

Knowledge Paper - Establishing Oil-Seed Tree Investments in Degraded and Regenerating Landscapes

Requirements for Public Sector Actions, Development Finance, and Private Sector Investment Globally and with a Guinean Case Study Example.

Executive Summary

The objective of this knowledge paper is to outline the requirements for establishing viable oil-seed tree investments in degraded and regenerating landscapes, focusing on the roles of the public sector, development finance, and private sector participation within the overall approach to nature-based solutions (NBS). Drawing on an emerging example from Guinea, it highlights the necessity for a comprehensive feasibility study for all oil-seed tree investments encompassing environmental, social, and governance (ESG) factors to guide the selection of the optimal business models. Key recommendations include strengthening policy and regulatory frameworks, including those necessary for carbon-trading systems mobilising development finance through support from World Bank country-level investments and trust funds, and creating incentives for private investment. The purpose of this paper is to provide actionable guidance for policy makers, investors, and development professionals seeking to drive sustainable landscape restoration and economic development.

Nitrogen-fixing oil-seed trees such as pongamia (*Millettia pinnata*) have unique ability both to restore degraded, non-productive lands in subhumid to per humid climates where other forms of agriculture are not viable, and sustain a profitable business that can create rural and peri-urban jobs, provide sources of renewable energy in the forms of biofuel and biomass, and contribute to food security. Pongamia is well suited and commercially most viable at large scale. Unlike many bio-energy crops, it requires adjacent natural habitat as source and refuge for pollinators. As such, pongamia is a compelling alternative to classic biofuel species such as oil palm, jatropha, sugar cane, castor and others in regions that are of marginal interest for other forms of agriculture, both restoring soil and healthy landscapes, and creating value and improving food security.

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1. Introduction

Degraded and regenerating landscapes present significant challenges and opportunities for sustainable investment. Plantations of certain oil-seed trees can be used not only to provide feedstock for renewable fuels but also to pursue ecological restoration, biodiversity benefits, income generation, and climate resilience at the landscape level. Realising this potential requires coordinated action across the public sector, development finance institutions, and private investors. This paper examines critical requirements necessary to establish large-scale, profitable oil-seed tree investments, referencing an emerging example from Guinea, and drawing on the World Bank Group's mandate to foster inclusive and sustainable development. Also noting that Guinea has now joined the IFC major agribusiness development initiative AgriConnect.

2. Required Roles Across Sectors (Public, Development Finance, and Private)

Oil-seed tree investments in degraded and regenerating landscapes typically face a '*valley of death*' between early-stage project preparation, in anticipation of significant capital and operational investments but 5-10 years before revenue-generation starts, and long-term commercial sustainability is established. Clear role definition across the public sector, development finance institutions (DFIs), and private actors helps: (i) build an enabling environment, (ii) develop a bankable project pipeline, and (iii) crowd in private capital at scale through appropriate risk-allocation and performance incentives.

Public sector: core required roles

- **Lead cross-sectoral relevance:** seek alignment of oil-seed tree plantations within public and private sectors' strategic priorities, e.g., agriculture, energy, environment, rural development, job creation, industry, transport, mining and others.
- **Land and resource governance:** clarify land tenure (including customary rights), establish reliable, transparent, long-term land allocation/lease mechanisms, and set rules for benefit sharing where communities provide land, labour, and/or stewardship.
- **Permitting and safeguards:** streamline licensing and approvals across forestry / agriculture / environment agencies; define and consistently apply environmental and social safeguard requirements including indicators to monitor; and provide clear guidance for sustainable harvesting, processing, and transport of products.
- **Public goods and infrastructure:** invest in or lead the development of public-private partnerships that enable infrastructure (rural roads, power, storage), public research and extension services, phytosanitary controls, and nursery/seed system standards that raise productivity and reduce investors' operational risk.
- **Market rules and standards:** establish quality and traceability standards for oil-seed tree products, strengthen contract enforcement, and support dispute-resolution mechanisms to reduce counterparty risk in potential out-grower and aggregator models.
- **Carbon and ecosystem-service market readiness:** set policy direction and oversight for measurement, reporting and verification (MRV), registry arrangements, trade, taxation and benefit-sharing rules to ensure that carbon-credit generation and

sharing of carbon revenues (where applicable) are credible, transparent, commercially attractive and socially legitimate.

- **Incentives aligned to outcomes:** use time-bound, transparent incentives (e.g., tax relief, accelerated depreciation, import-duty exemptions for equipment, performance-based grants) to address early-stage viability risks while avoiding permanent market distortions. Following these early-stage incentives, provide stable and predictable fiscal, regulatory and operational regimes over the long-term.
- **Social license and inclusion:** ensure meaningful community engagement, grievance mechanisms, and inclusion of women, indigenous people and vulnerable groups in decision-making, employment, supplier opportunities, and benefit-sharing arrangements.

Development finance (MDBs/DFIs/trust funds): core required roles

- **Project preparation and pipeline building:** co-fund prefeasibility/feasibility work, baseline studies, impact assessment and design of mitigations, stakeholder engagement, and early-stage structuring so that projects reach investment readiness, including ESMS design and MRV system set-up where carbon revenues are pursued.
- **Risk mitigation and credit enhancement:** deploy instruments that address political, regulatory, off-taker, and currency risks (e.g., guarantees, first-loss or subordinated capital, and risk-sharing facilities) to improve risk-adjusted returns for private investors as for example structured by the WBG's MIGA division.
- **Blended finance design:** combine concessional and commercial finance transparently to catalyse investments that would not proceed on purely commercial terms, using the minimum concessionalism necessary and clear governance over subsidy use.
- **Long-term finance and local currency solutions:** provide longer maturities than available locally, support local financial intermediaries, and (where feasible) facilitate local-currency lending or hedging to reduce FX-driven default risk.
- **Results-based and performance-linked support:** structure disbursements against verified milestones (e.g., hectares restored, survival rates, smallholder inclusion, and verified carbon sequestration or emissions reductions) to align incentives and protect public funds.
- **Capacity building and convening:** strengthen governmental systems (land administration, permitting, MRV, safeguard oversight) and convene public–private dialogue to resolve bottlenecks across the value chain.
- **Innovation, demonstration and replication:** finance pilots and early movers, advise early project preparation to adopt emerging technologies from other jurisdictions (e.g., nature-based solutions, innovative benefit-sharing mechanisms, non-proprietary plantation-related technologies), document lessons, and standardise templates (term sheets, outgrower contracts, safeguard instruments) to reduce transaction costs and accelerate replication.
- **Capacity-building to support local content and replication:** (co)finance systems to build technical and administrative skills in the private sector and government to allow operations to become run by national specialists, administered efficiently by government and replicated in-country with diminishing external inputs.

