A Field Guide to Reforestation in the Philippines
27 MAY 2015

From bare soil to a lush forest cover that benefits you and your community, reforestation strategies are set to change the game of agriculture and climate change mitigation.
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Preface

Deforestation and Reforestation in Philippines

Deforestation in the Philippines arguably began in 1521 when the Spanish colonial masters initiated land clearing. It continued through the country’s rule by the United States in the early 20th century and skyrocketed during the second World War as local people sought shelter and food in the forests of the islands. The Philippines started exporting timber in 1900 and became an important supplier in the world timber market (Bao, 2012). The forest cover in the Philippines decreased from nearly 50% in 1950 to a mere 8% in 1992 (Bao, 2008). The impact of this uncontrolled deforestation is associated with more natural disasters such as landslides and flooding, biodiversity loss and a decrease in income from non-timber forest products.

More recently, the Philippines has attempted to mitigate climate change by reducing carbon emissions from deforestation or increasing carbon sinks by afforestation (establishing a forest on land without forest cover in the recent past), rehabilitation (attempts to return the forest to a stable and productive condition, but not necessarily the original diversity, structure and function), and reforestation work (establishing a forest on recently deforested lands). With respect to the latter, three major reforestation strategies have been implemented across the Philippines: monoculture, assisted natural regeneration and rainforestation farming. Monoculture is a common reforestation strategy while the other two are emerging new methods with significant studies and literature.

At present, there is a lack of information to compare across all three reforestation strategies. Thus, we have developed this field guide for farmers, conservationists and urban planners who want to conduct reforestation. It aims to provide guidance on identifying circumstances and conditions of reforesting suitable land sites to bring back vital ecosystem services forests provide: improved air, soil and water quality, great biodiversity of plants and animals, as well as forest products and resources. Ultimately, this guide will help them decide whether and which of the three methods is most suitable based on contextual criteria.

Aw Jeanice, Judy Goh, Alicia Ng, Nicole Lee & Rex Tan
Cookie Monsters Inc.
May 26, 2015
Acknowledgements

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We also like to extend our appreciation and gratitude to Holy Name University (HNU) for hosting us in Bohol, Philippines, as well as Bohol Biodiversity Complex (BBC) and Habitat Bohol for their hospitality during our stay there in the research for this field guide.
Section 1: Introduction to Strategies

1.1 Monoculture

Monoculture is the practice of relying on a very small number of genetic variants or cultivars of a species for commercial agricultural forests (Science Daily, 2015). Monoculture usually includes only one or two species of trees for planting.

Man-made forest in Bohol

The original vegetation of the man-made forest site were cleared in the late 1940s during the World War II by people seeking refuge and safety in the forests. "Kaingins" or clearings in the forests were used for farmlands for the people’s livelihood. The resulting barren land was susceptible to soil erosion and floods during rainy seasons; water supply decreased as highland springs dried easily during dry seasons.

After the war, the Loboc Watershed Restoration Project (LWRP) was then established in 1953 to reforest the area to quickly prevent further erosion, and ensure a stable and abundant supply of water into the Loboc River where a Hydro Electric Power Plant were to be constructed. Thousands of seedlings of Philippine mahogany (*Swietenia macrophylla* and *Swietenia mahogani*) as well as other species of plants were planted during 1965–67, and now a tall and magnificent forest with sufficient ground cover to intercept rainfall stands on the site.

Why should you use this strategy?

If you are looking to reap economic benefits from your reforestation project, monoculture of cash crops such as teak, cacao (*Theobroma cacao*) and mahogany may appear to be the best strategy. However, planting trees with the objective of clear-cutting for wood or other products is not sustainable because the forest cover is not maintained once the trees are felled. It is crucial that the reforestation project is meant for the long term provision of ecosystem services such as erosion prevention instead of a commercially viable operative.

If maintained, monoculture reforested sites can quickly prevent soil erosion, by planting seedlings of fast growing trees such as mahogany or teak. It is suitable even on slopes to reduce landslide occurrences, and the large trees can intercept rolling boulders. However, if your site has a steep incline/slope, it would be dangerous to plant large trees in case of tree falls.

To begin, you need to decide on the species of trees to plant. Monoculture works best with fast growing species that can grow on degraded soils. The species should also be suitable for the
Section 1: Introduction to Strategies

weather and climate of your site. If there are significantly prolonged dry seasons, the species must be able to survive seasonal rainfall patterns, and you will need to create firebreaks to prevent forest fires from spreading into your site. To benefit sustainably from your plot, you can grow trees with larger canopy spread to intercept more rain (which can prevent erosion and increase water supply). It can even be so that the tree species can provide food or products for you and your community (if not cleared). To know what species you can plant to benefit most from your monoculture reforestation project, you may consult experts (Section 4: Recommendations).

