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SUMMARY

State forest enterprises (SFEs) in Vietnam for decades were the main source of industrial wood production, but smallholder forest plantations have become common. Smallholders need positive financial returns to be viable. Likewise, financial returns are an important consideration of proposals to turn SFEs into joint ventures, because the potentially involved private companies would seek reasonable returns on investment. Financial analyses of smallholder and SFE forest plantations were undertaken to evaluate their competitiveness and profitability, and to assess opportunities and challenges for the sector. It was found that forest plantations in Vietnam, under current market conditions, can be profitable. Smallholders who received technical assistance and financial support could generate average land expectation values (LEVs) of about US$ 5 100/ha at 8% discount rate. Even without financial support, and assuming smallholders pay for the cost of technical assistance, average LEVs were about US$ 4 600/ha. Smallholders participating in a Forest Stewardship Council (FSC) certification pilot had higher LEVs, assuming price premiums for certified wood. Positive LEVs were robust to lower wood price and higher discount rates. SFEs, on the other hand, had poorer returns because of lower growth and yield of wood, which may be due to differences in sites and management. Vietnamese wood producers are competitive internationally, and have opportunities to tap domestic and international markets.

Keywords: capital budgeting, *Acacia*, *Eucalyptus*, certification

Analyse financière et comparaison des entreprises de plantations forestières de petits exploitants et de celles d'état dans le Vietnam central

G.E. FREY, F.W. CUBBAGE, T.T.T. HA, R.R. DAVIS, J.B. CARLE, V.X. THON et N.V. DZUNG

Les entreprises des forêts d'état (SFEs) au Vietnam ont été pendant des décennies la principale source de production de bois, mais les plantations forestières de petits exploitants sont devenues de monnaie courante. Les petits exploitants ont besoin de revenus positifs pour pouvoir être viables. Similairement, les revenus financiers sont une considération importante dans les propositions de transformer les SFEs en entreprises partagées, les compagnies privées à même de participer recherchant des bénéfices raisonnables pour leur investissement. Des analyses financières des plantations de petits exploitants et de celles d'état ont été menées, pour évaluer leur compétitivité et leur rentabilité et pour obtenir une vue d'ensemble des opportunités et des défis liés à ce secteur. Leur résultat indique que les plantations forestières du Vietnam peuvent être profitables, dans leur condition présente. Les petits exploitants ayant reçu une assistance technique et un soutien financier pouvaient produire une valeur moyenne estimée du sol (LEVs) d'environ US$ 5 100/ha, à un taux de remise de 8%. On trouva même que sans assistance financière, et en assumant que les petits exploitants prennent en charge le coût d'une assistance technique, les LEV moyens atteignaient environ US$ 4 600/ha. Les petits exploitants participant dans une certification pilote du Forest Stewardship Council (FSC) obtenaient des LEV supérieures, en estimant les primes de prix accordées au bois certifié. Les LEVs positives demeuraient robustes face à un prix plus faible du bois et à des taux de remise plus élevés. Par contre, les revenus de ces LEVs faiblissaient du fait d'une moindre croissance et d'une chiche récolte du bois, résultant peut-être de différences entre les sites et les diverses gestions. Les producteurs de bois vietnamiens sont compétitifs à l'échelle internationale, tout en ayant la possibilité d'exploiter à la fois les marchés domestiques et internationaux.

Análisis financiero y comparación entre plantaciones forestales de pequeños propietarios y de empresas forestales estatales en Vietnam central

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Las empresas forestales estatales (EFE) de Vietnam fueron durante décadas la fuente principal de producción industrial de madera, pero las plantaciones forestales de pequeños propietarios se han vuelto comunes. Las pequeñas plantaciones necesitan retornos financieros positivos para ser viables. Del mismo modo, los rendimientos financieros son un factor importante en las propuestas para convertir las EFE en sociedades conjuntas, porque las empresas privadas potencialmente involucradas esperarían rendimientos razonables de dicha inversión. Se llevaron a cabo análisis financieros de pequeñas plantaciones forestales y de EFE para evaluar su competitividad y rentabilidad, y para evaluar las oportunidades y desafíos en el sector. Se encontró que, bajo las condiciones actuales del mercado, las plantaciones forestales en Vietnam pueden ser rentables. Los pequeños propietarios que recibieron asistencia técnica y apoyo financiero podrían generar, en promedio, valores esperados del suelo (VES) de aproximadamente USD 5100 / ha con una tasa de descuento del 8%. Incluso sin apoyo financiero, y suponiendo que los pequeños propietarios pagasen por el costo de la asistencia técnica, los VES promedio fueron de aproximadamente USD 4600 / ha. Los pequeños propietarios que participaban en una prueba piloto de certificación del Forest Stewardship Council (FSC) obtuvieron VES más altos, cuando se asumieron primas sobre el precio de la madera certificada. Los VES positivos se mostraron robustos para precios de la madera más bajos y tasas de descuento más altas. Las EFE, por otro lado, mostraron rendimientos más bajos debido a un menor crecimiento y rendimiento de la madera, lo que puede deberse a diferencias en los sitios y la gestión. Los productores de madera vietnamitas son competitivos a nivel internacional y gozan de oportunidades para aprovechar los mercados nacionales e internacionales.

Phân tích tài chính và so sánh giữa rừng trồng sản xuất quy mô tiểu điền với rừng trồng sản xuất của các công ty lâm nghiệp nhà nước ở khu vực miền Trung Việt Nam

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Trong nhiều thập kỷ, các công ty lâm nghiệp nhà nước tại Việt Nam luôn chiếm vai trò chủ đạo trong sản xuất gỗ công nghiệp, tuy nhiên, trong thời gian gần đây, rừng trồng quy mô tiểu điền của các nhóm hộ gia đình đang dần trở lên phổ biến. Các nhóm hộ gia đình cần đạt được một mức lợi nhuận tốt để có thể tồn tại và phát triển. Tương tự như vậy, lợi nhuận cũng là một yếu tố quan trọng khi xem xét việc chuyển đổi công ty lâm nghiệp nhà nước sang hình thức công ty cổ phần bởi các công ty tư nhân tiềm năng đều rất chú trọng đến lợi nhuận của các khoản đầu tư. Phân tích tài chính về rừng trồng ở quy mô tiểu điền và rừng trồng của các công ty lâm nghiệp nhà nước được thực hiện nhằm đánh giá khả năng cạnh tranh và lợi nhuận của các bên cũng như đánh giá cơ hội và thách thức đối đối với ngành lâm nghiệp. Kết quả đánh giá cho thấy trong điều kiện thị trường hiện nay của Việt Nam, rừng trồng có thể mang lại lợi nhuận. Các nhóm hộ được hỗ trợ tài chính và kỹ thuật có thể nhận được giá trị kỳ vọng đất (Land expectation values-LEVs) trung bình là 5.100 đô-la/ha với mức chiết khấu 8%. Ngay cả khi các hộ gia đình không được hỗ trợ về tài chính và kỹ thuật, thì LEVs vẫn đạt mức 4.600 đô-la/ha. Các hộ gia đình tham gia vào chương trình cấp chứng chỉ rừng Forest Stewardship Council (FSC) có giá trị LEVs cao hơn nhờ phần giá tăng thêm đối với lượng gỗ được cấp chứng nhận. Giá trị LEVs dương là chắc chắn kể cả khi giá gỗ thấp hơn và tỷ lệ chiết khấu cao hơn. Trong khi đó, rừng trồng của các công ty lâm nghiệp nhà nước có mức lợi nhuận thấp hơn do cây sinh tưởng chậm và sản lượng thấp hơn, cũng có thể là do sự khác biệt về điều kiện lập địa và phương thức quản lý. Nhìn chung, các nhà sản xuất gỗ tại Việt Nam có năng lực cạnh tranh trên trường quốc tế và có cơ hội phát triển ở cả thị trường trong nước lẫn thị trường ngoài nước.