Private sector: core required roles

- **Opportunity identification:** co-fund and conduct pre-feasibility and feasibility studies to identify commercially viable opportunities, in collaboration with public sector and DFIs.
- **Commercial execution and operational excellence:** invest in nurseries, planting, maintenance, harvesting, processing, logistics and quality control, and implement robust management systems for traceability and compliance.
- **Market development and offtake:** secure offtake agreements, develop downstream demand (domestic and export), and invest in branding and standards compliance needed for premium markets.
- **Innovation and business model design:** adapt models to local context (outgrower, nucleus estate, franchise/aggregator, service-provider, cooperative-linked models), and invest in digital tools for farmer support, payments, and monitoring.
- **ESG performance and accountability:** conduct environmental and social impact assessment (ESIA) to internationally recognized standards, implement environmental and social management systems (ESMS), apply due diligence on land acquisition and labour practices, and ensure accessible grievance mechanisms and transparent benefit sharing.
- **Supply-chain inclusion:** provide smallholders with inputs, training, and (where viable) pre-financing, structure transparent pricing and quality incentives, and build durable partnerships with communities and local SMEs.
- **Co-investment and leverage:** bring equity and/or commercial debt at scale through co-financing platforms once the enabling environment and project fundamentals are in place, including guarantees and insurance, and work to comply to DFIs' standards.
- **Carbon-revenue integrity (where applicable):** finance and operate validation, MRV and verification processes, manage registry and issuance workflows through authorized arrangements, and conduct transparent allocation of credits and/or carbon revenues consistent with national rules, community agreements and good international practice.

Practical sequencing and coordination: In early stages, the public sector reduces policy and tenure uncertainty while DFIs co-fund project preparation and demonstrate viability sharing of emerging practices and technologies. As projects reach investment readiness, DFIs shift toward de-risking and blended structures that crowd in private operators and financiers. At scale, private actors lead operational delivery and market expansion, while government focuses on enforcement, monitoring, and continuous improvement of the enabling environment.

Country-specific: Guinea as an emerging example of oil seed plantation investment.

Summary of a private sector investment in Guinea

(Full details are in Appendix 1 page 15)

A proposed private-sector investment of regenerative agriculture in Guinea, centred on large-scale oil-seed tree plantations, using pongamia as the main example¹ to demonstrate that regenerative agricultural investments are attractive when they are feasible, profitable, scalable, and socially and environmentally beneficial.

¹ While pongamia is a lead candidate for Guinea, other species are under consideration such as *Acrocomia spp.* and neem (*Azadirachta indica*).

Core investment proposal

Bioenergy Reforestation Partners (BRP) see link here for further information: [BRP](#) proposes a landscape-level, 75,000-hectare investment in Guinea, that includes:

- 50,000 ha of pongamia plantations,
- 25,000 ha of interspersed, restored and protected natural habitat, and
- supporting infrastructure such as nurseries, processing facilities, feeder roads, and community agricultural support.

Why pongamia?

Pongamia is presented as a strong candidate because it:

- produces oil-rich seeds for biofuel, (or alternatively for high-quality food oil)
- yields protein-rich meal as a solution to food security,
- biomass from seed shells for power generation,
- tolerates poor soils, drought, and salinity,
- improves soils through nitrogen fixation,
- offers carbon sequestration and possible carbon-credit revenues,
- provides a host of associated ecosystem services, and social & economic benefits, and
- is most profitable at large scale which also generates landscape-level land restoration and ecosystem services.

Expected outcomes

The investment will deliver:

- over 2,600 rural jobs,
- approximately 150 million litres of biofuel annually,
- 300,000 tonnes/year of protein meal as a contributor to food security,
- 500,000 tonnes/year of biomass,
- around 16 million tonnes of CO₂ sequestered over 40 years,
- estimated \$350 million in peak annual revenue, and
- an estimated ~20% internal rate of return.

Role of nature-based solutions

For large-scale, regenerative pongamia plantations, natural habitat restoration is not optional but essential. Restored habitat supports:

- pollinators needed for pongamia's productivity,
- biodiversity and ecological connectivity,
- watershed protection,
- improved soil health,
- local climate regulation, and
- carbon storage.

The investment study is based on 1 hectare of natural-habitat restoration for every 2 hectares of plantation.

Social and community benefits

The investment will focus on delivering:

- rural employment,

- improved rural roads and infrastructure,
- horticultural support and food-security benefits,
- better grazing systems and reduced farmer-herder conflict,
- potential carbon-credit revenue sharing, and
- stronger rural land-tenure recognition.

Conditions needed for private investment

Successful private investment requires:

- working at a large scale,
- suitable degraded land and topography,
- long-term commitments from communities, government and investors,
- defined partnerships between the private, public and development sectors,
- a major national industrial partner ideally as a market off-taker,
- diverse value streams to markets (national or international),
- clear carbon rights and benefit-sharing,
- strong community engagement, and
- durable social and political license to operate.

Risks and mitigation

The investment study identifies a range of technical and commercial risks to ensure the competitive establishment of pongamia or other oil seed tree plantations with specific mitigation plans, such as (but not limited to):

- price volatility,
- lack of or uncertainty of national regulations and their application,
- labour and supply-chain constraints,
- low plantation productivity,
- non-permanence of plantations or habitat restoration, and
- theoretical invasiveness risk of pongamia or other non-native oil seed trees.

The investment study states these risks can be mitigated through planning, monitoring, contractual protections, habitat buffers, seed-control measures, and long-term agreements.

Key Stakeholder Responsibilities

The table below translates certain role requirements into a practical “who does what” view for Guinea as an example.