Next, you need a nursery to raise seedlings, and if your potted seeds are dependent on rainfall, the site must have sustainable water supply. To understand which species’ requirement, you may consult experts (Section 4: Recommendations).

The planting of the seedlings on the site is time-consuming and labor-intensive, therefore you should either devote large amounts of time to it, and/or work with your community/barangay/village to be involved in the reforestation project.

After the monoculture reforestation site has stabilized, you may consider diversifying the site by planting plant species or setting bird perches to attract wildlife back. More birds, bats and insects can aid in pollination and pest control.

Table 1: Analysis of advantages and disadvantages of monoculture reforestation.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fast growing (5 – 10 years)</td>
<td>Low biodiversity from few species leading to reduction of ecosystem functions</td>
</tr>
<tr>
<td>Relatively fastest ecosystem functions such as erosion prevention, higher rainfall from greater forest cover and watershed restoration</td>
<td>Same age-structure of saplings does not provide many niches (lack of some layers of a rainforest)</td>
</tr>
<tr>
<td>Can be on steep slopes (if not intended for harvesting)</td>
<td>Relatively costly (for seedlings)</td>
</tr>
</tbody>
</table>
1.2 Assisted Natural Regeneration (ANR)

ANR is a practice used for converting *Imperata cylindrica* and other grass-dominated areas into productive forests (Durst, Sajise and Leslie, 2011).

**ANR plot by Janlud in Batuan, Bohol**

ANR is developed and promoted by United Nation Food and Agricultural Organizations (UNFAO) to enhance the establishment of secondary forest from degraded grassland and shrub vegetation by protecting and nurturing the mother trees and their wildings inherently present in the area (FAO, 2011).

ANR aims to accelerate, rather than replace, natural successional processes by removing or reducing barriers to natural forest regeneration such as soil degradation, competition with weedy species and recurring disturbances (e.g. fire, grazing, and wood harvesting) (FAO, 2011). For instance, lodging board is used to press down weeds surrounding a native tree sapling to reduce competition. It is practiced in Janlud, Batuan, Bohol since 2011 and 2012 respectively.

ANR provides a range of benefits: it (1) reduces cost of regenerating forest, (2) provides job opportunities for communities, (3) contributes to strengthening biodiversity, (4) provides hunting areas and (5) increases carbon sequestration and carbon sinks to help mitigate climate change.

**Why should you use this strategy?**

ANR is the most natural reforestation strategy next to leaving the site to its own devices to regenerate. Unlike the other two strategies, Mother Nature makes the decisions of producing and planting the seedlings, with the species best selected for the site. Therefore it is more likely to persist.

This strategy requires no capital for buying and nursing seedlings, and it does not require the effort of massive planting. Hence, it is a relatively low cost strategy.

First, you should learn to identify the saplings of native tree species you wish to have in your site. Then, competition with the sapling is get rid of by pressing surrounding grasses (especially *Imperata cylindrica*). You can purchase a lodging board to step and press the grasses down, or do it yourself: attaching a flat rectangular wooden board to a rope on both sides.

“ANR does not plant anything, but takes care of what Mother Nature has planted.”

Patrick Dugan
Section 1: Introduction to Strategies

You should understand any seasonal patterns in weather: if there are prolonged dry seasons, you should set fire breaks in the grasses to stop fire from spreading within and into your project site.

There are two versions of ANR: with enrichment planting and without enrichment planting. You can also enhance the success of the reforestation project by enrichment planting of several native and endemic plant species in the plot – even species you can sustainably harvest forest products. This will likely incur higher costs as it would involve the planting of seedlings as in conventional reforestation, or via direct seeding. It is particularly necessary if there are insufficient wild seedlings and saplings in the site identified (<800).

