H = 9.538$). Also, the annual benefits from forest products used for own consumption and the annual non-timber income were moderately and positively correlated ($\rho = 0.502$ at $P < 0.01$), which suggests that some proportion of silviculture products or harvests were moreover used for own consumption. Owners in the nT_{I0} group benefitted significantly less from own consumption of forest products than the remaining owner population ($H = 18.888$). The homogeneous subgroups of landowners according to these four variables are illustrated in Table 10.

Estimation of the linear regression model

The fit for the multiple linear regression models for the three forest management activities analysed (through dependent variables PLANT, TREAT and HARV) only provided significant results for the fraction of land planted annually relative to the total forest area between 1999 and 2003 (PLANT variable). We therefore decided to include and discuss only the predictive model obtained for the behaviour of resident NIPF owners in Mariña Oriental in terms of forest planting.

Of the total owners and with the continuous explanatory variables considered (Table 2), five steps were used to construct a multiple linear regression model with a step-wise selection procedure. The predictive model indicated which five regression variables were the most important and useful in terms of quantifying the forest planting behaviour in the study area: annual unit expenditure on planting and silviculture, annual unit investment in improvements to equipment and infrastructure, productive forest area, and unitary annual timber income. Therefore, as indicated throughout the study, forest investments and incomes cannot be overlooked in analysing and understanding the forest activities undertaken by NIPF owners, in this specific case planting activity. Model 1, which included only the annual unitary expenditure on planting, accounted for 64% of the variance in the annual rate of planting forestlands (Adjusted-$R^2 = 0.639$). The inclusion of the area of productive forestland in ownership into model 2 resulted in an additional 12% of the variability being explained (change in $R^2 = 0.121$). Models 3 and 4 incorporated sequentially the annual investments in silvicultural treatments and holding improvement, respectively, and these two independent variables together increased the explained variance in the dependent variable by 4.6% (change in $R^2 = 0.026$ and 0.020, respectively). Finally, model 5 (which added the annual unitary income from timber sales), the five explanatory variables jointly accounted for almost 84% (Adjusted-$R^2 = 0.833$) of the observed variability in the annual rate of planting. In addition, the *F*-statistic, the value of which was 71.871 ($P < 0.05$), indicated the existence of a significant linear relationship between the dependent variable and the set of independent variables.

All the explanatory variables had the expected positive signs, whilst the *t*-statistic revealed that each of them contributed significantly to explaining the annual rate of forest planting in Mariña Oriental region ($P < 0.05$), therefore with a significant linear relationship between each of the five independent variables and the dependent variable (Table 11). The results of the collinearity analysis are

also summarized in Table 11. According to this statistical test, the levels of tolerance associated with all of the explanatory variables were acceptable (values higher than 0.0001); in the regression model, the smallest proportion of variance not associated with the other independent variables corresponded to the annual unitary expenditures on planting and silviculture (30.8% and 28.3%, respectively), while the highest proportion corresponded to the annual unitary timber income and the size of the productive forestland (83.9% and 67.7%, respectively).

The individual interpretation of the value and sign of the partial regression coefficients (Table 11) indicated that, while maintaining constant the other explanatory variables in the regression equation, an increase in 1 €/ha per year in the investments associated with planting, silviculture and improvements in the forest holding (equipment and infrastructure) signified on average, annual increases in the rate of planting of 0.014%, 0.009% and 0.002%, respectively; likewise an increase in productive forestland of 1 ha and an increase in timber income of 1 €/ha per year would lead to annual increases in the proportion of planted forestland of 0.224% and 0.001%, respectively. Thus, the NIPF owners with large areas of productive forestland annually invested more economic amounts on forest management (planting, silvicultural improvements and equipment) and received more income annually from timber sales, were the most active managers in terms of annual forest planting activities.

With regard to the standardized partial regression coefficients (Table 11), the absolute values were used to complete the interpretation of the final regression model. These coefficients, measured in units of standard deviation, enable direct comparison of the relative contribution of the explanatory variables to the regression model (as variables are standardized, the scale is the same and the variables do not depend on their units, and therefore the level of variability is equal). The annual expenditure on forest planting was the independent variable with greatest weighting or relative importance in predicting the annual rate of forestland planted by NIPF owners in Mariña Oriental. This was followed by the annual expenditure on silvicultural treatments for forest improvements, then by the area of productive forestland in the holding. Finally, the annual investment in equipment along with improving the infrastructure and the annual income from timber were, in this order, the two independent variables with least weighting in terms of the forest planting activities.