INTRODUCTION

Forest plantations of exotic tree species have been presented in Vietnam as potentially profitable and a poverty reduction strategy (Salek and Sloup 2012, Sunderlin 2006). Furthermore, forest plantations can help conserve and improve soils (Dong *et al.* 2014), and while not as biodiverse as native forests (Thinh *et al.* 2012), they can provide important habitat and buffer area for some species (Cuong *et al.* 2013) and mitigate climate change by sequestering atmospheric carbon (Sang *et al.* 2013). They potentially could reduce human pressure on natural forests for wood (Sedjo and Botkin 1997, Pirard *et al.* 2016), although natural and plantation forests may compete for space in some areas within Vietnam (Meyfroidt and Lambin 2008).

Forest lands in Vietnam, including areas for forest plantations, were typically allocated to State Forest Enterprises (SFEs) in the 1950s through 80s (Sikor 1998). A shift from a state-planned to a market-oriented economy and a need to make SFEs profitable has motivated SFE reforms and allocation of forest lands to smallholders over the past 30 years (Dang *et al.* 2012, Sikor *et al.* 2005, World Bank 2010). As of 2015, SFEs were managing about 375 000 ha of forest plantations, whereas estimates suggest that smallholder households were managing about 1 600 000 ha (Ministry of Agriculture and Rural Development 2016), totalling about 6% of the country's total land area. However, there is relatively little literature related to the financial competitiveness of Vietnamese SFE and smallholder plantation. Such information is needed to evaluate market, financial, and other

opportunities and threats, and to determine if plantation forestry will continue to be viable if and when donor and government support programs are reduced or eliminated.

To that end, this research had the following objectives:

- Estimate profitability and productivity of smallholder and SFE plantations as they are typically practiced and experienced in Vietnam, including variability in environmental conditions and management regimes.
- Assess the competitiveness of smallholder and SFE plantations in relation to other countries, including opportunities and challenges.

BACKGROUND

Forests in Vietnam

Historical context

Forests in North Vietnam were nationalized in the 1950s (Sikor *et al.* 2005) and SFEs were established in the 1960s "to manage Vietnam's forests and to supply the industry with raw material" (Sandewall *et al.* 2015). Upon reunification in 1975, forests in the former South Vietnam were nationalized under the same system (Sikor *et al.* 2005). These SFEs were primarily established in the upland regions, particularly in areas with steep slopes (Clement and Amezaga 2013, Poffenberger and Phon 1998, Sikor 1998). By the late 1980s, there were 413 SFEs managing about 6.3 million ha, including plantation and natural forests (Tan 2006, Duc *et al.* 2012).

In the late 1980s and 1990s, Vietnam implemented the "*Đổi Mới*" ("Renovation") policy, a general shift from a state-planned to a more market-oriented economy (Clement and Amezaga 2013). The government devolved substantial state-controlled lands to households and other non-state actors, a process known as "socialization" (Dang *et al.* 2012, Sikor *et al.* 2005). In addition, most environmentally-sensitive "protection" and "special use" forests were moved from SFEs to Forest Management Boards (Dang *et al.* 2012, Artemiev 2003, Sam and Trung 2003).

Devolved "production" forests were considered property of the people of Vietnam, but could be allocated to individual households or communities for long-term use (Dang *et al.* 2012). The allocation could take various forms, with the most secure form being an allocation for a period of 50 years, via a document called a land use right certificate or "Red Book" (Dang *et al.* 2012). The Red Book for individual households grants land-use rights to invest in and manage the land; to own and trade the goods produced from the land; and to exchange, transfer, mortgage, inherit, or lease those rights (Clement and Amezaga 2013, Dang *et al.* 2012, Sam and Trung 2003).

In the context of these changes and reforms, several trends fostered a general shift in the rural household economy away from shifting cultivation within natural forests towards cash crop and exotic plantation tree farms (Clement and Amezaga 2013, Sandewall *et al.* 2010, Sandewall *et al.* 2015), including: creation of financial and technical assistance programs to smallholders, implementation of international support programs for tree domestication and improvement, development of regional economies that demand a large amount of wood imports, and improvement of infrastructure (Midgley *et al.* 2017, Sandewall *et al.* 2010). Many land areas that were once marginal cropland or degraded natural forests transitioned to smallholder plantation forestry (Tan 2006). However, some studies have indicated that economic benefits have not extended fully to the poorest and most marginalized (Clement and Amezaga 2013, Sikor and Baggio 2014, Sunderlin 2006, Thulstrup 2014).

The SFEs that remained went through a process of restructuring and budget reduction leading to layoffs of workers (Artemiev 2003); however, the SFEs still employ large numbers of workers per hectare compared to timber investment operations in other parts of the world (World Bank 2016, Cubbage *et al.* 2015a). There have been proposals to reallocate part or all of the remaining SFE holdings to smallholders or public-private joint ventures (Artemiev 2003, World Bank 2016).

Plantation forestry

Starting in the 1980s and 1990s, programs in Vietnam led to genetic improvement of plantation trees, including seed-source trials, traditional breeding, hybrid breeding, and clonal propagation (Bartlett 2016, Harwood *et al.* 2015). The primary plantation genera in Vietnam, commonly grown in single-species stands, are *Acacia* and *Eucalyptus* (Harwood and Nambiar 2014b). The most widely used species are seed-propagated *A. mangium*, clonally-propagated *A. mangium* x *A. auriculiformis* hybrid (*Acacia* hybrid), and *E. urophylla*.

Growth rates of *Acacia* spp. vary widely in Vietnam from 6 to over 30 m^3/ha/yr, depending on genetic stock, site conditions, and management (Harwood and Nambiar 2014b, Nambiar *et al.* 2015). Among site conditions, depth of soil, position on slope, and climate have been cited as important factors (Harwood *et al.* 2017, Hung *et al.* 2016, Nambiar *et al.* 2015, Sam and Bình 2001). Management factors affecting growth rates include planting density, site preparation, erosion control, and nutrient management[1] (Harwood and Nambiar 2014b, Harwood *et al.* 2017, Nambiar and Harwood 2014, Nambiar *et al.* 2015). With effective soil conservation, growth rates can be maintained or improved over successive rotations (Nambiar and Harwood 2014, Harwood and Nambiar 2014a).

Numerous additional factors can alter management, yields, and profitability. Natural factors such as typhoons, flooding, fires, pests, and disease can reduce growth, damage wood, or cause tree mortality (Harwood *et al.* 2017, Nambiar

[1] Harwood *et al*. (2017) and Huong *et al.* (2015) found that small doses of phosphorous fertilization on former abandoned land can increase Acacia growth at young ages particularly in the first rotations; whereas larger doses of P or application of nitrogen or potassium fertilizers have small or no impact. Soil conservation measures such as limiting soil disturbance and retaining litterfall and harvest debris on site had more substantial benefits.

et al. 2015, World Bank 2016). These risk factors can lead producers to alter their management regimes. For example, producers may plant at very high densities and harvest quickly in order to reduce risk. Furthermore, factors related to accessibility such as slope, roads, etc., can affect harvesting and transportation costs, potentially changing land use and management (Freitas *et al.* 2010). Finally, factors related to the individual household or entity managing the plantation, such as constraints on capital, labour, or land, can alter management (Mercer *et al.* 2014).