Table 2: Analysis of advantages and disadvantages of Assisted Natural Regeneration (ANR) program.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relatively low cost</td>
<td>Only possible on degraded lands where there are signs of recovery (presence of saplings and wildlings)</td>
</tr>
<tr>
<td>More natural and more likely to persist given that Mother Nature has selected for the sapling</td>
<td>Only possible if surrounding areas contain natural forests or are productive (allows pollinator and seed disperser species to come over and spread into site)</td>
</tr>
<tr>
<td>Viable on steep slopes</td>
<td>Monitoring on steep slopes may be difficult</td>
</tr>
<tr>
<td>Viable for easily accessible sites with additional crop planting</td>
<td>Requires continuous maintenance to eliminate threats to deforestation which may increase costs (eg. selective weeding, lodging grass)</td>
</tr>
</tbody>
</table>
1.3 Rainforestation Farming

Rainforestation farming is a practice of using native or endemic trees to reforest an area, henceforth giving importance on improvement of structural habitat to support wildlife and restore ecological services (Milan, 2014). It is also an ecologically aware form of integrating economic benefits with ecosystem services.

Rainforestation farming in Bohol Biodiversity Complex (BBC) in Bilar, Bohol

Rainforestation farming was initially conceptualized by Visayas State University with a demo site in Leyte, planted in 1992. In collaboration with Bohol Island State University (BISU), the BBC started their Rainforestation project in 1998. There are already two completed Rainforestation projects done in 1998 and 2014, as well as one ongoing project expected to complete in 2015.

Why should you use this strategy?

Rainforestation farming aims to preserve biodiversity and expand Philippine forests and simultaneously sustain human food production (DENR, 2004). Therefore if you are looking to benefit not just from sustainably harvestable forest products but also increased biodiversity and water supply. In Leyte, some farmers who adopted rainforestation farming enjoyed a 3–35 times increase in income (by being able to harvest sustainably over ten long years from their site). The high benefits-cost ratio is beneficial to not just you but your community as well, if your site is large enough.

In Leyte, some farmers who adopted rainforestation farming enjoyed a 3–35 times increase in income.

Rainforestation farming prioritizes the planting of indigenous and endemic tree species, where saplings can be obtained as wildlings from surrounding areas or purchased from nurseries. However, one of the key advantages of rainforestation farming is that native tree species can be planted in conjunction with valuable species such as fruit trees in

Figure 1: Rainforestation farming have five objectives: (1) establish buffer zone around primary forest, (2) replace destructive kaingin practices, (3) protect forest biodiversity, (4) maintain water cycle, and (5) provide stable, high income to farmers (Milan, 2014).
addition to dipterocarp and premium timber species for harvesting. Alternate year planting and harvesting of sun-loving and shade-loving species enable rainforestation farms to thrive. Ultimately, selective logging can be carried out.

Table 3: Analysis of advantages and disadvantages of the rainforestation farming program.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can be combined with agricultural crops to increase economic productivity</td>
<td>Moderately high cost (for buying saplings)</td>
</tr>
<tr>
<td>Good for degraded or deforested lands</td>
<td>Time-consuming</td>
</tr>
<tr>
<td>Large site not necessary</td>
<td>Labor-intensive</td>
</tr>
<tr>
<td>Relatively high biodiversity</td>
<td>Cannot be on steep slopes (difficult to plant saplings and harvest)</td>
</tr>
</tbody>
</table>
Reforestation strategies are varied and have advantages and disadvantages that are interrelated, complementary or subsets of one another. It can be confusing to pick the best reforestation strategy for your purposes, so Cookie Monsters Inc. recommends the following guide for decision-making:

- First, determine your intended objectives and aims of your reforestation project (Section 2.1 Objectives of Reforestation Project). These should most strongly guide your reforestation strategy selection.
- Once you have your site, look to geographical and ecological factors (Section 2.2 Geographical and Ecological Factors) to assess the fixed characteristics of your site which may limit your choice of reforestation strategy.
- Cost and time are clearly important factors that require separate considerations, and Section 2.3 Cost & Time Factors) is designed for a clear comparison of known costs and time horizons that have been found in previous studies on each restoration project. This toolkit is not intended to be a full cost-benefit analysis for opportunity cost comparison nor calculations on potential rate of returns, although this may be explored in future editions of this field guide.
- Lastly, human resource factors of community involvement and engagement, funding sources and collaboration for expertise and specific project design (eg. species of trees) can be considered using 2.4 Resource Factors).
2.1 Objectives of Reforestation Project

As a farmer, conservationist or land-owner, you may be interested in the following examples of objectives and aims that reforestation can achieve. These are not mutually exclusive, but overlap with one another for multiple benefits. However, it is necessary to highlight your priorities in order to narrow down the type of reforestation strategy that is most likely to fit your unique context.

