

Article

Community Tree Nurseries in the UK: Promise, Potential and Pitfalls

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Abstract: Forest restoration and tree-planting projects initiated as a response to climate change and biodiversity loss are increasingly important around the globe. Small-scale and community-based tree nurseries have been promoted as a potential route to meeting some local or regional supply-side bottlenecks. A study in the UK used a mixed methods approach to assess the potential contribution of community tree nurseries (CTNs) to tree material supply. Semi-structured interviews (SSIs) were undertaken with 16 CTNs across the UK to generate a sector-wide characterisation of CTNs. A UK-wide online survey assessed the total number of CTNs, production methods and volumes, biosecurity practices and benefits of community involvement. Another 13 CTNs receiving support to establish and extend their operations took part in SSIs assessing their development. The results indicate that there are four broad types of CTN (Organisation- and project-based, Community-based, Enterprise and Network CTNs). A significant number of CTNs in Britain are new and establishing. The sustainability of CTNs relies in large part on grant support rather than income from tree sales. Production is almost exclusively native broadleaves and local provenances. There are policy implications concerning: i. the suitability of species being produced to future climatic and market conditions and ii. the tension around financial viability, grant dependence and CTN sustainability for those CTNs focused on social and environmental benefits rather than income generation. Identifying gaps in the provision of trees by commercial nurseries, e.g., uncommon or recalcitrant species, could be a feasible financial strategy. It is likely that financial support and skills development are likely to be required as social innovation in the community-supported tree nursery sector establishes and develops. Judging the success and impact of some types of CTNs in terms of production and finance measures may be unfair, as other social and environmental benefits may be as important and valuable. It is clear that more evaluative research is needed to quantify and better understand these kinds of outcomes and the added value they accrue.

Keywords: community tree nurseries; small-scale tree nurseries; tree seedling production; forest reproductive materials



Citation: Ambrose-Oji, B.; Pearson, M.; Cross, E.; Shallcross, J.; Polschneider, S.; Hattersley, R.; FitzGerald, O. Community Tree Nurseries in the UK: Promise, Potential and Pitfalls. *Forests* **2024**, *15*, 560. <https://doi.org/10.3390/f15030560>

Academic Editor: Carolyn E. Smyth

Received: 7 February 2024

Revised: 13 March 2024

Accepted: 15 March 2024

Published: 20 March 2024



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1. Introduction

Increasing urban, peri-urban and rural tree cover is a strategy used across the globe as a means to meet the challenges of landscape restoration, the maintenance of biodiversity, the mitigation of and adaptation to climate change impacts, net zero strategies and maintaining nature connectivity and the provision of greenspaces for human well-being [1–3]. A common approach to achieving these outcomes is through national and international public and private afforestation and reforestation programmes using tree-planting that operate at various geographical scales from a farmer’s field to city regions, watersheds and larger

landscape-level units [3–9]. This is not the only demand for forest reproductive material. Managers of existing forests and woodlands continue to demand trees for restocking after felling and planned silvicultural operations or, increasingly, in response to significant events, such as tree mortality through pests and disease outbreaks, or other disturbances such as forest fires and drought [10]. However, many countries have experienced supply-side issues as government-supported and private nurseries providing trees for the forestry and landscaping industries have struggled to meet growing demand [1,11]. The capacity of different countries to uplift tree seedling production to the volumes and qualities required within appropriate timeframes varies widely and, in some cases, is under-evidenced [11,12]. Furthermore, climate change impacts on tree seedling growth, tree establishment conditions and future resilience, along with increasing pressure from pests and diseases, means that what stock tree nurseries should be producing (e.g., species and provenance) and how they should be producing that stock (e.g., seed source and bare root/container grown) have also become the focus of some debate [13–15]. The need to move towards the production of a more diverse range of tree species, with greater attention focused on the genetics and adaptation potential of stock, has become a key issue [16]. The sustainability and biosecurity of tree production methods that rely on the movement of soil and water, as well as forest reproductive material that travels across large distances, and which are difficult to monitor or subject to hygienic best practices are also an increasing concern; see for example: [17–19].

Small-scale and community-based tree nurseries have been promoted in some regions and contexts as an important potential solution to local and regional supply-side issues [20–22]. However, some evidence suggests a more complicated and nuanced potential. Research in Africa and North America has shown that small-scale community nurseries can make important contributions whereby they serve a specific function, i.e., contributing to agricultural development interventions and large-scale public tree-planting programmes or supplying trees of conservation value rather than commercial interest [1,21,23]. Other studies evidence the many significant challenges that small-scale and community tree nurseries face, including the uncertain and often poorly developed markets for the types and numbers of trees they might be producing, the difficulties of scaling up to a size where income can cover the capital and recurrent costs of production and problems associated with access to appropriate land, infrastructure and a reliable supply of community volunteers, e.g., [20,24,25]. Besides the supply of trees, there are a myriad of claims about the other benefits community tree nurseries might be able to leverage. For example in West Africa, they have been linked to poverty alleviation [26] and building community social and cultural connections with landscape restoration [27]; in East Africa, they have been linked to maintaining traditional farming systems [28]; and in America, Australasia and Europe, they have been linked with providing a route to nature connection, local environmental action and individual and community well-being [29]. However, community tree nurseries are very variable in form and function, including small backyard nurseries and village-level community growing projects through to larger-scale enterprises working as not-for-profit or community-good businesses. There is no accepted definition of a community tree nursery and how this relates to their objectives, local environmental and economic context, community and volunteer involvement and the benefits and impacts produced. Some research disaggregates results by defining features at a high level to make some comparisons between CTN types, for example, by differing between governance/legal arrangements [22]; business models [21]; and types of outputs produced, i.e., numbers and types of trees [30]. Some differentiation has then been drawn at the regional level. For example, work across Asia characterised community tree nurseries by the type of organisation leading the endeavors and by a key purpose. This revealed a major division between community tree nurseries that were time-bound features of specific restoration projects that involved local communities compared with those that were supported by government or NGOs through finance or other resources as semi-commercial models [22]. There were significant variations in outcomes between the two included production volumes,