Forest Sector Development Project (FSDP)

In this historical, social, and sector context, Vietnam prioritized increasing allocation of land for plantation forest to smallholders (World Bank 2010), and implemented a Forest Sector Development Project (FSDP) (World Bank 2004). Approximately 44 000 households participated from 6 provinces (Binh Dinh, Quang Ngai, Quang Nam, Thua Thien Hue, Nghe An, and Ha Tinh) in the South Central Coast and North Central Coast regions. Enrolled households received financial, technical, and material assistance to support establishment of about 77 000 hectares of smallholder plantation forests (World Bank 2015).

FSDP financial assistance included low-interest loans of about US$ 1 000 for site preparation and planting (World Bank 2015). Technical assistance included legal support to facilitate the Red Book applications; help in land-use and management planning; guidance in site preparation, planting, and tending trees; establishment of harvest and transport services; provision of market information; and training for alternative livelihoods activities (World Bank 2015). The project provided material assistance in the form of genetically-improved seedlings and improvements in road infrastructure in some communities (World Bank 2015).

354 FSDP households joined a sustainable forest management (SFM) certification pilot program resulting in Forest Stewardship Council (FSC) certification of more than 850 hectares. The FSDP assisted in establishing smallholder "forest farmer groups", and covered the costs of start-up and annual audits (World Bank 2015).

Markets and Certification

Domestic markets and trade

Smallholder plantation managers manage small parcels of a fraction of a hectare up to a few hectares at a time. When trees reach merchantable size, smallholders may approach or be approached by a buyer that manages harvesting, aggregation, consolidation, and sorting of wood for sale to mills. Wood buyers sometimes offer prices perceived to be low by external observers, but they also take on significant risk as well as legal, logistical, and transaction costs (Midgley *et al.* 2017). The majority (84%) of Vietnam's *Acacia* plantations end up as woodchip, pellet, or particleboard products, with most of this destined for export. The balance (16%) is used by domestic furniture and veneer manufacturers (Midgley *et al.* 2017).

International trade

Vietnam both imports and exports significant quantities of wood and wood products[2]. In 2015 Vietnam imported US$ 4.7 billion in wood and wood products, including from China, Cambodia, and Lao PDR (World Bank 2017). A large portion of this imported wood may originate from illegal harvesting (Meyfroidt and Lambin 2009). Wood imports are primarily raw materials and semi-finished materials and flow towards industries such as furniture manufacturers. In 2015, Vietnam exported wood and wood products accounting for US$ 8.2 billion, representing about 5% of total export revenues. This wood and wood product export value was dominated by finished manufactured products such as furniture to countries in North America, Europe, and East Asia. A potential Voluntary Partnership Agreement (VPA)[3] with the European Union (EU) provides a future opportunity to increase these exports; however, the regulatory burden and documentation requirements may be difficult for smallholders to fulfil (Smith *et al.* 2017). Exports of wood raw material such as chipwood and roundwood were also substantial, totalling US$ 1.4 billion, primarily to China, Japan, and South Korea (World Bank 2017).

Certification of sustainable forest management

Since SFM certification began with the FSC in 1993, it has been adopted mostly by large-scale forest ownerships, because of large fixed overhead costs. According to Cubbage *et al.* (2009), median costs for certification audits and fees in the Americas were US$ 6.45–$39.31/ha/yr for small ownerships (< 4 000 ha), but only US$ 0.07–$0.49/ha/yr for large ownerships (> 400 000 ha). Larger wood producers have managed to leverage certification into access to markets in countries that require proof of sustainability and/or legality or through retailers seeking to market sustainable products (Putzel *et al.* 2012). Group certification of small holdings is an option, but worldwide results have been mixed (Klooster 2005, Midgley *et al.* 2017).

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[2] Data presented in this section on wood and wood product imports and exports are from the World Integrated Trade Solution (World Bank 2017), based on data reported by member countries to the United Nations Comtrade Database. The World Trade Organization's Multilateral Trade Negotiation (MTN) classification system was used to obtain import/export data for 2015 on Wood, pulp, paper and furniture, raw materials (0101), Wood, pulp, paper and furniture, semi-finished manufactures (0102), and Wood, pulp, paper and furniture, finished manufactures (0103).

[3] A VPA between the EU and a participating timber-exporting country is a "legally-binding trade agreement" aimed at ensuring legality of timber products (EU FLEGT Facility 2017). At the time of writing, the VPA with Vietnam had been agreed in principle but not yet signed or ratified (EU FLEGT Facility 2017).

Certification of small holdings in Vietnam include efforts supported by the World Wide Fund for Nature (WWF)[4] and the FSDP. Results so far have been relatively positive, showing potential price premiums for wood destined for export, higher percentage of wood sold for sawlogs, and improved administration and management (Auer 2012, Hoang *et al.* 2015a, Hoang *et al.* 2015b, WTO Center 2014). If and when supply of certified wood in Vietnam increases to meet demand, prices may fall back to a lower equilibrium price. However, premiums may persist if the EU VPAs with Vietnam and neighbouring countries are effective in stemming illegal logging in the region, if certification demand increases, or if native wood inventories decrease after years of overcutting. Certification disadvantages are significant up-front administrative and transaction costs, longer rotation lengths, and a high level of complexity (Auer 2012, Hoang *et al.* 2015a, Hoang *et al.* 2015b, Midgley *et al.* 2017). The costs of certification have been borne in large part by development funding and international donors, which may not continue in the long term (Auer 2012).

Financial and Economic Analysis

A few past refereed studies have assessed financial viability of smallholder plantations under hypothetical management regimes. Salek and Sloup (2012) found that long-rotation mixed-species plantations incorporating native trees can be profitable, and Maraseni *et al.* (2017) found that long-rotation *Acacia* plantations focused on producing more sawlogs can be profitable at discount rates up to 12%. In reality, most of the existing smallholder plantations in Vietnam are single-species and short-rotation. Studies of hypothetical management regimes, while important in understanding opportunities for future improvement, may not fully take into account the degree to which smallholder management is affected by their cash constraints, perceived risks of wind damage, land tenure insecurity, understanding of markets and policies, etc. In contrast, this research evaluates typical management regimes.

Hoang *et al.* (2015b) compared FSC and non-FSC certified *Acacia* plantations, and found that the two management approaches have similar plantation management costs, whereas FSC plantations achieve price premiums, making them more profitable. However, this does not account for certification auditing and registration fees, and logistical coordination among smallholders, which were subsidized by an external donor. Even with these subsidies, Hoang *et al.* (2015b) found that some smallholders left the FSC group, primarily because they needed to cut the trees on a shorter rotation than that prescribed by FSC due to household financial needs, and also because of the complex paperwork, doubts about the existence of price premiums, and risk of typhoons or fire.

More broadly, Cubbage *et al.* (2014) compared plantation financial returns from various countries without land costs. Most plantations, which included those in specific countries in tropical, subtropical, and temperate areas of North and South America, Asia, and Oceania, used exotic species, primarily *Pinus* spp. and *Eucalyptus* spp. Profits for exotic plantations in South America and parts of Asia were substantial. In 2011, returns for *Eucalyptus* species generally had internal rates of return (IRRs) of 14% or more. The IRRs for *Pinus* spp. in South America were slightly less, ranging from 8% to 12%, except for Brazil, where they were 19% to 23%. IRRs ranged from 5% to 12% for plantations of coniferous or deciduous species in China, South Africa, New Zealand, Australia, Mexico, and the United States.