<table>
<thead>
<tr>
<th>Economic Benefits</th>
<th>Ecosystem Service Benefits</th>
<th>Conservation Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainable harvesting of timber (staggered felling of trees)</td>
<td>Improved air quality</td>
<td>Attracting wildlife back with potential ecosystem service benefits (eg. Birds, bees)</td>
</tr>
<tr>
<td>Commercial harvesting of timber (felling of trees)</td>
<td>Improved water quality</td>
<td>Increasing native plant and animal diversity</td>
</tr>
<tr>
<td>Sustainable harvesting of fruit crops</td>
<td>Watershed restoration</td>
<td>Carbon sequestration and storage</td>
</tr>
<tr>
<td></td>
<td>Soil erosion prevention</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improved microclimates and shading</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nutrient cycling</td>
<td></td>
</tr>
</tbody>
</table>
# Section 2: Strategy Selection Toolkit

## 2.2 Geographical and Ecological Factors

This checklist is an easy way to look into different factors that can affect the decision of choosing which strategy to uptake. Please proceed to tick either ‘Yes’ or ‘No’ binary answers for each question in the checklist. Then you may read the recommendations (from the experts at Cookie Monster Inc, our advisors and existing available literature) presented in each question. The last column ‘Your Chosen Strategy’ is for you to fill in your decided strategy for each question. At the last row titled ‘Most likely reforestation strategy so far’, a tentative conclusion of the final chosen strategy is reached based on the strategy that appeared the most times in the checklist.

<table>
<thead>
<tr>
<th>No.</th>
<th>Geographical &amp; Ecological Factors</th>
<th>Yes (x)</th>
<th>No (x)</th>
<th>Recommendation</th>
<th>Your Chosen Strategy</th>
</tr>
</thead>
</table>
| 1   | Is your site located **within a watershed**?  
* A watershed is defined as the area of land where all of the water that is under it or drains off of it goes into the same place (EPA, 2012). You may wish to check with your municipality for specific watershed boundaries. |         |        | If **NO**, your site may be unsuitable for purposes of watershed restoration. Forests can still provide enhancements to water quantity through aiding water infiltration for groundwater sources. |                      |
| 2   | Is your site on a **steep slope**?  
* A steep slope is defined as one that is more than 45° and is prone to slope failure events, such as soil erosion and landslides. |         |        | If **YES**, your site may be more suitable for **ANR** because it is difficult to plant seedlings on steep slopes. You may also wish to explore options for contour farming. |                      |
| 3   | Is your site **easily accessible** based on its terrain?  
* An easily accessible site is one that you would feel comfortable navigating on a frequent basis to harvest and reap the land. |         |        | If **NO**, your site may be more suitable for **ANR** because it is difficult to harvest agroforestry crops on rugged terrain. |                      |
| 4   | Does your site have **fertile soil**?  
* If your soil has high organic matter biomass and essential macronutrients, then it is considered fertile soil. |         |        | If **NO**, your site may incur greater costs because more effort is required to encourage the establishment of plant species through soil management. |                      |
| 5   | Is your site microclimate **susceptible to long dry periods**?  
* A long dry period is defined as low rainfall for more than 4 months. |         |        | If **YES**, your site may incur greater costs because more effort is required to reduce the threat of fire through cutting fire lines. |                      |
## Section 2: Strategy Selection Toolkit