After running the regression model, the residuals were analysed in order to ensure a reasonable degree of independency, homoscedasticity, normality, and linearity. The Durbin–Watson test revealed that the residuals in the model were independently and identically distributed ($DW = 2.246$). The visual inspection of the standardized residuals plotted against predicted values and the histogram of the standardized residuals showed that the residuals displayed kurtosis and were skewed to the right, but were close to normally distributed. Taking into account the number of variables in the model and the number of observations the model was based on, it is possible to state that the residuals were approximately normally distributed under the Central Limit Theorem (Rice, 1995; Vilar, 2002). Finally, the linearity hypothesis was fulfilled by means of the good fit of the regression equation (Adjusted-$R^2 = 0.833$).

Conclusions and implications

A key factor in advancing NIPF sustainable forest management within the framework of rural development is to create economic opportunities that allow landowners to fulfil social and environmental demands. In this sense, and as a first step in promoting supporting policies and tools in NIPF land management, the main objective of the present study was to examine management by NIPF owners by empirical analysis of the role and importance of economic attributes of the *balance sheet, and the profit and loss account in forestry*, but always and inseparably determined by the preferences and circumstances of the managers, the family unit, and the territorial system. According to this framework of analysis, the study was carried out on the basis of data obtained from personal interviews, in 2004, with a total of 103 resident NIPF owners in Mariña Oriental region (Northeast Galicia, northern Spain), each responsible for more than 1 ha of productive forestland, in the study area.

The results for the period 1999–2003 showed that (a) the annual rate of planting forestland was significantly affected by the annual investment in holding improvement, annual expenditure on planting and silviculture, whether or not the landowner applied for public subsidies, the amount granted annually through subsidies, and annual income and unitary stumpage price for timber sales; (b) the

annual rate of forest stand treatments was significantly associated with annual investment in holding improvement, annual expenditure on planting and silviculture, and whether or not the landowner applied for public subsidies; and (c) the annual rate of harvesting woodlands was significantly related to annual expenditure on planting and silviculture, annual income and unitary selling price from timber sales, and annual income from land sales. The multiple linear regression model for the annual forest planting activities on NIPF land indicated that this practice was almost exclusively explained by forest economic attributes (annual unit investment incomes), although the area of productive forestland within the holding was also found to be important.

Within the type of forest management applied in the area, attractive forest returns and favourable market conditions for timber production appeared to influence, either directly or indirectly, the land-use practices carried out by the NIPF owner population, as clear motive for investing in the land as a capital asset and for encouraging the continuity of forest management. Thus, active forest managers were characterized by benefitting greatly from forestry, by investing heavily in holding improvements and though planting and silviculture in order to maintain the productivity of the forestland and make it profitable. Nevertheless, the personal and family situations of NIPF owners and the characteristics of their holdings were also important factors in explaining and describing the type of land management applied. Commitment to the land and forest management was carried out by two main types of labour force. Firstly, retired and active farmers usually managed the land themselves, supported by training in forestry, whilst non-agricultural landowners mainly relied on professional assistance to carry out and make land management viable. In addition, landowners who already worked as farmers managed more parcelled and smaller areas of productive forestland, as a consequence of improving and increasing agrarian productivity, while on the contrary, less parcelled and larger productive forest holdings generally belonged to professionals outside farming.

Therefore, without underestimating the weight of other attributes linked to the social, geographical and policy context of the NIPF management, the key and indisputable role of economic factors in the development and intensity of forestry activities carried out by NIPF owners suggests that encouraging socially and environmentally sustainable forest practices among these types of owners must involve the promotion of economically sustainable forest practices.

Responsible forest management in terms of the environment and rural development depends on the existence of a social network of forest owners, which in turn must obtain economic income from forest activities or fair public economic compensation for conserving, improving and managing forestland, as a source of goods and services for society. Only when land managers fully understand the economics involved in management, will guidelines for land management be socially and environmentally responsible, and be suited to the principles of forest sustainability.

Research lines and public measures with regard to NIPF owners must improve profitability as a focal point for effective and efficient motivation for sustainable forest decision-making and management. Thus, the associated economic factors and how they affect landowners' decisions to devote human and material resources to forestry within the holding must be taken into account. It may be of interest to design and promote public measures such as timber market and economic incentives for forest management to enable NIPF owners to maintain or improve forestry income (profit options) and which are consistent with objectives of sustainable forestry and rural development (utility options), i.e. to incentivize sustainable forest management.

Thus, considering the current direction of forestry policies, guide the future of forest resources on an international scale, public measures or incentives related to forest certification will be particularly important. It will therefore be essential to motivate and compensate NIPF owners to undertake forest practices that improve and maintain the natural richness and vitality, contribute to the global carbon cycle, generate products, provide highly diverse services, and increase the gross domestic product (GDP) and employment in different regions. These combined roles of forest resources contribute to the *balance sheets, and the profit and loss accounts* for forestry, and therefore should be economically quantifiable and politically incentivized. Although some of these functions are difficult to estimate at the scale of individual owners, and are currently not the object of public campaigns, they should nevertheless still be considered in the economic balance of forestry and in related public strategies.

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