METHODS

Data

Smallholder plantations

The Ministry of Agriculture and Rural Development (2014) of Vietnam collected data on smallholder plantations within the FSDP through a survey, with the goal of developing growth and yield estimates for the highly variable site conditions and management regimes employed in smallholder plantations across the FSDP. The study was conducted in November 2014 by a team of consultants employed by the FSDP with the participation of 350 households randomly selected from each of the 6 FSDP provinces (Ministry of Agriculture and Rural Development 2014). The consultant team first interviewed farmers about market prices, costs, product mix, and other relevant factors, then established 220 sample plots (10m x 10m plots) in representative plantation locations for measurement of tree height, diameter and density. These data were used to estimate standing stock of typical plantations at the ages of 4–7, at Site Classes I (excellent) – IV (poor), for *Acacia* hybrid, *Acacia mangium*, and *Eucalyptus urophylla* (Dalmacio 2012, Kim Hoang Company Ltd. 2011, Ministry of Agriculture and Rural Development 2014). Interviews by the authors of smallholders, wood traders, farmer forest groups, government technicians, and local foresters validated typical yields, price and cost information, and management regimes.

Although Ministry of Agriculture and Rural Development (2014) and related reports (e.g., Dalmacio 2012, Kim Hoang Company Ltd. 2011) documented mean annual increments (MAIs) for smallholders up to and even above 40 m^3/ha/yr on the best soils, such high yields have rarely been documented in refereed literature.[5] The refereed literature, on the other hand, has not provided comprehensive growth and yield estimates for smallholders in Vietnam by site class and rotation age. Therefore, the Ministry of Agriculture and Rural Development (2014) estimates were utilized, but assumed yields on Class I (excellent) and II (good) soils were adjusted

[4] The WWF program in 2013 included 334 smallholder households with 862 ha of plantations (Hoang *et al.* 2015a).

[5] Relevant refereed literature reporting growth and yield by smallholders of plantation species, particularly *Acacia* spp., includes Beadle *et al.* (2013); Dong *et al.* (2014); Harwood *et al.* (2017); Hung *et al.* (2016); Huong *et al.* (2015); Kha *et al.* (2012); Schnell *et al.* (2012).

downward by 20% and 10% respectively, to be conservative and bring it more in line with refereed literature.

State Forest Enterprise plantations

Data for SFE plantation rotations, management practices, growth and yield, wood prices, planting and management costs, employment, and administration costs were collected through interviews with SFE stakeholders in 2015. The project team interviewed management teams at two SFEs with lands in the Central Coast region near Da Nang and Hue, as well as one SFE with lands distributed throughout much of Vietnam. The data were obtained by completing a plantation investment spreadsheet in person with representatives of the project team and the SFEs. Data were entered into a spreadsheet and discussed among the team and SFE representatives, and then financial returns were estimated in real time, and adjusted subsequently if some input costs were unknown or needed adjustment. Questions in the interviews were written and highlighted on the spreadsheet, and the team members checked back with the SFE managers to clarify them if needed. A kick-off meeting and a wrap-up meeting were also arranged at the beginning and the end of the project mission for information sharing purposes. Feedback from participants of the two meetings was a valuable source of information and data as well.

Analysis

Financial analyses

The approximate exchange rate in 2015 of 1 US$ = 21 600 Vietnamese Dong (VND) was used. Typical costs for materials and labour were compiled and included for establishment and management at their 2015 market prices. Much of the required labour for smallholder plantations may be unpaid and provided by household members or neighbours in an exchange ("I help you with your plantation; you help me with mine."). This labour was included by sub-activity and valued at about US$ 6 (130 000 VND) /day, an approximate market wage rate for rural, unskilled labour in 2015.[6] SFE labour costs were included by major aggregated plantation activities.

The cost of obtaining Red Book certificates – about US$ 33/ha – was not included in the analysis. Since the Red Book administrative cost was a one-time, beginning of period cost, including it would simply reduce capital budgeting indicators described below by that amount. Similarly, the one-time cost of establishing tree farmer groups was not included. The cost of other technical assistance and support to smallholders (including support for FSC certification) in the FSDP was included in these stand/household-level financial analyses, by dividing the total project expenses for technical assistance over the number of hectares involved in the project. This equalled US$ 76 (1 650 000 VND) /ha once per rotation for a management plan, and other technical assistance was valued at US$ 19 (407 000 VND) /ha/yr, and FSC costs of US$ 128 (2 775 000 VND) /ha/yr.

Revenues were assumed from sale of wood only. Average 2015 stumpage values of US$ 41.40/m^3 for roundwood sold for chips (< 15 cm diameter) and US$ 54.70/m^3 for sawlogs (> 15 cm) were used. FSC-certified wood also had an intermediate class of wood sold as small sawlogs (10–15 cm) for US$ 45.10/m^3.

The capital budgeting indicators net present value (NPV), land expectation value (LEV), and IRR were calculated (Cubbage *et al.* 2015b). NPV and LEV are appropriate indicators of financial optimality when land is the most constrained input. IRR is an appropriate indicator of optimality when cash or time is the most constrained input (Mercer *et al.* 2014).

Once the financial returns were calculated, weighted averages of returns for FSDP smallholder plantations were calculated in order to find a single average value for each case for simple comparison. The weights were estimates of the proportion of smallholder plantation land area in the FSDP under each of the various scenario conditions – proportions by species, soil class, and rotation age (Ministry of Agriculture and Rural Development 2014) (tables 1 and 2).

Stylized cash-flow tables

For both the smallholders and SFEs, cash-flow tables describing typical situations were created. These tables show income and expenses and are stylized in the sense that they are representative of groups of sites and land managers, rather than exact values for specific individual landholdings. This allowed for comparison of smallholders to SFEs, and to better understand the differences, opportunities, and challenges for each. In order to benchmark Vietnam's financial returns, the stylized cash-flow scenarios from forest planation financial returns were compared to those from other countries, in Cubbage *et al.* (2014). The Cubbage *et al.* (2014) benchmarks are based on "typical or representative stands". Therefore, for smallholders, the most common species (*Acacia* hybrid), site conditions (midpoint between Class II and III soils), and management regime (5 yr rotation) were selected. The SFE stylized budget was based on typical rotation, management practices, costs, wood prices, and yields, which the managers concurred were the standard for their forests.

Smallholder cases

The nature of the smallholder data allowed much more detailed analysis of smallholders, including a few "cases", each of which contained numerous "scenarios". "Cases", as the term is uses here, are sets of financial assumptions such as output prices or cost levels. Analysing cases allows us to evaluate the impacts of various programs, policies, and market conditions on smallholder finances. Four cases, as

[6] This approximate informal (non-contract) wage rate was based on the official minimum wage rate in rural areas, which translates to roughly 100 000 VND/day in 2015 (Socialist Republic of Vietnam 2014). Data from Thanh *et al.* (2017) suggest that, while some informal workers earn less than minimum wage, and other earn more than 1.5 times minimum wage, the mode of informal worker earnings is around 130 000 VND/day.

TABLE 1 *Estimated distribution of the 76,571 hectares of FSDP smallholder plantation area by tree species, and distribution of species by soil class. Source: Ministry of Agriculture and Rural Development (2014)*

Species	Acacia hybrid	A. mangium	E. urophylla
Percent of Total Area	65%	20%	15%
	Percent of species in each soil class		
Class I	10%	20%	0%
Class II	45%	40%	40%
Class III	40%	35%	60%
Class IV	5%	5%	0%

TABLE 2 *Estimated percent of the 76,571 hectares of FSDP smallholder plantation area by rotation length. Source: Ministry of Agriculture and Rural Development (2014)*

Rotation length	4 years	5 years	6 years	7 years
Percent of area	10%	60%	20%	10%

described below, were analysed: a "base" case, "project financing and assistance" case, "FSC-certified" case, and "FSC, no price premium" case. "Scenarios" are different sets of environmental and management assumptions. This included plantation species (*A. mangium*, *Acacia* hybrid, *E. urophylla*); soil class (Classes I [excellent] – IV [poor]); and rotation age (four to seven years).

The "base" case assumed smallholder plantations with good management and land tenure security, but no SFM certification or loans. It assumed that smallholders pay for the cost of technical assistance support. This is a view of what smallholders could expect without the FSDP project, under the assumptions that they already have Red Book certificates and that they could and would simply pay for the technical support that the project provided.