<table>
<thead>
<tr>
<th>6</th>
<th><strong>What is the state of your site currently?</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td><strong>Pristine</strong> – natural primary or secondary mature forest</td>
</tr>
<tr>
<td></td>
<td>If <strong>YES</strong>, reforestation is not required. You are strongly encouraged to preserve the area as it is instead of utilising the land. Another site ought to be selected.</td>
</tr>
<tr>
<td>b</td>
<td><strong>Plantation</strong> – an estate of planted crops</td>
</tr>
<tr>
<td>i</td>
<td>o Are you planning to harvest your current plantation crops and clear the land entirely?</td>
</tr>
<tr>
<td></td>
<td>If <strong>YES</strong>, your site may be suitable for Monoculture, ANR or Rainforestation farming depending on your time horizon of expected benefits.</td>
</tr>
<tr>
<td>ii</td>
<td>o Are you planning to continue with your current plantation crops without clearing the land and to grow more to improve the land?</td>
</tr>
<tr>
<td></td>
<td>If <strong>YES</strong>, you may wish to explore agroforestry methods to integrate native species of trees and shrubs into your crop plantation (see upcoming 2016 edition).</td>
</tr>
<tr>
<td>c</td>
<td><strong>Slightly degraded</strong> – selectively logged forest with reduced level of ecosystem services or recovering secondary forest (WRI, n.d.)</td>
</tr>
<tr>
<td></td>
<td>If <strong>YES</strong>, your site may be more suitable for ANR to speed up the rate of forest recovery.</td>
</tr>
<tr>
<td>d</td>
<td><strong>Moderately degraded</strong> – cleared land showing signs of recovery (including presence of pioneer species as saplings or seedlings)</td>
</tr>
<tr>
<td></td>
<td>If <strong>YES</strong>, your site may be more suitable for ANR to speed up the rate of forest recovery.</td>
</tr>
<tr>
<td>e</td>
<td><strong>Highly degraded</strong> – cleared forest with only grasses and shrubs</td>
</tr>
<tr>
<td></td>
<td>If <strong>YES</strong>, your site may be more suitable for Rainforestation farming or ANR with enrichment planting to plant native tree seedlings.</td>
</tr>
<tr>
<td>f</td>
<td><strong>Deforested</strong> – previously forested land recently cleared, with large patches of exposed soil and little regrowth.</td>
</tr>
<tr>
<td></td>
<td>If <strong>YES</strong>, your site may be more suitable for Rainforestation farming to plant native tree seedlings.</td>
</tr>
<tr>
<td>7</td>
<td>Does your site currently have &gt;800 native seedlings or sapling growing per hectare?</td>
</tr>
<tr>
<td></td>
<td>If <strong>YES</strong>, your site may be more suitable for ANR to speed up the rate of forest recovery as sapling materials are present.</td>
</tr>
</tbody>
</table>

**Most likely reforestation strategy so far:**
2.3 Cost & Time Factors

Cost and time factors for five variations on reforestation methods are seen in the table below. These costs and time frames are only approximate for relative comparison purposes; they can vary with specifics of a project. For instance, the time horizon for benefit returns can depend greatly on the type of tree species or crops being planted. The costs include management and maintenance but exclude the cost of land purchase.

<table>
<thead>
<tr>
<th>Reforestation Project</th>
<th>Cost per hectare (US$)</th>
<th>Time Horizon</th>
<th>Your Chosen Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monoculture plantation (sustainably harvested forest products eg. fruit trees, selective logging)</td>
<td>46,856*</td>
<td>10-25 years for selective logging</td>
<td></td>
</tr>
<tr>
<td>Monoculture plantation (for clear cutting)</td>
<td>35,287*</td>
<td>10-25 years for clear cutting</td>
<td></td>
</tr>
<tr>
<td>Assisted Natural Regeneration (without enrichment planting)</td>
<td>25,887~</td>
<td>&gt; 4-10 years to reach a young forest</td>
<td></td>
</tr>
<tr>
<td>Assisted Natural Regeneration (with enrichment planting)</td>
<td>approx. 26,781~</td>
<td>&gt; 2-10 years to reach a young forest</td>
<td></td>
</tr>
<tr>
<td>Rainforestation Farming</td>
<td>44,046*</td>
<td>5-10 years for fruit trees (eg. durian, lanzones, rambutan) 10-25 years for selective logging</td>
<td></td>
</tr>
</tbody>
</table>

* based on US$1:pessos44.7 exchange rate (Google Currency Converter, retrieved 26 May 2015).

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### 2.4 Resource Factors

<table>
<thead>
<tr>
<th>No.</th>
<th>Resource Factors</th>
<th>Yes (x)</th>
<th>No (x)</th>
<th>Recommendation</th>
<th>Your Chosen Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Do you own the proposed reforestation site?</td>
<td></td>
<td></td>
<td>If <strong>NO</strong>, you may wish to refer to Section 4: Recommendations on sources of funding.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Is your reforestation site larger than 2 hectares?</td>
<td></td>
<td></td>
<td>If <strong>NO</strong>, your site may not be applicable for watershed restoration, which requires more than localised areas. Forests still can provide enhancements to water quality through aiding water infiltration for groundwater sources.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Are the benefits of this reforestation strategy primarily for your own economic livelihood?</td>
<td></td>
<td></td>
<td>If <strong>YES</strong>, you may wish to consider <strong>Rainforestation farming</strong> despite the higher initial costs because of the high benefit-cost ratio leading to higher rates of return.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Do you have sufficient funds to manage the reforestation strategy?</td>
<td></td>
<td></td>
<td>If <strong>NO</strong>, you may wish to refer to Section 4: Recommendations for sources of funding.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Will you be engaging the community within your barangay to assist you in this reforestation project?</td>
<td></td>
<td></td>
<td>If <strong>NO</strong>, you may wish to consider <strong>Rainforestation farming</strong> on a smaller site to cope with the maintenance and management. <strong>Monoculture</strong> is also possible depending on the species that you select.</td>
<td></td>
</tr>
</tbody>
</table>