efficiency and quality of nursery working practices and levels of community engagement and cohesion [22]. A fully developed characterisation of CTNs and one that is applicable to the European context is lacking, however.

1.1. Tree Nurseries and Supply in the UK Context

The governments of the UK have pledged to increase tree cover as a widely agreed mechanism to help facilitate the UK reaching net-zero greenhouse gas emissions by 2050 [31]. Each nation has established its own tree planting and woodland expansion figures [32–34]. There are various challenges to meeting these targets including the availability of land and competing land use interests [35], a difficult and changing agricultural, forestry and conservation policy environment and market conditions and a need for the supply capacity in the nursery sector to expand significantly to keep pace with the required saplings, including growing a skilled workforce [36]. The production of forest nurseries in England, Scotland and Wales was estimated to be around 173 million saplings for the year 2022–2023 [37]. The requirement in England alone is estimated to be between 90–120 million trees; thus, there is a domestic supply shortfall [36]. In addition, the majority of tree nursery production is focused on the commercial forestry and woodland sector with c. 72% of production in 2022–2023 being conifers, of which close to half were Sitka spruce (*Picea sitchensis* (Bong.) Carr.) [37]. The UK forest reproductive materials and tree nursery sector are relatively complex [14], and it has faced significant challenges in recent years, including fluctuating and uncertain markets; changing terms of trade and labour supply after the UK left the European Union; market and biosecurity impacts linked with novel pests and diseases; poor rates of investment in mechanisation and sector innovation for production at scale and difficulties anticipating species demanded along the supply pipeline [14,35,37]. Relying on imports of trees and saplings to overcome some of these supply-side issues is no longer seen as a sustainable strategy for the UK because of the associated economic and biosecurity risks [19,38,39]. For example, between 1992–2019, the imports of trees into the UK increased from a value of GBP 6 million to GBP 93 million, and twenty serious plant pests or diseases were “inadvertently imported” with them [40]. Consequently, policymakers and trade associations are focusing increased attention on how best to support the capacity and growth of domestic tree nurseries.

1.2. Objectives of the Research: Evidencing the Community Tree Nursery Sector

Community tree nurseries have been suggested as another route to supplement production volumes from traditional commercial sources, in particular contributing to increased species diversity of stock and uplifting volumes of broadleaved trees. However, there is recognition that small and community tree nurseries are poorly understood and significantly underrepresented in research [37]. Even though there have been many other studies in the UK on how communities engage with woodland and forest management and what the outcomes might be [41–48], and other research looking at the development of community-based woodland enterprises [49], tree nurseries have not been investigated in any depth or any systematic way. We know of only one study looking at the potential for community tree nurseries to service supply needs in London [50].

1.3. Research Context and Specific Questions

The research described in this paper sought to fill this evidence gap and provide the first broad view of the community tree nursery landscape, which acts as a “baseline” perspective from which to draw an initial understanding of the potential of the sector to meet some of the supply side pipeline issues the forestry sector faces.

For the purposes of our study, a community tree nursery (CTN) is defined as “an enterprise, social enterprise, community-based group, charitable or public sector endeavor or network where volunteers, community groups and community members take part in growing trees, including seed/wilding collection, nursery management and sales/distribution,

and also in some cases planting out". This definition underpinned the development of our research design and methodology.

The research was undertaken for the Trees Outside Woodlands (TOW) Project led by the UK Government Department for Environment, Food and Rural Affairs (Defra), specifically the "Boosting Community Tree Nurseries" operational and evidence collection component. This workstream, referred to as the Pilot Project, was run as a developmental pilot to test how CTNs might be established and what role they could play in increasing the supply of good-quality and biosecure trees. This was carried out through the design and delivery of interventions including direct grant support to CTNs and through an evaluation of these interventions. In addition to the evaluation, the research component of the Pilot Project undertook additional empirical research to address the following specific questions:

- i. What kind of CTNs exist across the UK and what are the key differences in terms of objectives and business models?
- ii. What benefits, costs and impacts are associated with the different kinds of CTNs?
- iii. What are the key challenges to establishment and sustainability and what kinds of interventions might overcome these?