The second smallholder case was the "project financing and assistance" case. It assumed that (non-FSC) smallholders received low-interest loans for forest establishment and subsidized technical assistance including forest management plans, the usual practice in the FSDP. The loan interest rate was 7.8%.[7]

The third smallholder case was the "FSC-certified" case. FSC participants were assumed to have higher costs in order to obtain SFM certification, but also small sawlog differentiation (diameters >10 cm but < 15 cm) and 20% price premiums for sawlogs and small sawlogs. Smallholders who participated in the FSC group certification pilot through the FSDP had the administrative costs of certification paid for them; however, those costs of about US$ 128/ha/yr were allocated to individual households, for comparison to the base case. FSC-certified households were assumed to have 10% higher labour costs associated with more intensive establishment and management regimes. In 2015, interviews with various stakeholders indicated that certified wood was currently earning a 20% price premium over uncertified wood on the market; this approximate level of premium is also reported by Hoang *et al.* (2015a). Also, FSC-certified smallholders utilized management regimes with longer plantation rotations – six to seven years, rather than four to seven years among non-certified smallholders.

The fourth smallholder case was the "FSC, no price premium" case. Current premiums could decrease if FSC-certified forests are expanded and meet the demand for certified wood. Therefore, it was assumed that FSC-certified wood received no price premium above the market price for uncertified similar wood.

Sensitivity analysis

The sensitivity of the weighted average LEVs from each of the four cases presented above were tested to changes in two variables. First, the discount rate was varied from 8%, to 4% and 16%. Selecting a discount rate for an analysis such as this is relatively arbitrary since it is recognized as a preference that can vary from individual to individual and firm to firm. Second, the wood prices were reduced by 25% compared to 2015 prices to test the effects of lower market prices on profitability.

RESULTS

Stylized Cash-Flow Tables

Examples in the form of stylized financial spreadsheets are given in tables 3 (smallholder) and 4 (SFE). These were just two out of numerous potential scenarios based on soils,

[7] The loan interest rate was determined based on factors such as the interest rate due on project financing to the World Bank, and transactions costs for implementing the program through the Vietnam Bank for Social Policy.

TABLE 3 *Stylized cash-flow table for Vietnamese smallholder* Acacia mangium x A. auriculiformis *hybrid plantation, five-year rotation, on Class II/III (average) soils. 8% real discount rate, 2015 US$. Parentheses indicate negative currency values*

	Year					
	0	**1**	**2**	**3**	**4**	**5**
			US$ /ha			
COSTS (services, materials, and labour)						
Management Plan	76					
Technical Assistance	19	19	19	19	19	
Stand management*	66	66	66	66	66	
Site Preparation	120					
Planting	285	21				
Fertilizer	338	26				
Cleaning/Weeding	181	181	120			
REVENUES						
Sale of chipwood (126 m^3 @ US$ 41.40/m^3)						4 342
DISCOUNTED CASH FLOW	(1 085)	(290)	(176)	(68)	(63)	2 955
Net Present Value (NPV)	US$ 1 274/ha					
Land Expectation Value (LEV)	US$ 3 989/ha					
Internal Rate of Return (IRR)	22.7%					

* Includes stand-level management activities associated with fire protection and prevention, trail/road maintenance, and other administration/supervision tasks.

TABLE 4 *Stylized cash-flow table for Vietnamese state forest enterprises* Acacia mangium x A. auriculiformis *hybrid plantation, seven-year rotation. Base case, 8% real discount rate, 2015 US$. Parentheses indicate negative currency values*

	Year							
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**
COSTS (material and labor)				*US$/ha*				
Management Plan								
Technical Assistance								
Stand management*	30	30	30	30	30	30	30	
Site Preparation	610							
Planting	575							
Fertilizer								
Cleaning/Weeding		300	300					
REVENUES								
Sale of chipwood (77.0 m^3 @ US$ 41.40/m^3)								3 188
DISCOUNTED CASH FLOW	(1 215)	(306)	(283)	(24)	(22)	(20)	(19)	1 860
Net Present Value (NPV)	US$(29)/ha							
Land Expectation Value (LEV)	US$(69)/ha							
Internal Rate of Return (IRR)	7.7%							

* Includes stand-level management activities associated with fire protection and prevention, trail/road maintenance, and other administration/supervision tasks. Does not include other enterprise-level overhead costs.

TABLE 5 *Comparison of returns for* Acacia mangium *x* A. auriculiformis *hybrid in Vietnam to select other countries around the world. 8% discount rate, 2015 US$. For the United States, "smallholder" and "corporate" refer to low-intensity and high-intensity forest platnations, respectively. Source: Vietnam from authors; other countries from Cubbage* et al. *(2014)*

Country	Species	Site prep cost (US$/ha)	Planting cost (US$/ha)	MAI (m^3/ha/yr)	Rotation length (years)	NPV (US$/ha)	LEV (US$/ha)	IRR (%)
Vietnam (smallholder)	***Acacia* hybrid**	**120**	**670**	**21**	**5**	**1 274**	**3 989**	**22.7**
Vietnam (SFE)	***Acacia* hybrid**	**610**	**575**	**11**	**7**	**–29**	**–69**	**7.7**
Brazil	*E. grandis*	170	330	30	16	7 712	10 891	27.9
Chile	*P. radiata*	340	230	30	22	1 764	2 161	14.7
China	*Eucalyptus* spp.	608	260	30	7	6 723	16 142	33.6
Ecuador	*O. pyramidale*	384	677	40	5	303	949	10.8
New Zealand	*P. radiata*	356	490	24	28	–21	–23	8.0
United States (smallholder)	*P. taeda*	803	332	10	25	–650	–761	5.3
United States (corporate)	*P. taeda*	803	332	13	25	–720	–843	5.4
Uruguay	*E. globulus*	300	350	22	9	1 281	2 563	17.9
Venezuela	*E. urophylla*	156	2 066	25	7	560	1 343	10.4

species, and age class; however, they are typical and similar to many smallholder or SFE sites. In these particular scenarios, the smallholder generated an LEV of approximately US$ 4 000/ha (at 8% discount rate) and IRR of 23%, while the SFE generated approximately US$(70)/ha and 8%.[8] These tables show an example of the general difference in costs and revenue levels between smallholders and SFEs. Smallholders had slightly lower establishment costs, with the significant investment in fertilizer being balanced by lower site preparation and weeding costs. SFEs may undertake significant tilling for site preparation and weed control, which was discouraged for smallholders. Smallholders also had higher per hectare annual management costs, which included labour involved with fire protection and prevention, trail/road maintenance, and other administrative/supervision tasks. However, the typical growth and yield of smallholders was significantly higher than for SFEs, culminating in a larger harvest and shorter rotation length. This may be due to factors related to both site quality and management, as discussed in more detail below.

The costs and returns for *Acacia* spp. plantations from the stylized cash-flow tables were compared to international forestry returns benchmarks given in Cubbage *et al.* (2014) (table 5). Returns for smallholders in Vietnam were competitive internationally, and had LEVs and IRRs in the upper half of the countries compared. Returns for SFEs in Vietnam were among the examples with lowest returns; however, they were still comparable to returns in countries that have vibrant forestry sectors such as the United States and New Zealand. Still, because of natural and institutional factors, Vietnam likely would be considered a more risky investment. Rotation ages for plantations in other countries ranged from 5–40 years, although only rarely as short as the 4–7 years that were common in Vietnam. Most plantations in the selected countries had rotation ages in the range of 10–25 years.