Function / workstream	Public sector (Guinea)	Development finance (Guinea)	Private sector (Guinea)
Land tenure & land-use planning	Establish or clarify procedure for commercial, large- scale access to land for agricultural investments; establish transparent rules for leasing land and benefit-sharing;	Provide technical assistance and financing for land administration systems, mapping, and dispute-resolution capacity where these are binding constraints for investment readiness.	Avoid contested land; apply rigorous due diligence when accessing land; structure community agreements and benefit sharing that are legitimate, verifiable and enforceable.

Function / workstream	Public sector (Guinea)	Development finance (Guinea)	Private sector (Guinea)
	resolve legal and practical conflicts between positive law and customary rights of land use, allocation and ownership; implement practical land-use planning		
Permitting, safeguards & compliance	Coordinate approvals across environment, forestry, agriculture and mining authorities, incl. for restoration of degraded landscapes in and around plantations; clarify safeguard expectations; enforce compliance.	Support safeguard systems (ESMS templates, institutional capacity) and co-fund baseline studies, impact assessment and stakeholder engagement needed for permits.	Conduct ESIA, develop and implement ESMS; comply with permitting conditions; maintain traceability and audit readiness across operations and supply chains and mitigate risks of spread of non-native species.
Public goods, standards & extension	Approve investments in propagule/nursery standards (e.g., approve imports of applicable seeds and genetics), extension, and enabling infrastructure; set product quality and traceability standards; and guarantee contract enforcement.	Finance productivity and service-delivery systems (extension partnerships, training, nursery upgrades) and standardisation to lower transaction costs.	Co-invest in nurseries and farmer services; implement quality control and traceability; build aggregation and logistics capacity.
Project preparation & bankability	Provide data access, align public agencies behind a pipeline, and support local approvals and stakeholder processes to reduce delays.	Fund/co-fund prefeasibility/feasibility, baselines, ESIA, ESMS design, and business model structuring to reach investment readiness.	Bring operator input early (costs, logistics, processing options); validate unit economics; secure offtake discussions.
Finance, de-risking & scale-up	Offer time-bound incentives aligned to outcomes (not permanent subsidies); ensure predictable rules that reduce political/regulatory risk;	Deploy blended finance and risk-sharing (guarantees, first-loss, long term) and crowd in	Invest equity and commercial debt as risk reduces; scale processing and working capital; maintain performance to

Function / workstream	Public sector (Guinea)	Development finance (Guinea)	Private sector (Guinea)
	ensure zero-tolerance for rent-seeking.	commercial co-finance once viable.	unlock follow-on finance.
Carbon/MRV & benefit sharing (where applicable)	Establish/strengthen MRV and institutional arrangements; set authorisation and benefit-sharing rules to ensure credible participation in carbon markets.	Support MRV system's set-up and capacity; structure results-based finance linked to verified outcomes.	Operate MRV and verification workflows; ensure transparent allocation of carbon revenues consistent with national rules and community agreements.
ESG Interventions	Participate in education and capacity-building of in-country technical specialists and public-sector administrators; co-define desired biodiversity objectives to guide natural habitat restoration including ecological connectivity in protected areas' buffer zones.	Co-support education and capacity-building of in-country technical specialists and public-sector administrators.	Co-support education and capacity-building of in-country technical specialists and public-sector administrators; provide horticultural support program for host communities; co-define desired biodiversity objectives to guide natural habitat restoration.
Monitoring, enforcement & learning	Monitor compliance, safeguard performance and land-use outcomes; and adjust procedures and regulations based on lessons learnt.	Finance learning agendas, independent evaluations, and replication toolkits (templates, term sheets, contracting approaches).	Report performance (survival rates, inclusion, ESG); share lessons; adopt continuous improvement and corrective actions.

In terms of sequencing, clarity on land governance and cross-ministry permitting is the first priority, followed by DFI-co-funded preparation and de-risking. Private capital scales up once tenure, safeguards, and market access (including potential carbon finance channels) are credible.

Overall conclusions (Guinea)

The main conclusion is that **bankable, regenerative, landscape-level agricultural investments in Guinea are possible if they are market-driven, financially viable, and designed to generate both commercial returns and shared public benefits**. The proposal stresses that investments succeed when they create a win-win-win for communities, government and investors, and when public and private finance work together with clearly defined roles to reduce risk and support long-term investment. To date in Guinea, the Ministries of Agriculture and Environment have issued formal letters of support

for proceeding with a detailed feasibility study of the investment in compliance with international standards. The Ministries of Energy and Mines & Geology have expressed strong interest in a detailed feasibility study for the investment.

Country-specific: Paraguay as an emerging proof of concept for an oil seed plantation investment.

(Full details are in Appendix 2 page 24)

Investment Summary – Investancia (further information: [Investancia - Pongamia Reforestation & Feedstocks At Scale](#))

Investancia operates large-scale reforestation programs focused on restoring degraded cattle land in the Chaco through silvopasture systems, allowing grazing to continue while improving land productivity and environmental outcomes.

The investment launched in 2014 today has the aims of; i) planting 50 million trees across 120,000 hectares of which 10,000 hectares has been planted to date and first harvesting begins in 2027 in the R&D centre, and in 2031 in the commercially planted areas ; ii) sequestering 1.2 million tons of CO₂ annually; iii) producing 480,000 tons of bio-protein per year; and iv) replacing 300,000 tons of fossil crude annually.

The program uses selected productive and native tree species grown in an on-site nursery. These species are adapted to harsh conditions such as salinity, drought, and flooding, and some also improve soil health through natural nitrogen fixation. The reforestation effort also reconnects green corridors and generates certified nature-based carbon removals under the Verified Carbon Standard and CCBS.

Investancia's propagation and research centre is described as the world's largest production site for oil-producing tree species, with a planned annual capacity of over 7 million trees, supporting expansion into Brazil and to Africa in a joint venture with BRP. For every 100,000 hectares of Pongamia plantings, the investment is expected to create significant:

Economic impact

- 250 permanent direct jobs
- Large-scale employment for planting, harvesting, and processing
- Production and export of:
- 480,000 metric tons of protein feed annually
- 300,000 metric tons of oil annually
- Development of nurseries, infrastructure maintenance, and apiculture

Social impact

- Involvement of local Chaco communities, including indigenous populations
- Employee housing, school aid, and medical support programs
- Transfer of technology, know-how, training, and best practices to the local workforce

3. Markets for Tree Crop Oil and Non-Oil Products – International or National

Commercial viability depends on matching the model for producing and processing oil seeds to an identifiable market pathway. For this paper, the primary focus is on pongamia oil, an oil that is increasingly positioned as a feedstock for renewable diesel and sustainable aviation

fuel (SAF), as well as selected industrial applications (e.g., soaps/oleochemicals). Pongamia press cake can be processed into human food-grade protein or an animal-feed protein, a major contributor to food security. Shells of pongamia seed-pods provide a high-calorie, high-grade biomass useful for power generation and biochar. At scale, all three pongamia products have ready international and national markets.