2. Materials and Methods

This research used a mixed methods approach to collect data from across the UK (England, Scotland, Wales and Northern Ireland) between August 2021 and January 2023. Three complimentary datasets, as described below (Figure 1), were built to tie together empirical scoping, validation and baselining research with the Pilot Project CTN evaluations in a way that would also address the research questions.

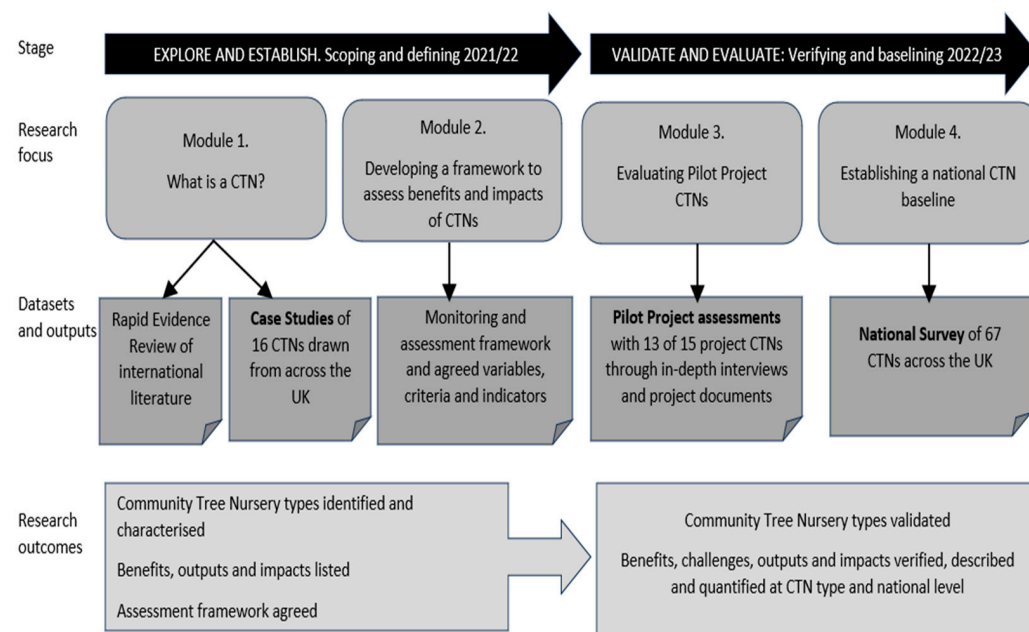


Figure 1. A schematic description of the project approach and links between datasets.

Case study research [51] was undertaken between August and October 2021 with 16 CTNs across the UK to generate a sector-wide characterisation of CTNs distinguishing differences between operating models, objectives, outputs, successes and challenges associated with the different models. A sampling frame of 49 CTNs was constructed through i. an extensive Internet search for CTNs with a web presence, including social media, and ii. By canvassing national organisations (including those involved in the Pilot Project) for information about CTNs they were aware of but without a web-presence. Case study selection was purposive according to specific criteria that would capture a range of CTN types and contexts, including age and stage of development, land tenure and type (e.g., public or

private), size of enterprise measured by number of trees produced and governance. Case studies comprised: i. an examination of publicly accessible web-based descriptions of the CTN as published on their websites or social media accounts or mentioned on blogs and in articles; ii. A series of semi-structured interviews with CTN leaders which were conducted over MS Teams (see Supplementary Material Item S1); iii. Examination of business plans and other documents passed on by the CTNs after the interviews. The semi-structured interviews lasted between 45–120 min and were digitally recorded. All interviewees provided informed consent. Recordings were transcribed professionally. Content analysis was used to examine the interview transcripts and other case study documents and code important themes and sub-themes [52]. A high degree of generality is indicated by themes and sub-themes as they indicate a common clustering around the ideas and issues of particular importance and saliency amongst research participants [53,54]. Three researchers discussed their impressions and understanding of the data to agree on the themes and interpretations of them, building intercoder consistency and the reliability of the analysis [55].

An assessment of the Impact of Pilot Project interventions was undertaken amongst 13 of all 15 CTNs participating in the project between October 2022 and January 2023. Interventions assessed included financial and other support and the establishment of a community of practice for CTNs to engage in peer-to-peer learning. Semi-structured interviews (see Supplementary Material Item S2) were used to evidence the establishment and development history of the CTN, any challenges and successes experienced and the impact, if any, of Pilot Project interventions. The questions asked were linked with a theory of change that identified qualitative and quantitative indicators of change and impact [56]. The semi-structured interviews lasted between 45–120 min and were digitally recorded. All interviewees provided informed consent. Recordings were transcribed professionally. Interview transcripts were subject to content and thematic analysis as described for the case studies.

A UK-wide survey aimed at CTNs was carried out between October and December 2022 and was administered through a web-based platform (SmartSurvey). A total of 32 questions collected information about production and biosecurity practices, use of staff and community volunteer time, the range of benefits produced and perceived barriers to establishment and sustainability (see Supplementary Material Item S3). Recruitment of CTN representatives was carried out through a web link to the survey sent out: i. by email directly to all known CTNs with publicly available contact details; ii. to organisations with connections to CTNs able to share the link with their membership and iii. through the social media accounts of the research and Pilot Project team organisations. The survey was open for 5 weeks, and all respondents were offered an incentive to complete the survey (*The Tree Grower's Guide* book). A total of 67 valid responses were collected. Excel was used to analyse the data. This was limited to simple descriptive statistics and disaggregation by key variables, including the type of CTN, size (by annual turnover and number of trees produced) and age of endeavor.