Cubbage *et al.* (2014) included financial estimates for "low-intensity" and "high-intensity" forest plantations in the United States, which roughly correspond to smallholder and corporate forest plantations, respectively. They found little difference in returns for smallholders and corporations in the United States, unlike this research's findings for Vietnam, and returns in both landowner categories were lower than for smallholders and SFEs in Vietnam.

Smallholder Cases

The estimated MAIs and percent of chipwood, small sawlogs, and sawlogs for *Acacia* hybrid scenarios based on the smallholder data collection and subsequent adjustment are shown in table 6 (*A. mangium* and *E. urophylla* tables not shown). The estimates by scenario for the "base" case are given in table 7. The estimates by scenario for the other cases are given in appendix tables A1–A3, respectively.

In the base case (table 7), there are several trends apparent about how the environmental and management scenarios affect returns. First, it is obvious that better soils generate better returns for all species and rotation lengths. Second, *Acacia* spp. seem to have higher returns than *Eucalyptus* spp., at least for the range of scenarios considered here, and the *Acacia* hybrid generally has slightly higher returns than *A. mangium*. There may be other specific instances, not described by the scenarios used here, where *Eucalyptus* or

[8] Throughout this document, parentheses around dollar values are used to indicate negative values (i.e., losses).

TABLE 6 *Assumed smallholder plantation mean annual increment (m^3/ha/year), and (in parentheses) percent of harvest for chipwood, small sawlogs, and sawlogs, of* Acacia *hybrid for varying soil class and rotation length. Chipwood is < 10 cm in diameter; small sawlogs are 10-15 cm diameter; sawlogs are > 15 cm diameter. Small sawlogs applicable for FSC-certified cases only; otherwise that class is combined with chipwood*

Soil Class	Rotation Age (years)			
	4	5	6	7
I	27.0 (100 / 0 / 0)	28.8 (100 / 0 / 0)	30.5 (40 / 40 / 20)	28.6 (20 / 40 / 40)
II	22.5 (100 / 0 / 0)	25.2 (100 / 0 / 0)	27.2 (40 / 40 / 20)	26.7 (20 / 40 / 40)
III	17.2 (100 / 0 / 0)	16.8 (100 / 0 / 0)	22.7 (50 / 40 / 10)	21.6 (30 / 40 / 30)
IV	10.8 (100 / 0 / 0)	14.2 (100 / 0 / 0)	14.3 (50 / 40 / 10)	14.0 (30 / 40 / 30)

TABLE 7 *Financial indicators for the base case, including land expectations values (LEVs, 8% discount rate, 2015 US$/ha) and internal rates of return (IRRs), according to various smallholder plantation management and environmental scenarios. Parentheses indicate negative currency values*

	Soil Class	LEV Rotation length				IRR Rotation length			
		4	5	6	7	4	5	6	7
		---------- *US$/ha* ----------				---------- % ----------			
Acacia hybrid	I	6282	7 430	9 047	8 793	31.9	31.6	32.0	29.1
	II	4 248	5 835	7 563	7 944	25.4	27.8	29.3	27.8
	III	1 789	2 143	5 217	5 322	16.2	16.7	24.3	23.0
	IV	(1 149)	996	1 528	1 942	1.7	12.4	13.9	14.8
Acacia mangium	I	5 695	8 092	8 895	8 370	30.1	33.1	31.7	28.5
	II	3 865	5 917	7 233	7 232	24.1	28.0	28.6	26.6
	III	1 667	3 679	4 930	4 957	15.7	21.8	23.6	22.3
	IV	(1220)	803	1 237	1 595	1.3	11.6	12.9	13.7
Eucalyptus urophylla	II	834	2 846	4 710	5 741	12.0	19.2	23.1	23.8
	III	(223)	1 614	3 019	3 945	6.9	14.8	18.6	20.0

A. mangium might be preferred, but this explains why the plantation area by species in table 2 leans heavily towards *Acacia* hybrid. Third, in this base case, a rotation age of 6–7 years seems to maximize LEV for *Acacia* spp. at this 8% discount rate, while a rotation age of 4–6 years maximizes IRR in most cases. The fact that smallholders are more likely to harvest at 4–5 years instead of 6–7 years may therefore be indicative of the fact that they have discount rates higher than those used in this analysis (8%), perhaps driven by risk factors or cash constraints.

When project financing and assistance were included ("project financing and assistance" case; table A1 [appendix]), smallholders had lower net costs in the first year, but higher net costs in the remaining years of the rotation, as they paid interest on their loans in interim years and finally paid the loan in full at the end of the rotation. Some of the increased costs in later years were balanced by reduced technical assistance cost, which was free under FSDP. Since the interest rate of the loan (7.8%) was very close to the discount rate used in this analysis (8%), the LEV results are similar to the base case results. Sensitivity analysis (see below) on the discount rate alters this result. However, IRRs are different between the project financing and base cases. The loans tend to make the poor investments (poor soils) even poorer in terms of IRR, and the good investments (good soils) better. When the loans and technical assistance are included, they actually have the effect of making the highest IRRs come at earlier years in some scenarios. For smallholders with extremely high discount rates, this could drive early harvest.

Certification of smallholder plantations for SFM through the FSC brought financial costs as well as benefits (table A2 [appendix]). These price premiums and product differentiation led to wood revenues that were approximately 10–30% higher in the FSC-certification case than in the base case.

TABLE 8 *Weighted average financial indicators for each smallholder financial/economic case, including land expectations values (LEVs, 8% discount rate, 2015 US$/ha) and internal rates of return (IRRs). Weights for management and environmental scenarios for each financial/economic case are given in tables 1 and 2*

Case*	Key assumptions	LEV	IRR
		US$/ha	*%*
Base	No product differentiation, no loan; technical assistance paid for at cost	4 612	23.1
Project financing and assistance	Loan and free technical assistance	5 122	40.2
FSC-certified	Product differentiation, longer average rotations, price premium, additional cost	5 780	22.2
FSC, no price premium	No price premium	4 339	19.3

* It is important to note that the two "FSC" cases include only 6- and 7-year rotations, whereas the remaining three cases include 4-7 year rotations.

TABLE 9 *Sensitivity analysis of the effect of changes to the discount rate (4%, 8%, 16%) and wood price (2015 prices and 25% lower) on the weighted average smallholder LEVs (2015 US$/ha) for each financial/economic case. Highlighted column shows the assumptions used in previous tables*

Discount rate	4%	8%	16%	4%	8%	16%
Wood price	**2015 prices**	**2015 prices**	**2015 prices**	**25% Lower**	**25% Lower**	**25% Lower**
	---------- *Land Expectation Value, LEV (US$/ha)* ----------					
Base	11 848	4 612	1 087	6 482	2 153	54
Project financing and assistance	11 873	5 122	1 840	6 507	2 663	807
FSC-certified	15 892	5 780	1 118	9 021	2 820	16
FSC, no price premium	12 542	4 339	583	6 509	1 739	(385)

This, combined with longer rotations, was more profitable than the base case, at the assumed 8% discount rate. The LEVs under the FSC-certified case were higher, and the IRRs similar to the base case. If certification costs had been assumed to be paid by an external donor, the FSC case would have even higher returns for smallholders.

The fourth case analysed was the "FSC, no price premium" case (table A3 [appendix]). This case assumes the same level of costs as the "FSC-certified" case, but no price premium for certified wood, so the returns in "FSC, no price premium" case were always less than the "FSC-certified" case. Compared to the "base" case, the "FSC, no price premium" case tended to have somewhat lower financial returns, because the costs of FSC are not counterbalanced by enough small sawlog differentiation, without price premiums. If smallholders could achieve the small sawlog differentiation without the need for FSC certification, that would be the best outcome in the absence of price premiums.