If **YES**, all three are suitable. It is imperative that you share the importance of your site with the rest of the...
**Section 2: Strategy Selection Toolkit**

<table>
<thead>
<tr>
<th>A</th>
<th>Co-management of the reforestation project</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Assistance in maintenance activities (eg. lodging grass, seedling planting, monitoring and assessing)</td>
</tr>
</tbody>
</table>

Community, such as your purpose in setting up a reforestation project. This will ensure that there is buy-in from the community and a sense of shared ownership and stewardship to protect the area from illegal loggers or harvesters, which can cause a reforestation project to fail.

If **YES**, you may wish to set up a formal framework (eg. co-operative) to institutionalize and manage the site. This is more commonly used for ANR sites where the benefits of ecosystem services are shared by the community.

If **YES**, it is important that they are properly trained by forest technicians on the steps. Refer to Section 4: Recommendations for recommendations on expertise.

**Most likely reforestation strategy so far:**
Section 3: Monitoring and Assessment

3.1. Importance of monitoring

How would you ensure that your reforestation plot is working in your favour? Simple, through conscious monitoring! Monitoring is crucial for the effective management of your site and the identification of changes within the site (Dolswald & Miles, 2010). Besides gaining a better appreciation for the benefits of reforestation, monitoring would also shed insights on future complications. Analysis of monitoring data may subsequently provide information for adaptive management, improvements to best tailor to your site and your needs. Long-term monitoring practices may help to develop an optimal maintenance strategy and maximise the productivity of your reforested plot.

3.2. Monitoring protocol

The following indicators serves to access the quality of your plot and reflect the effectiveness of the reforestation strategy in addressing the various objectives.

Survival rate of vegetation

The growth of wildlings and new vegetation growth should be documented, including information such as tree mortality and growth measurements of each tree species. Consequently, the survival rates and resilience of each species may help identify tree species selection of future plantings (Lebanon Reforestation Initiative, 2014). Seedling or wildling survival rates may also be reflective of past conditions limiting the growth of the various species.

Improvements of ecosystem services

- Microclimate

  Microclimate directly influences ecological processes (e.g. plant regeneration and growth, soil respiration, nutrient cycling, wildlife habitat selection e.t.c) and reflects subtle changes in ecosystem function and landscape structure across scales. Examples of microclimatic conditions that can be measured within an area are the ambient temperature, wind speed, relative humidity, and precipitation.
Table 4: Microclimate assessment parameters and relative importance.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Assessment</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient temperature</td>
<td>Temperature in most tropical forests is 25-35°C. May vary for different forest sites and elevation. Measured with thermocouple.</td>
<td>Each component of the microclimatic environment exhibits unique spatial and temporal responses to changes in structural elements. The dynamics of these responses differ with the choice of metric used to quantify microclimate. Therefore, the sensitivity of the microclimate to structural transformation (e.g. stand-level changes in over-story height and landscape-level fragmentation) offers strong potential for monitoring ecosystem and landscape changes at multiple spatial scales.</td>
</tr>
<tr>
<td>Wind speed</td>
<td>Measured with anemometer.</td>
<td></td>
</tr>
<tr>
<td>Relative humidity</td>
<td>Measured with hygrometer.</td>
<td></td>
</tr>
<tr>
<td>Precipitation</td>
<td>Measured with a rain gauge.</td>
<td></td>
</tr>
</tbody>
</table>

- Edaphic conditions
  Relevant soil measurements include the physical analyses (i.e. soil texture, soil type, soil colour) and chemical analysis inclusive of organic matter, nutrient availability, pH of soil and soil temperature. Physical analysis of soil is reflective of soil properties such as porosity and permeability, which in turns impacts drainage. Whereas, chemical analyses of soils such as pH, level of nitrogen and phosphorus as well as temperature are important for the selection of species for plantings. Additionally, indicator plants may be observed for the presence or absence of nutrients. The physical analysis of soil texture includes the identification of soil type (Agpaoa et al., 1976).
Section 3: Monitoring and Assessment