The results were discussed and deliberated with Pilot Project partners and a project steering group at four workshops throughout the course of the work to agree on the interpretation of the results from the different datasets and what implications this had for the iterative development of the Pilot Project. It also informed policymakers about possible routes to support CTNs going forward. This is a common approach in contemporary collaborative research and serves to maintain analytical transparency and robustness in research interpretation and application [57,58].

3. Results

3.1. Characteristics of the Mixed Methods Samples

Table 1 shows key characteristics of the sample from the three datasets. Overall, the sample captured a larger proportion of newly formed and still establishing CTNs. The sample is also dominated by CTNs in England.

Table 1. Characteristics of CTNs sampled in the three datasets.

Factor	Case Studies	Pilot Project CTNs Assessment	National Survey
Country			
England	12 (75.0%)	13 (100%)	53 (79.1%)
Wales	2 (12.5%)	0	6 (9.0%)
Scotland	2 (12.5%)	0	5 (7.5%)
Northern Ireland	0	0	3 (4.5%)
Total	16	13	67
Age of CTN (years)			
<1	0	0	17 (25.4%)
1–<5	6 (37.5%)	13 (100%)	36 (53.7%)
5–<10	2 (12.5%)	0	4 (6%)
10–<20	4 (25%)	0	3 (4.5%)
>20	6 (37.5%)	0	7 (10.4%)
Total	16	13	67
Production p.a. (no of trees)			
Just established	0	7 (53.8%)	19 (28.4%)
<500	4 (25%)	3 (23.1%)	22 (32.8%)
500–<2000	3 (18.8%)	2 (15.4%)	13 (19.4%)
2000–<10,000	2 (12.5%)	1 (7.7%)	6 (9.0%)
10,000–<50,000	2 (12.5%)	0	5 (7.5%)
>50,000	5 (31.3%)	0	2 (3.0%)
Total	16	13	67

3.2. A Typology of CTNs Found across the UK

Four different kinds of CTN were identified through case study research and validated by the national survey in which all respondents were able to self-identify the type of CTN they represented using the typology. CTNs are characterised by broad differences in their governance model, objectives, community engagement mechanisms, production volumes and type.

- Organization- and project-based CTNs are nurseries managed by organisations including local authorities (local government bodies), charitable or non-governmental organisations (NGOs) or partnership projects. These CTNs usually provide trees to a particular site or a specific tree-planting project associated with the lead organisation. They have paid staff that manage the nursery as well as managing the community volunteers. Volunteers help in the nursery and may also be involved in seed collection and planting seedlings. Decision-making and nursery management are undertaken and overseen by paid staff.
- Community-based CTNs are nurseries wholly managed and run by community groups and volunteers. They may or may not be supplying trees directly to local authorities or other organisations involved in tree-planting projects. The community group members and volunteers running these CTNs are rarely paid for their time.
- Enterprise CTNs are set up as commercial or social enterprises where the objective is to produce tree seedlings at scale and sell at cost or for profit. Financial sustainability is a key objective, and the nursery is run as a business, with decision-making resting with the business owner/s. Trees are generally supplied to the open market, although there may be established relationships with particular tree-planting organisations or projects. Paid staff manage the nursery and facilitate community engagement through recruiting and supporting nursery volunteers.
- Network CTNs are characterised as collectives of tree growers who are community volunteers. The individuals are based in different locations (often using their own domestic gardens) and use different techniques to produce seedlings. The growers may or may not be supplying directly to local authorities or other organisations involved

in tree-planting projects. Collective actions may be part of their way of working, e.g., to gather seeds or distribute seedlings, but they may collaborate with projects or organisations to undertake these actions for them.

Drawing on the three datasets to produce the best range estimates, Table 2 summarises the key differences between these four CTN types, illustrating the benefits, challenges and unique features associated with each. The data show that, proportionally, Organisation- or project-based and Community-based CTNs account for the majority at around two-thirds. Enterprise types and Network CTNs exist in smaller numbers. Data from the case Studies and the national survey suggest that there are around 80 (± 10) CTNs established across the UK.

A more detailed look at the different attributes associated with CTNs is described in the following sections.

3.3. Production Volumes and Species

The national survey showed that between October 2021 through March 2022, around a quarter of a million trees (239,428) were produced by CTNs across the sample, the majority of which were broadleaved species. The average annual production was 3574 trees, although this ranged by individual CTN from 0–60,000. Most CTNs were producing a small number of trees, i.e., 61% of those in the national survey produced less than 500 per annum. The CTNs with the highest production volumes were largely Organisation- and project-based CTNs and Enterprise CTNs.