How markets differ (end uses, quality, and scale)

- **Biofuels (biodiesel, renewable diesel, SAF):** pongamia's strongest medium-term international market attraction is as a non-food oil feedstock for hydroprocessed fuels like renewable diesel/HVO and HEFA-SAF. Demand is policy-driven and sensitive to lifecycle emissions accounting, traceability, and land-use change risk.
- **Biomass:** pongamia oil production also creates significant biomass that can be used as a fuel, including for power generation, or for biochar.
- **Domestic industrial uses (non-food):** pongamia is generally treated as a non-edible oil; domestic demand can be developed through soap makers, industrial users, and institutional buyers that value reliable supply and consistent specifications.
- **Food Security:** the leftover cake from pressed pongamia seeds can be processed into a high-protein human or animal feed.
- **Oleochemicals (regional and global)** demand reliable volumes and chemical consistency for soaps, detergents, and surfactants; buyers often purchase in bulk and benchmark against other lauric/vegetable oils for pricing and quality.

While international markets tend to pay higher prices and purchase in hard currencies that producing nations may desire, supplying products to national markets can address in-country concerns like food security, energy security, industrialisation, adding value to domestic products and carbon-related objectives. Thus, a balance between national objectives and giving preference to profitability should be explicitly negotiated in contracts and reflected in an investment's governance.

4. Job Creation Across the Value Chain with Emphasis on Rural Jobs

Oil-seed tree investments can be significant generators of rural employment because many activities, such as; nursery work, planting, maintenance, harvesting/collection, aggregation, and first-stage processing must occur in or close to the landscape where trees are established. Job creation is not automatic; it depends on business model choices (e.g., outgrower vs. estate), mechanisation levels, the location and scale of processing, and the reliability of offtake markets. A full feasibility study for an investment should therefore assess not only financial returns but also the volume, quality, and distribution of jobs across the value chain, and the potential for synergies with other infrastructural and industrial developments, for example in transport (roads, rail, ports), power and mining. The induced impacts of rural job creation are noteworthy, too, including reducing rural-to-urban migration and stimulating rural economies from improved rural infrastructure and spending power.

Where jobs are created (from nursery to market)

- **Nursery and seed systems (rural):** seed collection, nursery technicians, grafting/propagation, potting and watering teams, and local input supply (bags, compost, tools).

- **Site preparation, planting, and maintenance (rural):** land preparation, planting crews, weeding, mulching, firebreak maintenance, tree-trimming, pest management, and basic monitoring—typically the largest labour demand occurs in early years.
- **Possible farmer/outgrower services (rural):** extension agents, lead farmers, input distribution, digital field agents, and community liaison roles that support productivity and inclusion, whilst controlling potential risk of invasiveness.
- **Natural habitat restoration and protection:** labour for assisted natural regeneration and reforestation if required, fire breaks, continued monitoring and protection, managing benefit-sharing.
- **Seed collection and aggregation (rural–peri-urban):** seasonal collectors, village-level buying points, weighing/grading staff, local transport (motorbikes/vehicles), and storage management.
- **Primary processing (rural/peri-urban):** shelling and oil pressing operators, maintenance mechanics, warehouse roles, and safety/HSE supervision; co-product handling (press cake, shells).
- **Quality assurance and compliance (often peri-urban):** lab technicians, sampling and documentation staff, traceability and audit support including sustainability and, where relevant, carbon MRV roles.
- **Logistics, trading, and downstream markets (urban and port-linked):** road maintenance, bulk transport, packaging, sales, export documentation, and distributor networks—jobs that are typically less rural but supported by rural production volumes.

Job quality, inclusion, and safeguards

- **Decent work standards:** apply clear labour policies on wages, working hours, contracts, and freedom of association; ensure no child labour; and implement strong occupational health and safety (OHS) practices for agrochemicals, machinery, and transport.
- **Women's and indigenous peoples' economic participation:** design roles and procurement to include women and indigenous peoples (nursery operations, grading, extension, finance/administration, small-scale aggregation, natural habitat restoration, protection and monitoring), and address constraints such as childcare, mobility, and access to finance, access to horticultural support from year 1.
- **Youth and skills development:** create structured training programmes for equipment operation, maintenance, quality control, and digital traceability, enabling progression from seasonal work to skilled roles.
- **Grievance mechanisms:** maintain accessible channels for workers and communities to raise concerns (labour issues, land access, benefit sharing), with documented response processes.

Design choices that maximise rural job creation

- **Plantation development** – by default, tree-based plantations are located in rural areas therefore a significant number of jobs are created, both full-time and seasonal.
- **Possible controlled outgrower and community-linked models where feasible:** these spread income and jobs across villages (planting, maintenance, collection) while reducing land-acquisition risks, provided extension and aggregation are well organised.
- **Design for labour productivity without excessive mechanisation:** select mechanisation that improves safety and quality (e.g., transport, handling) while

maintaining strong rural employment in planting/maintenance and collection, especially in early years.

- **Invest in local support services:** support local SMEs to know how to supply goods and services to a large agro-industrial company and contract them when ready for nursery supplies, transport, equipment maintenance, catering, and security, multiplying indirect rural employment.
- **Use transparent pricing and timely payments:** reliable payment systems (including mobile money where appropriate) help sustain collectors' and outgrowers' confidence and participation, and stabilise seasonal employment.
- **Build skills ladders:** link short-term rural jobs to training and certification (nursery technician, machine operator, lab assistant) so communities see progression beyond seasonal work.
- **Track and report jobs as a performance metric:** include rural job targets (direct, indirect, seasonal vs. permanent, gender/youth) in financing agreements and project monitoring to keep employment outcomes visible and hold the project developer accountable.