Table 5: Categorisation of soil texture

<table>
<thead>
<tr>
<th>Type</th>
<th>Identification feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>Does not stain hands when wet</td>
</tr>
<tr>
<td>Loamy sand</td>
<td>Slightly sticky, but cannot form stick of cigarette thickness</td>
</tr>
<tr>
<td>Sandy loam</td>
<td>Can form stick of cigarette thickness, sound produced when rubbed between fingers close to ears</td>
</tr>
<tr>
<td>Loam</td>
<td>Can form doll with arms and legs, light sound when rubbed between fingers</td>
</tr>
<tr>
<td>Clay loam</td>
<td>Can form a fragile string, no sound when rubbed between fingers</td>
</tr>
<tr>
<td>Clay</td>
<td>Highly plastic and slippery, can form a thin string</td>
</tr>
</tbody>
</table>

Additionally, water content of soil could also be simply categorised through:

Table 6: Categorisation of soil moisture

<table>
<thead>
<tr>
<th>Category</th>
<th>Identification feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry</td>
<td>Did not change colour when water was added</td>
</tr>
<tr>
<td>Fresh</td>
<td>Colour grew darker when water was added</td>
</tr>
<tr>
<td>Moist</td>
<td>Water felt when pressed</td>
</tr>
<tr>
<td>Wet</td>
<td>Water runs out when pressed</td>
</tr>
</tbody>
</table>
Subsequently to determine the change in intensity of soil erosion before and after the restoration project have been implemented, steam water samples of soil could be collected to derived soil erosion rate and sediment yield.

- Water quality and quantity
  The presence of forest is stated to primarily improve water quality (Neary et al., 2008). To measure water quality, the parameters below could be measured and analysed. For interpretation of the each of the parameters, please refer to Chapter 12 of the book by Neary et al.

  *Table 7: Parameters to determine water quality (Pike et al., n.d.)*

<table>
<thead>
<tr>
<th>Category</th>
<th>Parameters</th>
<th>Example measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical</td>
<td>Water temperature</td>
<td>Temperature</td>
</tr>
<tr>
<td></td>
<td>Sediment</td>
<td>Total suspended solids</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Turbidity</td>
</tr>
<tr>
<td>Chemical</td>
<td>Ions, dissolved constituents, and nutrients</td>
<td>pH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electrical conductivity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total dissolved solids</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dissolved oxygen</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ions (e.g., sodium, potassium, calcium, magnesium, iron)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nitrogen (nitrate, ammonium)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Phosphorus (various forms)</td>
</tr>
<tr>
<td>Toxic parameters</td>
<td>Pesticides (insecticides, herbicides, and fungicides)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Metals (e.g., lead, mercury, cadmium, aluminum, copper, selenium, zinc)</td>
<td></td>
</tr>
<tr>
<td>Biological</td>
<td>Biological parameters</td>
<td>Chlorophyll a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fecal coliform</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Benthic invertebrate communities</td>
</tr>
</tbody>
</table>

- Water Quality and Forest Management.
  Water quantity has to be derived by considering the watershed in which the area resides in. Observations of less flooding and moderated peak flows during high rainfall may be indicative of regulation by restored forest (Neary et al., 2008).
Flora & Fauna

Species diversity and assemblage could be done for both flora species as well as fauna species such as birds.

With regards to flora surveys, pre- and post-reforestation measurements such as tree density, tree species wealth, tree diameter, forest species diversity and grassland species diversity (for ANR plots) could be recorded. Subsequently, comparisons between the two measurements would be indicative of the changes and growth in vegetation largely attributed to the reforestation strategies (Durst et al., 2009). Additionally, these tree measurements have been shown to be correlated with the species richness of various biodiversity including birds, rainforest reptiles and beetles (Kanowski et al., 2008).

The landscape function analysis (LFA) procedures for vegetation structure could also be used. Three indices: infiltration, nutrient cycling and stability were developed from various vegetation measurements. The indices reflect the traditional factors of vegetation structure and more importantly, consider the functional role of vegetation in regulating vital resources that act as mobilizing agents, like wind and water (Tongway, 2015). The list of measurements required for the landscape function analysis (LFA) procedure can be found below:

- **Transect methods**
  For measuring distances to plants from points established along transects. Traditionally used to estimate vegetation density. There are two types of transects recommended: Point Centred Quarter (PCQ) and Wandering Quarter (WQ).