Seeds collected in the local area, i.e., harvested from less than 20 km away, proved to be the most common source of production for all CTN types. The national survey showed that 34% of CTNs said that >90% of their production was sourced through locally collected seeds. About a fifth of those CTNs declared that 100% of their production relied on locally collected seed. Evidence from interviews with case studies and Pilot Project CTNs reflected this, with interviewees confirming that seed collection was the most common activity that volunteers were involved in and the main source of material for tree seedling production.

The majority of CTNs (87%) in the national survey stated that they intended to upscale production volumes by 10% or more in the next 1–5 production years. This stands in contrast with the response of case study CTNs, of whom only 25% expressed an interest in upscaling. Pilot Project CTNs had a mixed response to the idea. Whether CTNs were interested in upscaling or not, they could see opportunities to shift production towards species that were in high demand by customers but in short supply from commercial nurseries. In the national survey, 37% of the respondents recognised unmet demand for particular species. When asked if they intended to meet that demand, 67% said yes. The species identified most frequently were native broadleaves, including wild service (*Sorbus torminalis* (L.) Crantz), hawthorn (*Crataegus* spp. L.), small leaf lime (*Tilia cordata* Mill.), holly (*Ilex* spp. L.), field maple (*Acer campestre* L.) and black poplar (*Populus nigra* L.).

3.4. Income Generation and Costs

A total of 51% of CTNs in the national survey, the majority of case study CTNs and all of the Pilot Project CTNs relied on grants from a variety of funders for 100% of their income. Of those who did not rely on grants for all of their income, tree sales were the second most important income source. A small number of CTNs in the case studies also reported engaging in secondary markets (e.g., running training courses), for part of their income, but this was not the case for those answering the survey or for the Pilot Project CTNs. The Pilot Project CTNs relying 100% on grants probably reflects the fact that the majority were too recently established to be generating an income from tree sales. However, the reliance on grants is a significant feature of the sector.

Table 2. Summary of particular benefits, challenges and unique features associated with different types of community tree nurseries (CTNs) in the UK.

Type of CTN	Proportion of Sector ¹	Production Volume ²	No. of Community Volunteers ³	Benefits	Challenges	Unique Features
Organisation- and project-based	30%–40%	250–130,000	1–176	<ul style="list-style-type: none"> • Clear identity and aims to attract volunteers • Able to manage large numbers of volunteers and develop social outcomes • Leaders are professionals so are aware of quality and biosecurity standards 	<ul style="list-style-type: none"> • Time pressures on staff and volunteer body, so limited time to take part in training and peer-to-peer contact/networks of practice • Nursery may be limited to project time-frame 	<ul style="list-style-type: none"> • Good integration into large-scale and planned tree-planting projects • Able to manage challenging volunteer groups for a range of additional social benefits
Community-based	30%–40%	20–10,500	1–25	<ul style="list-style-type: none"> • Close community connections focusing on local people and local places which may have additional social benefits • Volunteers usually manage themselves, leading to upskilling • Offering trees directly to local projects and programmes with an identified need 	<ul style="list-style-type: none"> • Potential burn-out of volunteers • Succession and keeping volunteers • Volunteers may be untrained • Finding and applying for funding is a time-heavy continuous task • Availability/cost of suitable land 	<ul style="list-style-type: none"> • Able to specialise in particular species or output types • Local social and environmental benefits
Enterprise	10%–15%	1500–1,000,000	5–23	<ul style="list-style-type: none"> • Professional nursery staff • Skills and social benefits for volunteers • Potential for good biosecurity practice 	<ul style="list-style-type: none"> • Staff recruitment, training and retention • Up-scaling dependent on capital investment 	<ul style="list-style-type: none"> • Higher production volumes • Potential to up-scale production for the market • Better knowledge of the market and ability to react
Network	5%–10%	20–3000	2–220	<ul style="list-style-type: none"> • May involve many people in the community • May have no costs linked to land rents/lease 	<ul style="list-style-type: none"> • Leadership and group identity • Funding is hard to find and secure • Coordination between dispersed volunteers difficult • Biosecurity practice difficult to monitor and maintain 	<ul style="list-style-type: none"> • Local social and environmental benefits • Wide reach • Potential to reduce risks through growing on multiple sites

¹ Estimate based on sample data from the case study sampling framework and national survey responses. ² Ranges are production figures for CTNs more than 1 year old, taken from case studies and national survey data. ³ Figures are taken from the national survey and represent the number of people per calendar year 2021/2022.

The declared levels of turnover in the national survey showed that the majority of CTNs are generally small ventures since 51% were operating with GBP 5000 or less per annum, 12% were operating with between GBP 5000 and GBP 20,000, 7% were operating with between GBP 20,000 and GBP 50,000 and 6% were operating with more than GBP 50,000. Those with greater levels of turnover were largely Enterprise and Organisation- or project-based CTNs.

Asking respondents across datasets to rank their costs, they were ranked as 1. consumables (e.g., pots, soil, labels, etc.) and of equal rank 2. costs of staff and capital costs of infrastructure and equipment (e.g., irrigation, polytunnels and fencing) and rank 4. costs of land and buildings (i.e., rent/lease).