5. Pre-Feasibility and Feasibility Studies: Environmental, Social, and Governance Considerations

Full feasibility studies are required to assess the viability of oil-seed tree investments in specific landscapes. They should evaluate environmental impacts including positive and negative impacts on biodiversity and ecological connectivity, soil quality, provision of ecosystem services (erosion control, water quantity and quality) and the potential for generating carbon credits. They must assess social factors such as community engagement, land rights and livelihoods, and governance aspects including inclusive project management structures and compliance with IFC and other recognized international standards.

General Policy and Regulatory Frameworks Required

Establishing oil-seed tree investments may require reforms to existing policies and regulations, which need to be identified in prefeasibility studies and solutions identified during feasibility studies. Key requirements include streamlined approval processes across sectors, integrating landscape restoration objectives into national development plans, and aligning publicly funded incentives to private sector led investments. If carbon credits are part of the business model, policy makers must enact specific regulations to enable transparent and effective carbon-trading systems. Implementation of reforms to enable competitive private sector investment should be supported by clear guidance, ongoing capacity building, and robust enforcement mechanisms. Collaboration between governmental agencies, development partners, and the private sector is essential to ensure effective policy adoption and regulatory compliance for both oil-seed tree investment and carbon trading.

Required Policies and Regulations for Carbon Project Development and Trading

Carbon finance can strengthen the commercial case for land restoration and regenerative agricultural investments, but only where the host country has clear rules on carbon rights, trading and markets, approval criteria and procedures for carbon projects including criteria for their environmental and social integrity, and benefit sharing. For oil-seed tree investments that may generate credits, the policy framework should reduce uncertainty for communities, developers, and buyers while ensuring transparency, safeguards, and credible accounting.

The core, minimum policy components to address are:

1. **Legal basis and institutional mandate:** establish a climate and carbon law (or binding regulation) establishing associated objectives, carbon markets and a competent authority responsible for oversight of carbon crediting and carbon markets including project approval, authorization decisions (where relevant), supervision of registries, and enforcement powers. The mandate must define how carbon-market rules relate to existing forestry, land, biodiversity, and environmental assessment laws.
2. **Carbon rights and ownership:** define who has what rights to carbon assets and benefits, and who may develop, transfer and retire credits: e.g., landowner, community, concession holder, project proponent, or the state under specified conditions, specifying how carbon rights operate on private land, customary/community land, leased land, or state-owned concession areas.
3. **Project cycle rules (approval to issuance):** set transparent national project-approval requirements including eligibility criteria, documentation, timelines and disclosure, require independent third-party validation and verification, and establish rules for credit issuance, handling of reversals (e.g., buffers), and corrective actions for non-compliance.
4. **MRV and data governance:** define monitoring, reporting and verification standards, acceptable datasets, monitoring frequency and audit requirements; set data-governance rules that protect sensitive land/community data while enabling market transparency.
5. **Registry, tracking, and anti-double counting controls:** establish or designate a registry (national or interoperable) to uniquely identify projects and units, track issuance/transfers/retirements, and provide controls to prevent double issuance, double claiming and double use.
6. **Authorization and transfer approvals (where applicable):** define procedures for authorizing international transfers and clarify permitted uses of credits (domestic compliance, international compliance, voluntary claims) and any associated conditions.
7. **Safeguards, Free Prior Informed Consent (FPIC) requirements for accessing land, and grievance mechanisms:** integrate carbon-project requirements into land governance and safeguard systems; require meaningful community engagement and FPIC where relevant; ensure accessible grievance and dispute-resolution mechanisms.
8. **Benefit sharing and revenue management:** establish benefit-sharing rules (shares, timing and performance triggers) and transparency requirements (reporting and audits), including treatment of community benefits and any public funds that receive proceeds from sale of credits.
9. **Fiscal treatment and financial regulation:** define taxation and fee regimes, foreign exchange rules, and whether credits are treated as commodities, financial instruments or another asset class, for the purpose of reporting and oversight.
10. **Enforcement, penalties, and remedies:** provide inspection powers, sanctions for fraud/misrepresentation, remedies for under-delivery (including credit cancellation where appropriate), and clear administrative-appeal pathways.

Where credits are intended for international transfers under the Paris Agreement through Article 6's cooperative approaches, regulations should include explicit authorization procedures and rules to support transparent tracking and avoidance of double-counting. Where credits are intended for voluntary markets, governments may still require national approval and registry tracking, but may apply different authorization and reporting

requirements depending on objectives. In both cases, registry-based tracking, robust MRV, and enforceable safeguards are critical for market confidence

Managing the Potential Risk of Invasiveness

Many oil-seed trees are not native to where they may be planted, e.g., pongamia in Guinea, thus the risk of them becoming invasive must be thoroughly considered. The characteristics that render an oil-seed producing species commercially attractive tend to be key risk factors for becoming invasive, although they do not necessarily mean a species will become invasive. These general factors include:

- Proven success in becoming invasive outside its native range,
- A broad native range,
- Abundance and dominance in native range,
- Highly adaptable to different environments – an ecological ‘generalist’,
- Pioneering in/colonises disturbed areas,
- Tolerant of shade,
- High relative growth rate and early maturation,
- Significant seed production and frequent seed crops, and
- Reproduces asexually (e.g. suckers, vegetatively).

Degraded landscapes tend to be more susceptible to exotic species developing invasive characteristics, compared to intact habitats which have more resilience.

Invasive plants generally go through three stages when becoming invasive:

1. Introduction of a new species or a new variety of a pre-existing species into a particular habitat where it is not established,
2. Establishment of the species as a self-sustaining population with adequate numbers and recruitment to withstand pressures and stochastic events, and
3. Aggressive spread of the species, that is, the species expands its range and crowds out pre-existing species, causing the latter to decrease in numbers or go extinct, and causing significant changes in habitats’ composition, structure and/or functions.

This process can proceed quickly (years) or slowly (centuries). Frequently, a species may be self-sustaining but not invasive, in which case it is called ‘naturalised’. However, when local conditions change, such as related to changes in local land use, temperature, climate, fire regime, flooding, grazing or absence thereof by wildlife and domesticated animals, local pests and pathogens, or other factors, a species can gain an advantage over its neighbours and become invasive.