The weighted averages of the cases are given in table 8. It is important to note that the two "FSC" cases include only 6- and 7-year rotations, whereas the remaining three cases include 4–7 year rotations. In general, under the assumption of FSC with price premiums, certification pays off well for the smallholders, even with administrative costs and increased labour costs. The average LEV for FSC certification was about 25% higher than the base case at 8% discount rate, and the IRR was about the same.

Sensitivity Analysis

Weighted average LEVs were compared for each case using the standard assumptions for the discount rate and wood price variables (8%; 2015 prices) to alterative assumptions where those were varied (4% and 16%; 25% lower wood prices) (table 9). With standard 2015 prices, altering the discount rate had the expected effect – lower discount rates generated higher LEVs. Still, even at a 16% discount rate (2015 prices), smallholders had positive LEVs on average. This is important since smallholders may have high discount rates. On some poorer soils (e.g., class III and IV), LEVs were negative in some cases (tables 7; A1–A3 [appendix]), and this is more pronounced when the discount rate is higher (full tables not reproduced). The FSC-certified case was affected more strongly by discount rate, because those smallholders had longer rotation ages of 6–7 years, rather than 4–7 years for the other cases. When considering high discount rates and no price premiums, the base case was more profitable than FSC; this is consistent with Hoang *et al.* (2015b) who found that smallholders who left FSC certification indicated both a need for urgent cash and an expectation that price premiums would not materialize.

Perhaps more interesting was the comparison of 2015 wood prices to 25% lower prices. Even with these lower prices, smallholder plantation forestry on average still had quite strong returns, including positive average LEVs at the

highest discount rate. This was an important result, as it indicated possible opportunities for Vietnamese smallholder plantations even if the relatively high current wood prices do not persist. The only case that had negative average returns was the FSC, no price premium case at the highest discount rate. However, the positive average does mask the diverse scenarios; poorer site classes did have negative returns.

DISCUSSION

Smallholder to SFE comparison

Smallholders typically had substantially higher rates of return than SFEs under our assumptions. In fact, the results from the SFE stylized budget was quite similar to the results for smallholders on Class IV (poor) soils, which is assumed to be the poorest 5% of smallholder land area (table 1; Ministry of Agriculture and Rural Development 2014). In one sense, given different economic constraints, it would be expected that smallholders have higher returns per hectare (NPV and LEV) than the less land-constrained SFEs. Rational operators would seek to maximize returns to their most constrained input (Mercer *et al.* 2014). Therefore, if smallholders were constrained by land (assuming, for instance, that they have access to capital through loans), they would intensify production to drive higher returns per hectare, which would be manifest in measures such as NPV and LEV.

On the other hand, SFEs could be more constrained by capital since they had debt and relied on funds from the government (World Bank 2016). In this case, SFEs would be expected to invest little per hectare. This would generate lower measures of LEV, but higher IRRs (Mercer *et al.* 2014). However, SFEs had both substantially lower LEVs and IRRs, pointing to some explanation underlying the poor returns that was different than simple constraints of profit-maximisers. Production costs were somewhat higher for SFEs, but not enough to have such a large effect. Economies of scale that may exist were not strong enough to favour SFEs. The main driving factor of the differences between smallholders and SFEs, and among different smallholder scenarios, is wood growth and yield. SFEs were found to have typical MAIs of 10–12 m^3/ha/yr, whereas smallholder plantations had typical MAIs of 20–25 m^3/ha/yr. These faster growth rates allowed the smallholders to have shorter rotations than the SFEs.

The difference in growth rates between smallholders and SFEs may be due to land quality or management. A review of refereed literature found no research that systematically and comprehensively compared the soil quality and allocation history of SFE to smallholder land. Some possible reasons for differences in land quality are hypothesized here, which could be tested in future research. The original allocation of land to SFEs in the 1950s-80s included many of the steepest, upland areas (Poffenberger and Phon 1998, Sikor 1998), whereas smallholders gravitated towards the more productive agricultural land. Eventually, much of the abandoned agricultural land was allocated to smallholders for forestry purposes (Tan 2006). While some of the least productive and environmentally sensitive SFE lands may have been transferred to Forest Management Boards, some of the better former SFE lands were reallocated to former employees and other smallholders (World Bank 2010). Also, the current SFEs reported high rates of forest land encroachment by locals on the better lands. These new smallholders would often eventually be able to obtain Red Book rights to the land they occupied as the SFEs normalised their holdings periodically (Cubbage *et al*. 2015a).

Our results from smallholders were based on data from the FSDP project, in central Vietnam. These may or may not be representative of smallholders in the region or country as a whole. If the FSDP project tended towards communities with better land or infrastructure, the returns would be overstated. However, this is not likely because the project targeted low-income and ethnic minority communities (World Bank 2015). However, within communities, households voluntarily participated in the project. This could be a source of self-selection bias among households, and is one potential weakness of this research.

In terms of management, the support package for smallholders in FSDP included technical assistance, fertilisation, and access to seedlings of improved genetics, which were available to SFEs, but not typically utilized, likely because of capital constraints. Some SFEs have had poor soil conservation practices such as removing or burning debris and ploughing frequently, leading to erosion and loss of organic material (Harwood and Nambiar 2014b, pp. 53–55). This excessive tilling of the soil might potentially occur to put the large labour force to work (Cubbage *et al.* 2015a). These erosive practices were discouraged by the FSDP for smallholders, and might not be favoured by smallholders anyway since they are quite time-consuming. It can be concluded that efforts by SFEs to improve administration, site quality, and forest productivity, such as modest fertilization[9], genetic improvement, better nursery stock, site preparation, planting, weeding, improved silviculture (form pruning, thinning), fire control, improved harvesting or insect and disease control would improve LEVs.

In addition, past work has noted that SFEs suffer from "excessive debt, dysfunctional business arrangements, unclear land rights, poor forestry practices, high overheads and unnecessarily large numbers of employees" (World Bank 2016). While the SFEs had lower costs per hectare than smallholders, their costs per unit of output were higher partially because they had very large labour forces. Cubbage *et al.* (2015a) and World Bank (2016) noted that surveyed Vietnamese SFEs had the equivalent of 200 to 500 employees per 10,000 ha, compared to a global average of 1 to 60 employees

[9] Research (Harwood *et al.* 2017; Huong *et al.* 2015) challenges the notion that large-dose fertilization improves yields significantly. If this holds true on most SFE lands, application of large amounts of fertilizer would reduce profitability. However, these results may vary depending on site class and soil conservation history.

per 10,000 ha. This may be partially explained by lower wage rates in Vietnam and lower levels of mechanization, but having too large a staff would compromise profitability. If yields were good on SFE land, they could support this level of staff; in fact, smallholders in our sample utilized the equivalent of about 1 600 full time employees per 10 000 ha. However, the low yields of the SFEs do not support the high level of staff and international experience suggests it is possible to manage forests with less.

The potential direct reasons stated above for the relatively poor returns for SFEs could be caused by interlinked underlying motivations and factors. SFEs may have been seen as sources of public benefits such as employment for local people (Sikor 1998), causing them to employ more labour than is optimal from a financial standpoint. At the same time, other funds from the government may have been limited and many SFEs had high overheads and large amounts of debt (World Bank 2016), so capital-intense inputs like fertilizer or improved seedlings were difficult for the SFEs to afford (although Acacia hybrid clones would come from the same genetic stock as smallholders). This may have been compounded by poor soils due to the allocation process.

Vietnam international competitiveness

Vietnam forest plantation investment returns for smallholders are profitable. This was helped by proximity to regional countries with high demand for wood products creating some of the best roundwood pulp/chip prices in the world. Pulpwood roundwood stumpage sold for around US$ 12 /m^3 in 2015 for much of the world such as the US South (TimberMart-South 2015), but prices in Vietnam were closer to US$ 40 /m^3. This is largely because they sell directly to countries with high demand such as China and Japan. An update of international timber investment returns in 2017 found that Asia had the highest roundwood prices in the world, driven by China, and that investment returns dropped substantially in the Americas. Thus the comparative Vietnam investment returns were even better by 2017 (Cubbage *et al.* 2017).