3.5. Biosecurity Practices in Nurseries

CTNs of all types demonstrated variable, generally low awareness and implementation of appropriate biosecurity practices. The national survey showed that only 10% had a biosecurity policy that staff and volunteers were made aware of. Over a third (37%) explained a more informal approach, believing that staff and volunteers built a common understanding of principles and practice through social learning. A significant 45% did not have any policy or biosecurity plan. However, when asked if they had any interest in Plant Healthy certification (a UK-wide government-supported sector-wide scheme for horticultural and other businesses managing plant material, launched in 2020 <https://planthealthy.org.uk> accessed on 1 February 2024), 43% of survey CTNs said yes, they did, 40% said maybe and just 17% said they had no interest at all. These findings were mirrored in the responses of the case study and Pilot Project CTNs. Only one of the Pilot Project CTNs had a rigorous biosecurity regime and any form of formal accreditation (1/13 or c.8%) and two of the case studies (12.5%) said that they did.

There was a common misconception amongst the CTNs that utilising locally sourced seeds and growing and selling production locally meant the risk of spreading pests and diseases was low or non-existent. This meant that the need for biosecurity training, practices or accreditation was not recognised. One Pilot Project CTN did have Plant Healthy certification, but they emphasised challenges in finding and accessing concise biosecurity information useful to them and their nursery practice. This was reflected across all three of the datasets with CTNs explaining that available biosecurity resources do not provide advice suited to their particular context and circumstances, i.e., practices that can be applied at a small scale and information easily understood and applied by volunteers and non-professional nursery managers.

3.6. Staff and Volunteers

Employment of paid staff by CTNs is not the norm. Looking at the national survey data, the average number across all types of CTNs was 1.22 full-time equivalent (FTE), but the median was just 0.2. National survey data showed that the average number of volunteers supporting each CTN was 18, with a total of 1233, participants taking part in CTN activities over the year. They contributed a total of 34,995 volunteer hours across the year, which averages at 522 h per CTN per year. This translates to 4729 total working days or 22.5 FTE workers.

The case study research and Pilot Project assessment demonstrated that the type of volunteer and motivations for volunteer engagement are wide-ranging. Volunteers include but are not limited to school children, adolescents and vulnerable adults including those with learning difficulties, some living with mental health conditions, some in the criminal justice system or managing substance abuse, along with parish members, as well as individuals and groups concerned about the environment. Volunteers tend to have few horticultural or nursery skills and are generally involved in day-to-day activities such as planting, watering and weeding and particular seasonal tasks that can be organised as events, such as seed collection. Nursery leaders (whether community volunteers or paid staff) tend to be highly skilled and are involved in the establishment, day-to-day business

decision-making and forward planning of nurseries, as well as the more complex aspects of tree propagation, planting and maintenance.

3.7. Social and Environmental Benefits

Across all CTN types, the additional social and environmental benefits were reported as central to nursery objectives and important outcomes of their activities. The benefits respondents thought they leveraged included increased social inclusion, local community cohesion and upskilling of individuals. These benefits were emphasised most by CTNs working with vulnerable volunteers (e.g., adults with learning difficulties and people with experience of substance abuse) or those with experience of the criminal justice system, where education, upskilling and integration or reintegration into society and employment were seen as critical objectives. Education and nature connections were important to CTNs whose volunteers were mainly school-aged children and their families. Benefits to physical and mental well-being were reported as important benefits of taking part in activities for all volunteer types and CTNs, with the practical, nature-based focus of tree nursery activities reported as good for managing stress and anxiety. Local environmental improvements were emphasised by Community-based CTNs, who were often looking to focus on the social and environmental benefits of producing local trees for local people and local places. Organisation- or project-based CTNs were most likely to be contributing to specific environmental outcomes by, for example, producing a priority species of conservation interest such as black poplar (*Populus nigra* L.) or juniper (*Juniperus communis* L.) for local restoration projects.

3.8. Sustainability

All CTN types expressed challenges to sustainability connected with maintaining resources, including finances, site, infrastructure, machinery, staff and volunteers. Equally important for sustainability, CTNs of all types raised the need for resources that would support community, volunteer and staff skills development. Communities of practice and peer-to-peer learning opportunities, as well as training courses, were perceived to be particularly valuable and needed. In terms of knowledge and skills gaps, market awareness and entrepreneurship, business and nursery management and scale-appropriate biosecurity measures were the most commonly listed. Shortages of volunteers and the lower skill level of available volunteers place high demand on nursery leaders across CTN types. So too does responsibility for future planning and ensuring succession. Unsurprisingly, fatigue is high among these individuals and the likelihood of nursery lead burn-out is a challenge to the ongoing viability of CTNs. The short-term project-based nature of grants, lack of awareness of the grant landscape and time to find and apply for grants are problems for the financial security and longevity of CTNs. Further to the financial uncertainty of grants, CTNs face income variability in linking supply with demand cycles. Finally, CTNs of all types face issues of sustainability in terms of land availability and affordability. This has a particularly negative impact on those CTNs that wish to increase production and need more space to do so.