IUCN’s Guidelines on Biofuels and Invasive Species (2009) provides in-depth discussion of the dynamics, risks and recommended mitigation measures for reducing such risks.

In the case of pongamia, the species was evaluated and approved for commercial-scale plantations in Australia, Paraguay, Hawaii and Florida. To date, the species has not proved to be invasive anywhere.

6. Key Recommendations

- To encourage landscape-level private investments, the role of oil-seed trees for restoring and rendering productive degraded landscapes should be formally endorsed as a preferred methodology within the framework of nature-based solutions (NBS).

- To establish functioning oil-seed tree investments to regenerate degraded landscapes, governments and DFIs should strengthen enabling environments for investments, mobilise development finance targeting key barriers and risks, and incentivise private sector engagement.
- For all oil-seed investments, completing a comprehensive pre-feasibility study, as demonstrated in Guinea, is a critical first step, informing business-model selection and guiding subsequent actions ².
- Following the pre-feasibility study, if no major 'red flags' are identified, a co-funded detailed feasibility study in compliance with IFC / recognized international standards must be conducted.
- To develop comprehensive capacity, training and skills programs to ensure national staff can be employed in all activities across the value chain.
- Facilitate and develop defined partnerships delivering key social and economic activities across the public, development and private sectors.
- Oil-seed tree investments will require comprehensive MRV systems to be independently managed and report to agreed multi-sectoral stakeholders to ensure full compliance to ESG commitments.

² The pre-feasibility study completed for Guinea mapped degraded areas with appropriate climatological and pedological conditions for pongamia, after which on-the-ground stakeholder consultations assessed the availability of degraded land not needed for local communities' agriculture and pastoral activities, and stakeholders' willingness to allocate land long-term at scale for plantations. Because the prefeasibility study identified no major 'red flags' to proceeding, there is now a need to undertake the full feasibility study. The results of these studies will inform business-model investment and guide inclusive stakeholder decision-making and operations as well as including strategies for participation in carbon-trading systems.

Appendix 1: Case Study - Oil-Seed Tree Plantations in Guinea: a Private Sector Example of Regenerative Agriculture with Multiple Value Streams applying Nature-Based Solutions

When considering investing in a regenerative agricultural project, the private sector considers the potential investment's:

- Feasibility and risk: technical, financial, governance, social, political, environmental,
- Diversity of products and benefits: financial, economic, social, environmental,
- Developing and maintaining social license to operate,
- Building resilient value chains, and
- Scale and profitability.

Bioenergy Reforestation Partners (BRP) is proposing a large-scale investment in oil-seed producing trees in the Republic of Guinea. While BRP is considering several species³, this case study uses pongamia (*Millettia pinnata*) to illustrate the drivers and expected results of the proposed investment.

BRP is a UK-registered company that develops projects in Africa producing biofuel oils, bio-protein and biomass from oil-seed trees while restoring and protecting associated native habitat. For further information follow this link: [BRP](#).

Land Degradation

In Guinea, land degradation is a major threat to rural livelihoods, food security, health, energy supply, water supply, biodiversity and many other essential components of a prosperous, resilient society. Soil erosion, deforestation and declining land productivity directly impact people's well-being and the national economy.

However, degraded and unproductive land can be restored through regenerative agricultural using nature-based solutions (NBS) and large-scale plantations of selected oil-seed trees accompanied by restoration and protection of native habitat. An investment study of degraded landscapes in Guinea identified significant potential for regenerative plantations of pongamia, producing a raft of commercial and non-commercial benefits.

Pongamia

Pongamia is a hardy leguminous tree known for nitrogen fixation, drought tolerance and producing seeds rich in oil suitable for biofuel. Thought to originate in coastal Asia (India to Indonesia), it is naturalized today in Australia and across the Indian Ocean including many island and coastal countries in East Africa. The species has undergone intensive genetic selection in recent decades, selecting mainly for high productivity. High-producing varieties start producing seed after 4-5 years and reach full production at 8-9 years, then producing for another 40+ years. The species needs a minimum level of rainfall, generally between 1200 and 1600 mm/year, depending on local conditions, to produce commercially attractive harvests and will produce more abundantly in higher rainfall. Research for commercial

³ Other species under consideration include acrocomia (*Acrocomia totai* or *A. aculeata*) and neem (*Azadirachta indica*). Species native to Guinea are being examined but none have undergone genetic selection to the extent of pongamia.

plantations has intensified in the last 10-15 years and today, commercial plantations exist in Australia, Paraguay, the USA (Florida, Hawaii), Brazil, Madagascar and India. Plantations are expanding rapidly worldwide.

The study for degraded lands in Guinea identified the following commercial and non-commercial benefits from and advantages of large-scale pongamia plantations using a regenerative-agriculture approach and adopting NBS whenever reasonably possible:

- Oil-rich seeds in quantity for feedstock for biofuel,
- Shells of seed pods in quantity for energy production,
- High-protein meal from seeds after extracting oil for animal or human food,
- Thrives on poor soils not suitable for continuous agriculture,
- Naturally resists many pests (insects, birds, rodents, grazers),
- Tolerant of drought and salinity,
- Improves soils by fixing nitrogen and adding organic matter,
- Sequesters carbon in biomass and soil, and could generate carbon credits,
- Can be integrated with grazing (silvo-pastoralism),
- Create rural jobs, value chains and economic activity,
- Requires improvements to rural infrastructure, esp. roads, that benefit participating communities,
- Enhances ecosystem services: e.g., soil quality and stability, erosion reduction, protection of watersheds, improvement of water quantity and quality, local climate regulation, and
- Requires associated regeneration and protection of natural habitat that enhances biodiversity and ecological connectivity (*see below*).

BRP's proposed initiative in Guinea would occur on 75,000 hectares, consisting of:

- 50,000 ha of pongamia, planted in 5 phases X 10,000 ha/phase, on degraded land not actively or intensively used by local people and on which they do not materially depend for their livelihood,
- Restoration and protection of 25,000 ha of associated, interspersed natural habitat in and around 50,000 ha of plantations,
- Leased communal land and possibly State land,
- Improvement or establishment of rural feeder roads,
- High-tech industrial nursery, capable of producing 7 million seedlings per annum,
- De-shelling seeds, sale of shells for energy production,
- Modular seed-processing facilities for extracting oil and producing press-meal,
- Generation of carbon credits from plantations' biomass, soil carbon, restored natural habitat, and avoided emissions from biofuel and REDD+, and
- Irrigated horticulture and agricultural support to host communities.