SFM certification also provides a comparative advantage for Vietnam (Putzel *et al.* 2012). Currently, Vietnam experiences price premiums for certified wood, which is not typical worldwide. The up-front costs for preparation and maintenance costs for annual audit, and coordination among numerous smallholders may be difficult obstacles for smallholders to surmount without direct assistance from the government or non-governmental organizations. One alternative to lessen the cost burden might be to provide the growers with low-interest loans to pay the FSC costs at the beginning and during the tree rotations, which could be paid with revenues at the end of the rotation, so that effectively the fees are paid when the smallholders are relatively flush with cash. If managed like the FSDP loans, the collateral for the loans would be a Red Book.

Forest plantations in Vietnam have several opportunities. First, growth rates are excellent on the best soils and still moderate on the poorest soils. Second, international trade is favourable with strong demand from regional countries generating relatively high prices. Third, even if the high prices for chipwood and certified wood subside, there are opportunities for strong returns with sound management. Fourth, there is room to expand wood production to serve domestic buyers, such as furniture makers, who currently depend partly on wood imports. Fifth, the country has worked with international partners over several decades and has developed national expertise in silviculture and improving technology and genetic stock. There is a relatively efficient system in place for distributing improved tree seedlings to smallholders. Finally, attitudes towards and perceptions of plantation forestry in the country and international community seem positive.

At the same time, there are several challenges and potential barriers to increased forest plantations. First, despite progress on granting Red Book land use right certificates through the FSDP, many other non-project smallholders still lack clear land tenure[10], and without that, are hesitant to invest in long-term forest plantations. Second, devolving more SFE land to smallholders or public-private joint ventures may not be as successful in generating strong positive returns, given the apparently poorer soil quality of the remaining SFEs, and the daunting prospect of laying off hundreds of SFE field labour employees. Third, the narrow range of species could pose at least a temporary threat in the future if pests and diseases invade the country. So far, pests have not posed a serious problem, and other timber species are being studied and developed for Vietnam (Nambiar *et al.* 2015). Fourth, Vietnam is very vulnerable to extreme weather events, especially typhoons. Apparently very high discount rates of smallholders may be driven in part by these risks. If so, risk-mitigation mechanisms like insurance may help smallholder find ultimately more profitable management regimes. Fifth, there is high competition for the most productive land, including for agriculture and rubber plantations in the south.

CONCLUSIONS

In summary, forest plantations in Vietnam present a good opportunity for the country. There are excellent regional and global markets for the wood that can be generated from standard technology for plantation forestry, with demonstrated success. On the one hand, prospects for expansion of these successes are promising, and returns could be improved further through soil conservation and improved genetic material. On the other hand, increased forest plantation productivity will be limited by the availability of good land given very high population densities and demand

[10] Estimates from 2009 suggested that 75% of forest land in Vietnam had been allocated, but only about 55% had received formal "Red Book" land use right certificate. This lagged behind the allocation and certification of agricultural and residential land (Joint Development Partners 2010).

for food crops. As forestry continues or is expanded to more marginal plantation forestry lands, returns will tend to decrease over time.

Vietnam is exploring the possibility of turning some or many SFEs into public-private joint ventures, which would extend the total area of quasi-private land ownership and management in large increments. While this venture could improve management of SFEs (Artemiev 2003), it could be at the cost of laying off many workers, which could be hard for many to accept.

The smallholder plantation forestry component of the country's Forest Sector Development Project appears to have been quite successful in the regions and provinces where it was implemented. This included technical assistance, improved infrastructure, assistance acquiring more secure tenure through a land use right certificate ("Red Book"), low-interest financing, access to improved genetic material, and other support. There is potential scope to institutionalize technical support and extension services and access to low interest loans for smallholders, and to up-scale this smallholder assistance model into other provinces.

If price premiums for SFM certified wood are realized and maintained – not a certainty, given experiences in other parts of the world – certification for both SFE and groups of smallholder plantation owners could help increase returns. However, price premiums are likely to decline if large areas of plantations join the ranks of certification, causing an expansion in supply. Assisting smallholders to access market information related to sawlog prices and production practices to pursue greater returns from product differentiation, would help mitigate future challenges if the chipwood price drops closer to the global average.

Vietnam relies on wood imports to support industries such as furniture-manufacturing, and also has excellent ports and access to markets in Asia and the USA, and a potential Voluntary Partnership Agreement with Europe. In addition, new pulp mills for chipwood are opening in the region, which could certainly increase prospects for uncertified and certified wood. Overall, the robust wood demand trends continue strongly favour Vietnam based on its central location and relatively good land in the populous Asia market.

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APPENDIX A. TABLES

TABLE A1 *Financial indicators for the "project-financing and assistance" case, including land expectations values (LEVs, 8% discount rate, 2015 US$) and internal rates of return (IRRs), according to various smallholder plantation management and environmental scenarios*

	Soil Class	LEV Rotation length				IRR Rotation length			
		4	5	6	7	4	5	6	7
		---------- *US$/ha* ----------				---------- % ----------			
Acacia hybrid	I	6 848	7 947	9 531	9 254	72.7	62.3	56.8	48.2
	II	4 813	6 352	8 047	8 405	58.6	55.1	52.2	46.1
	III	2 355	2 660	5 701	5 783	37.2	33.4	43.8	38.5
	IV	(583)	1 513	2 012	2 403	–1.9	24.2	25.1	24.8
Acacia mangium	I	6 261	8 608	9 379	8 831	68.9	33.1	56.3	47.1
	II	4 430	6 434	7 717	7 693	55.6	28.0	51.2	44.2
	III	2 233	4 196	5 415	5 418	35.9	21.8	42.7	37.3
	IV	(655)	1 320	1 721	2 056	–3.3	11.6	23.1	22.9
Eucalyptus urophylla	II	1 400	3 363	5 194	6 202	26.8	19.2	41.8	39.9
	III	343	2 131	3 503	4 406	13.2	14.8	33.8	33.7

TABLE A2 *Financial indicators for the "FSC-certified" case, including land expectations values (LEVs, 8% discount rate, 2015 US$) and internal rates of return (IRRs), according to various smallholder plantation management and environmental scenarios*

	Soil Class	LEV Rotation length		IRR Rotation length	
		6	7	6	7
		US$/ha		--------- % ---------	
Acacia hybrid	I	8 468	9 391	28.2	27.3
	II	7 276	6 683	26.1	23.2
	III	3 685	4 170	18.7	18.6
	IV	1 092	1 411	11.6	12.2
Acacia mangium	I	8 433	9 220	28.1	27.1
	II	6 679	6 002	25.0	22.1
	III	4 392	5 482	20.3	21.2
	IV	1 661	2 996	13.3	16.1

TABLE A3 *Financial indicators for the "FSC, no price premium" case, including land expectations values (LEVs, 8% discount rate, 2015 US$) and internal rates of return (IRRs), according to various smallholder plantation management and environmental scenarios*

	Soil Class	LEV Rotation length		IRR Rotation length	
		6	7	6	7
		US$/ha		--------- % ---------	
Acacia hybrid	I	6 805	7 223	25.2	24.1
	II	5 747	4 900	23.2	20.1
	III	2 729	2 884	16.3	15.9
	IV	385	478	9.3	9.5
Acacia mangium	I	6 774	7 077	25.1	23.9
	II	5 219	4 315	22.1	18.9
	III	3 368	4 028	17.9	18.4
	IV	900	1 861	11.0	13.4