4. Discussion

The data show that a significant number of CTNs in Britain are new and established. This could be attributable to several factors. It may in part reflect that community-focused organisations, eNGOs and others have started to realise opportunities presented by the current policy support for tree-planting projects and changing biosecurity conditions and regulations that mean home-produced trees are in greater demand at regional and national levels. It might also reflect the general structure of the social enterprise and small-scale voluntary sector in the UK, analogous to the CTN context. Regular surveys of this sector consistently show that over 45% of social enterprises are start-ups of less than 5 years old and 25% are less than 3 years old [57–59]. This is a trend that has also been observed amongst community woodland groups across Britain [49]. The high level of new and

establishing CTNs might also be a direct result of new funding programmes such as the Boosting Community Tree Nurseries Pilot Project in England and other initiatives in Scotland and Wales. Follow-ups of the national survey should be able to establish trends in the future.

Our results suggest that there is no single model CTN but rather a variety of types. This echoes the findings of the only study we have found looking at CTNs in the UK [50]. We have refined our characterisation beyond the types of community nurseries delineated in the international literature by providing more quantitative and nuanced data about the objectives, inputs, outputs and outcomes of CTNs in the UK. The policy implications of this are that CTNs cannot be treated as a homogenous group. Different kinds of CTNs will be better suited to realising different policy objectives and a variety of other desired outcomes.

The various CTN models and the heterogeneity of objectives across the endeavors do not necessarily align with a single focus interest on increasing tree seedling production. Achieving medium- and long-term sustainability requires a careful balancing of nursery activity, which might not be solely reliant on commercialising or scaling up production. Although many of the smaller Community-based CTNs said that they would like to increase production over time, they also reported a significant range of challenges that bring the feasibility of such strategies into question. Rather than up-scaling production, a comparative advantage for some types of CTNs, particularly Community-based CTNs, may lie instead with producing trees that are not widely available from commercial nurseries (i.e., uncommon or difficult to grow species, or larger trees). The evidence suggests it may be the Enterprise and Organization or project-based CTNs with financial sustainability objectives where up-scaling potential may exist. This is likely contingent on accessing capital to invest in mechanisation that increases nursery efficiency and maintaining the labour force needed through upskilling and sustained staff/volunteer recruitment and retention. The international literature suggests that business size (by volume of trees produced) and the number of community volunteers involved impacts CTN sustainability and success [2,20–23,28,59]. Disregarding differences in CTN definitions, medium-sized CTNs (c. 10,000 trees p.a.) are documented as having better performance than smaller or larger enterprises. The high fixed costs of production are a major challenge to smaller CTNs' sustainability. Conversely, the costs and risks associated with larger-scale production, including volunteer labour supply challenges, have been shown to lead larger CTNs to over-extend themselves and sometimes produce poorer-quality trees. Many of these challenges are common to private commercial tree nurseries too, so policy solutions such as the UK Government's Tree Production Innovation Fund (<https://www.gov.uk/guidance/tree-production-innovation-fund>, accessed 1 February 2024) could find ways to support the development of both the private commercial sector as well as some types of CTNs.

Looking at what species CTNs are producing raises a series of questions. Production is dominated by native broadleaves and local provenances. Various standards and quality assurance processes are applied to source this reproductive material. This ranges from ad hoc community collections of seeds from the local area which are thought to be of "local provenance", through to full compliance with Forestry Commission's forest reproductive material (FRM) national standards [50]. This variation in seed collection protocols is important as the quality of seedlings is related to seed supply, and international experience with CTNs recognises that seedling production is better when this is formalised [15,30]. The production focus on trees of local provenance has profound implications. On the one hand, it may help to fill a gap in the current supply chain since commercial nursery production is dominated by conifers, but it may not be responding to the provision of trees suited to changing climatic conditions, urban planting and the demands of the tree-planting market which is always evolving. This appears to be a limitation of some, particularly small-scale, CTNs where producing trees is predicated on the use of local seeds and seedlings and where the realisation of financial returns through filling gaps in current demand is a key objective [28]. There is of course a counterargument that keeping the most diverse range of seed collection and propagation pipelines open is beneficial for adaptation, so CTNs may

be contributing to this. Not all CTNs seem to have the potential to act as market leaders to move towards more 'climate smart' species nor do they all appear to have the technical knowledge required to match production strategies to meet future resilience needs [15].

It is important to stress that all of the CTN models are associated with producing a diverse range of benefits over and above the provision of trees. This is part of the *raison d'être* of CTNs. It is probably quite unfair to judge the success and impact of different CTNs in terms of production and financial measures alone. Other social and environmental benefits may be as important and valuable as the trees produced. However, it is clear that more evaluative research is needed to quantify and better understand these kinds of outcomes and the added value they accrue. Measuring and quantifying these kinds of benefits is a challenge but are a necessary part of securing support for CTNs [47,60,61]. It also means that more nuanced policy responses are likely to be required that reflect the additional benefits of CTNs over and above traditional commercial nurseries and the focus on meeting the demand for trees [62].