As identified in the study of oil-seed tree plantations in Guinea of 2024, such an investment would deliver:

- 50,000 ha of pongamia plantations: 400+ trees/ha,
- 25,000 hectares of native habitat restored: interspersed, remaining forest patches, riparian/gallery forest, corridors,
- At least 2,600 rural jobs created with greater numbers of induced jobs or livelihoods,
- 150 million litres of biofuel annually (peak production),
- 300,000 tonnes/yr of high protein press-meal (peak),
- 500,000 tonnes/yr of shell biomass (peak),

- 16 million tonnes of CO₂ sequestered (total across 40 years,
- Est. \$350 million in yearly revenues (peak),
- An internal rate of return of ~20%, and
- Associated support for horticulture and silvo-pastoralism for host communities, and intercropping in-between rows of trees.

BRP will align the investment with IFC's Performance Standards.

Restoring Natural Habitat and Ecosystem Services

Pongamia flowers during a few months of the year, when it needs significant pollinators to ensure high seed production. When planted at large scale, maintaining adequate pollinators requires interspersing throughout plantations natural habitat as a source and refuge for pollinators. Promotion of apiculture to enhance bee populations is recommended. Thus, in order for pongamia plantations to be productive on degraded lands, restoration and maintenance of natural habitat is imperative, and can be enhanced by a rural income-generating activity.

BRP's regenerative agricultural investment in Guinea proposes to restore and maintain one hectare of natural habitat for every two hectares of plantations, interspersed to maximise the ecological benefits provided. Together, drawing heavily on nature-based solutions, plantations and natural habitat provide a range of economically and socially valued ecosystem services:

- Sources and refuges for pollinators,
- Enhanced biodiversity and ecological connectivity across formerly degraded landscapes,
- Watershed protection, enhanced infiltration and water quality, flood mitigation,
- Improved soil health and source of microbes, fungi and invertebrates,
- More diversified vegetation in the landscape which can limit pest outbreaks,
- Improved grasslands for grazing,
- Regulation of local climate,
- Carbon sequestration and storage, and
- Cultural services for local people.

Once adapted to the Guinean context and with experience managing risks, blocks of mixed pongamia and natural habitat could be used to restore degraded areas in buffer zones of protected areas, improving biodiversity and ecological connectivity in these areas and establishing long-term employment and incomes based on this land use.

Social Benefits

As outlined above, beyond ecosystem services, social benefits of such plantations with natural habitat include:

- Dispersed rural jobs and associated economic opportunities,
- Improved feeder-road networks,
- Silvo-pastoralism and separation of traditional agriculture and grazing, avoiding conflicts between farmers and herders,
- Anchor project for rural horticultural support to bolster food security and nutrition,
- Distribution of revenues from carbon credits, and
- Strengthened recognition of rural land-tenure rights.

Requirements of Private-Sector Investment in Plantations of Oil-Seed Trees

For this proposed large-scale regenerative agricultural initiative with an industrial dimension to succeed in Guinea, the following are necessary, but not necessarily sufficient, conditions to attract private investment:

- **Scale** – a minimum of 10,000 ha of plantations is required to justify investments in roads, nursery, processing facilities, power generation and carbon crediting, with significant economies of scale realized increasing to 50,000 ha of plantations. *BRP proposes an investment in five areas of 10,000 ha of plantations and 5,000 ha of associated natural habitat each, totaling 75,000 ha. Access to land must be compatible with national land tenure law and traditional land-management, avoid biologically sensitive areas as well as land needed by communities for agriculture, and leased for 40 or more years at a realistic price.*
- **Topography** – pongamia needs relatively flat areas for mechanical harvesting because in blocks of 10,000 ha, seed production is too great for manual harvesting.
- **Timing** – such plantations require long-term commitment because the investment starts generating revenues only after 5 years and becomes cash-positive only after 8-9 years when trees reach peak production and significant carbon credits are generated.
- **Major national industrial partner** – whether as project promoter or sponsor to the project promoter, a major industrial partner is necessary to co-finance studies, purchase certain products, and provide long-term financial, political and infrastructural backing.
- **Diverse products and value chains** – these diversify income streams and distribute risk, but increase the complexity through multiple products and value chains.
- **Clear carbon rights** – clear institutional and regulatory frameworks, with transparent, reliable and equitable ownership, benefit-sharing, sales and transfer rights, are key to stimulating investment in carbon crediting. Pre-sale of credits can mitigate early cash-flow constraints.
- **Community involvement** – while plantations create significant employment, pongamia is considered unsuitable for out-grower plantations in Guinea.
- **Social and political license to operate** – support from rural communities and from national and local authorities is critical over the long-term, without which plantations and associated natural habitat will not survive. Thus, while the investment generates four marketable products – vegetable oil, high-protein meal, biomass shells and carbon credits – the other benefits generated provide benefits shared across multiple sectors and levels of society, generating their support.

Because this investment needs to be done at large scale to be efficient, it is not suited for areas facing demographic pressures; otherwise it could result in loss of community land needed for subsistence and/or induced loss of native habitat (leakage). It requires careful identification of appropriate land and fair, transparent access agreements.

For the investment's social acceptance and security, it must provide tangible benefits to local population in short, medium and long terms:

- **Short term:** jobs, improved roads, horticultural opportunities
- **Medium term:** same as previous plus improved & separate grazing areas to reduce social conflict, new induced livelihood opportunities, watershed protection with improved & reliable water supply, local climate regulation, enhanced access to biodiversity products (plants, game, forest-related cultural services)

- **Long term:** same as previous plus systemic economic development, skills and SME development to replace internationally with nationally sourced staff, goods and services, sharing of carbon credits

Government must take long-term perspective providing a supportive policy and fiscal regime.