- **Plant measures (additional attributes on identified plants)**
  To assess functional roles of vegetation, such as how the plants affect resource regulating processes. Overall height, height to canopy, width and breadth of canopy and canopy density (% of overall canopy space occupied by foliage and stems) were recorded.
Section 3: Monitoring and Assessment

- Vegetation structure indices
  Using the distance data from PCQ and WQ and data from the additional plant measures in (b), the following vegetation indices can be calculated:
  - Plant density for each plant life form measured (e.g. tree, shrub, grass)
  - For trees and shrubs – canopy area and canopy volume (m$^3$ per hectare)
  - For grasses – total base area (m$^2$ per hectare)
  - The horizontal cross sectional area in height classes: an index for wind amelioration along the landscape surface

- Interpretation of the functional role of vegetation structure
  How vegetation functions to regulate the flows of wind and water through a landscape can be illustrated by graphing summaries of the vegetative cover.

  For example, if the forest is in good condition, there will be a vertical distribution of canopy cover that will strongly function to resist flows of wind or water through the landscape. This will hence retain vital water and soil resources. In contrast, if the forest is in poor condition, there will be a notable loss of ground cover consisting of mainly grasses and shrubs. This has important implications for the flow and loss of soil resources, due to wind and water, across the landscape surface.

Figure 2: Tree structure dimensions useful for assessing vegetation function (Tongway, 2015).
For fauna species, regular bird surveys could be conducted to compile an inventory of bird species within the plot and monitor the overall population of birds. Sampling could be done in the form of random quadrant sampling of 100m² plots or strip transects, where counts of birds are done along a fixed transect (Bibby et al., 1998). Surveys should be done before and after the restoration strategy for comparisons. Birds were chosen as they are relatively easy to spot. Diversity index such as the Shannon Wiener index or Simpson’s diversity index could be used to compare alpha diversity.

3.3. Manpower requirements

Total manpower and level of effort required for monitoring the full reforestation project:

- 1 Full-time project leader
- Full-time project level experts
- 15 Full-time field investigators
- 200 field level workers

Numbers of each may vary and adjusted accordingly. The above is just a guide on the rough ratio of division of manpower for the project.

The field level workers can be locals in the barangays, municipalities, or communities involved in and affected by the reforestation site. They need to be trained by the project level experts in monitoring efforts. You may want to approach governmental agencies for funding or help as well, including the Local Government Unit, Department of Environment and Natural Resources (DENR), Provincial Planning and Development Office, Office of the Provincial Agriculture, PENRO and CENRO Talibon & Tagbilaran (BIAD, n.d.).
If you lack funds and technical knowledge from knowing what plant species to select for your site, or how to monitor your sites, you may contact several local non-profit or non-government organizations, academic institutions and consulting agencies. Depending on the viability of your reforestation project and whether your objectives are aligned with the organization’s, the organization might be able to assist in capacity building, training, and equipment for monitoring or even capital funding.

You may approach organizations for different types of assistance:

1) Provide educational materials
2) Conduct training seminars for you and your community
3) Tailor your strategy to your site to make it more specific and effective
4) Provide tools and/or equipment pertaining to your reforestation strategy
5) Provide necessary equipment and even manpower to monitor and assess your reforestation project
6) Connect you to other organizations to collaborate with
7) Advise on what species of plants to select for your site
8) Advise on obtaining seedlings or saplings
9) Co-manage the project with you and your community
10) Provide funding, or if not
11) Formulate project proposal to request funding from other agencies or NGOs

Figure 3: Process flowchart of achieving technical support and funding, adapted from Aureo, W. (Graphic by Aw Jeanice)
Section 4: Recommendations

Guide to Rainforestation Tree Species in Leyte

If you have decided on rainforestation as your strategy, you can consult Visayas State University (VSU) and the Visca Foundation for Agricultural and Rural Development, Inc. They have co-created a guide to understand and select tree species for your site.

For more information, please contact Dr. Edwino S. Fernando, Taxonomio Identification Consultant via e-mail at edwino_fernando@yahoo.com.ph

Rain Forest Restoration Initiative (RFRI)

RFRI is a network of organizations and individuals from the academe, peoples’ organizations, non-government organizations, and business sectors engaged in environmental conservation, research and development.

RFRI aim to advance and promote Rainforestation Farming as a strategy to rehabilitate degraded landscapes and restore key ecosystem services and functions while providing forest-dependent communities with an alternative source of livelihood.

For more information about Rainforestation and RFRI, please contact the RFRI secretariat via e-mail at rfri.sec@rainforestation.ph
Bibliography


“Cookie Monsters Inc. provided quality service that is unparalleled in the Philippines.”

—Anjana-san, farmer of Shifu barangay, in Loboc.

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