An important feature of CTNs in the UK was the high reliance on grants rather than income through the sale of tree seedlings. There are many financial challenges faced by tree nurseries because of the generally high costs of establishment and production (including the costs of land, infrastructure, labour and operating costs such as energy and consumables and the lead in time before tree seedlings are available) and often unstable/fluctuating markets. The combination of low selling prices and high labour inputs, which impact financial margins, along with uncertain market conditions have been recorded as key challenges to achieving steady income, cost offsetting and annual net profits for CTNs in all different contexts across the globe. This highlights the important role that government- or organisation-provided grants, financial incentives and other support play in maintaining the viability and sustainability of CTNs. It is clear that social innovation in the community-supported forestry and woodland sector takes time to develop, as such financial, material and other support from funders is necessary, particularly in the establishment phase [13,41,49]. It is also clear that a large proportion of community-supported tree nurseries fail when this support is withdrawn [62,63]. Some research suggests that support is needed for longer than 3 years [21]. The inherent tension between financial viability and CTN sustainability does not have easy solutions, particularly since many CTNs are focused on social and environmental benefits rather than objectives based on income generation through sales.

The provision of support in the form of extension services or the provision of training and advice including the development of technical skills by CTN staff and community volunteers is shown to be as critical as, or even more important than, capital finance for CTN establishment and success [20,26,28,30,63–65]. This includes business and market training [24,25,66] as well as nursery skills, all of which are not only important for the quality of production but also in terms of maintaining motivation [21] and building social capital, sound relationships and processes that result in many of the other social and environmental benefits and outcomes CTNs are striving to produce [13,21,41,49]. This also includes building peer and practice groups for networking, social learning and building relationships with end users and customers [46,65].

CTNs of all models in the UK context not only identified a range of training and skills development needs that mirror these but, importantly, also included greater appreciation of the need for biosecurity practice and applicability in CTNs contexts, as well as a greater understanding of the identification and management of tree pests and diseases, issues which appear to be emerging concerns in other CTN country contexts.

5. Conclusions

We have shown that CTNs represent a heterogeneous group of ventures with different characteristics and potentials for the production of tree seedlings and other social and environmental benefits. Our characterisation of CTNs should be helpful for policy makers and other stakeholders in the UK as a tool for identifying where best the potential lies for

realising a range of policy objectives. This characterisation also provides a framework for development in other country contexts.

The need for financial and development support has emerged as a clear issue if CTNs in the UK and other parts of the world are to achieve any kind of longevity and sustainability. Opportunities for training, learning and social learning should be an important part of policy and stakeholder support for the CTN sector. How CTNs might move beyond such a high reliance on grant support is also an important consideration.

There appears to be further research, policy and operational work in relation to CTNs around how best to move towards the production of trees that may better meet future conditions and how to address biosecurity knowledge and appropriate practice at the CTN level [16] including the acceptability of nursery measures and risk communication [38].

Also important will be further assessment, evaluation and valuation of the social and environmental benefits that comprise the unique features of CTNs in all country contexts, beyond tree production and the operation of commercial nurseries. It is important that an evidence base of this sort is developed to link context, process, outputs and outcomes and demonstrate differences between different models of CTNs and who benefits in which ways [47,49,60,67]. This will help establish the case for ongoing support and encouragement for CTNs going forward.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/f15030560/s1>. Item S1. Community Tree Nursery case study interview guide. Item S2. Pilot Project Community Tree Nursery Interview Interview guide. Item S3. Community Tree Nurseries, National Survey Questions.

Author Contributions: Conceptualisation, B.A.-O.; methodology, B.A.-O., E.C., J.S. and R.H.; formal analysis, B.A.-O., M.P., S.P. and O.F.; investigation, O.F., R.H., M.P., S.P. and B.A.-O.; data curation, B.A.-O.; writing—original draft preparation, B.A.-O. and M.P.; writing—review and editing, B.A.-O., M.P., E.C., J.S. and R.H.; supervision, B.A.-O.; project administration, B.A.-O., E.C. and J.S.; funding acquisition, B.A.-O. and E.C. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by HM Government, United Kingdom, through the Shared Outcomes Fund, contract number NCC 693353.

Data Availability Statement: The data are not currently publicly available. Forest Research is a government research agency that has an interest in, and supports, making data public. The empirical data in this project are in the form of: i. transcripts of interviews with individuals and ii. national survey data. At the present time, the resources required for Forest Research to anonymise the data and ensure compliance with data subjects' rights under the UK Data Protection Act (2018), and General Data Protection Regulations (GDPR) are not reasonable or proportionate. As such, the risk of disclosure and potential harm to those individuals is high. Forest Research is currently working to ascertain how best to manage this dataset, including the identification of an appropriate archive.

Acknowledgments: Thanks are extended to all the community tree nurseries that provided their time and interest in contributing to the research, whether to the case studies or the national survey. Thanks are also extended to the following project officers who helped with participant contact, research co-ordination, pilot testing the national survey and research project coordination: Louise Butfoy—Kent County Council—Trees Outside Woodlands Project Officer; Nick Rowles—Shropshire Council—Trees Outside Woodlands Project Officer; Sophie Hamnett—Tree Project Officer—Chichester District Council and Sophie Rudgewell—DEFRA—Project Manager for Trees Outside Woodlands.

Conflicts of Interest: The authors declare no conflicts of interest. The funders had no role in the design of the study; in the collection, analysis, or interpretation of the data; in the writing of the manuscript; or in the decision to publish the results.

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