Selected Technical Risks

The investment has several technical risks such as:

1. The prices of products fall below commercially attractive levels. *Mitigations include developing a diverse set of products, signing long-term supply contracts with fixed minimum prices, seeking first national markets but having the ability to supply international markets in certain circumstances.*
2. Legal and regulatory stability. *Mitigations include clear agreements with government about fiscal and trade-related terms including stability clauses, and clear benefit-sharing terms including Government's shares.*
3. Labour pool. *Mitigations include training programmes for host communities, and specialised study and placements with internationally renown universities and agro-industrial businesses.*
4. Supply chains for high-tech aspects like the nursery and specialised machinery. *Mitigations include clear customs agreements and working with support from large, in-country industrial partners.*
5. Failure or low production of plantations. *Mitigations include a selection process of genetic varieties to identify those that grow and produce best in Guinea, and close observations of growth and productivity of seedlings and tree in initial years to identify optimal conditions.*
6. Non-permanence of plantations or restored natural habitat. *Mitigations include clear, thoroughly agreed land-access agreements for both plantations and restored natural habitat, and tangible, well-understood benefit-sharing mechanisms with land owners linked to protection and maintenance of both.*
7. Pongamia's theoretical risk of invasiveness:
 - Pongamia earned '**high**' risk of invasiveness when the Australian Weed Risk Assessment Tool was applied during the pre-feasibility studies of 2024.
 - However, nowhere does existing literature describe pongamia as invasive in areas similar to those proposed in Guinea, despite being present in some areas for over a century.
 - Humans and water are pongamia's only vectors, otherwise animals do not spread seeds, nor does wind, and it does not actively spread vegetatively.

Regarding point 7, pongamia's risk of invasiveness, proposed mitigations include:

- No distribution of propagules outside of plantations, no village-level or individual plantations, no sourcing of seeds from outside plantations and clarify this with smallholders and that processing of pongamia seeds requires technology they cannot access,
- Sending manual collection teams into plantations after mechanical harvesting to collect seeds that were missed,
- No plantations in biologically sensitive areas or within 20-30m of water courses,

- Protection of water bodies from seeds: restoration/protection of natural habitat along riparian areas to serve as filters, working with topography, dykes and channels to direct flooding to filters of natural habitat and geotextile fencing,
- No plantations in coastal areas,
- Strictly controlled handling, transport and storage of seeds and propagules, and
- Annual monitoring of areas surrounding plantations for escapees; contingency plan and independently held bond to pay for removal of plantations if needed.

As noted in [IUCN's Guidelines on Biofuels and Invasive Species](#) (2009), any non-endemic, oil-seed tree with high propagule pressure, which is desirable for oil-seed species, would have a high theoretical risk of invasiveness. Thus, it is unsurprising that pongamia scores high. However, the key question becomes whether it has demonstrated invasive tendencies in similar environments, which is not the case for eastern Guinea, and whether the mitigation measures are effective. It is worth noting that observations from Australia indicate that trees grown from the seeds of productive strains of pongamia are not generally productive. Commercial plantations use cuttings from super-producing parents grown in nurseries.

Conclusion

Experience in Guinea indicates that for private sector investment in large-scale, regenerative agricultural ventures based heavily on nature-based solutions, bankable initiatives must:

- Be market-driven and financially viable, with a large, national industrial partner-sponsor,
- Generate benefits through nature-based solutions that both enhance commercial benefits and generate broad social and political license-to-operate,
- Encourage non-commercial benefits to be generated and shared freely if they generate social and political acceptance, without the expectation that private investment is responsible to address all social problems, and
- Be designed for site-specific conditions and depend on win-win-win opportunities: communities, government and investors.

Financing that blends public and private sources can reduce risk and overcome initial barriers to developing and funding large, innovative regenerative agricultural investments. However, private-sector funding often moves faster than the public sector's so aligning all funding decisions can be difficult. Government's role is to create an enabling environment for private sector to be nimble, make investments and make profit, while sharing benefits broadly.

Appendix 2: Paraguay – Investancia an emerging proof of concept for oil seed trees investment.

Investancia runs high-impact reforestation programs

Investment objective

- The investment will plant 50 million trees over 120,000 hectares at the rate of 400 trees per hectare, to reforest degraded cattle land in the Chaco, currently 10,000 hectares has been planted
- This will lead to the sequestration of 1.2 million tons of CO₂ each year
- 480,000 tons of bio-protein will be produced each year
- 300,000 tons of fossil crude each year will be replaced
- First harvesting begins in 2027 in the R&D centre, and in 2031 in the commercially planted lots

Investancia reforests degraded cattle land in silvopasture systems, which improves pastures and allows cattle ranchers to continue their grazing activities simultaneously. Investancia reforests degraded cattle land that often-most is severely degraded due to very high salinity levels and seasonal drought followed by flooding, making the soils inapt for food production. The tree species survive and even thrive in these challenging soils, and rough weather conditions. In fact, some species even improve soil health as they fix atmospheric nitrogenic and auto-fertilize naturally. The reforestation programs reconnect green corridors whilst generating large-scale carbon sequestration, also known as nature-based carbon removals, which are certified under the Verified Carbon Standard and CCBS.

Only selected productive and native tree species, developed within the on-site nursery are used in the reforestation areas. The use of productive tree species allows to simultaneously produce low carbon proteins and non-edible vegetable oil as by-products to carbon sequestration. Non-edible oils produced from trees represent the lowest carbon intensity (CI) levels available for the production of renewable biofuels.

The elite tree propagation and research centre already represents the world's largest production site for oil producing tree species the specialist tree propagation and research centre which is scaled to reach an annual production capacity of over 7 million trees per year. This will supply both internal and external market requirements as further investments are planned in Brazil and within Africa.

Investancia and BRP will develop a joint venture approach for proposed investments in Africa, starting in Guinea, to take forward the proof of concept learnings and applicable technologies.

The following impacts per 100,000 hectares of Pongamia plantings will be;

1. Economic

- Creation of an estimated 250 direct permanent jobs

- Workforce creation for the land preparation and planting of 50 million trees
- Workforce for the harvesting and crushing of more than 2 million tons of pods per year
- Animal feed (protein) production from seed cake meal and export of 480,000 metric tons per year
- Crude vegetable oil production and export of 300,000 metric tons each year
- Creation of commercial tree nurseries operations
- Infrastructure maintenance
- Creation of apiculture

2. Social

- Full implication and involvement of local Chaco population including indigenous communities
- Employees' housing programs
- School aid programs
- Medical support programs
- Technology & know-how transfer
- Training of local workforce
- Best practices transfer