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LEBANON REFORESTATION INITIATIVE

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OUTPLANTING MONITORING REPORT - **PHASE II**

Disclaimer: This manual is made possible by the support of the American people through the United States Agency of International Development (USAID). The content of this manual is the sole responsibility of the Lebanon Reforestation Initiative (LRI) and does not necessarily reflect the views of the United States Government.

This technical report is developed by Lebanon Reforestation Initiative. It includes the results of 3 years of reforestation work across Lebanon, from October 2016 till the end of December 2018.

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I) GENERAL INFORMATION

A. Introduction

The Lebanon Reforestation Initiative (LRI) is a Lebanese NGO registered at the Ministry of Interior and Municipalities under no. 1186 on 18 June 2014 and had started as a project launched in 2010 by the United States Forest Service (USFS) Office of International Programs (IP) through the support and funding of the United States Agency for International Development (USAID). LRI aims to conserve and expand Lebanon's forests through a community-based approach and public-private partnerships. In addition, LRI also aims to empower communities to advocate for the improved management of their forest resources. LRI 's focus also includes the following:

- Assisting native tree nurseries with technical improvements and enhanced business planning;
- Developing comprehensive forest mapping to help identify existing forest resources and priority areas for the reforestation of native tree species;
- Promoting the importance of reforestation and biodiversity through community-led activities that foster local ownership and forest sustainability;
- Supporting the planting of quality native seedlings, and especially threatened species, throughout Lebanon;
- Strengthening capacities to prevent and respond to wildfires through technical assistance and specialized training of communities and firefighting agencies.

Through inspection and monitoring protocols, that are adapted from international best practices to the local Lebanese context, LRI measures the success of its reforestation activities and identifies the pathways to improvement. These procedures provide measurements of seedling's survival on LRI sites and allows the identification of potential causes of mortality. This data is then synthesized into a collection of lessons learned to be used by LRI and relevant decision makers in subsequent planting events.

This report provides an overview of the monitoring and inspection results attained by LRI throughout the 23 villages in which the LRI project conducted its activities during the period of 2015-2018, Phase II of the project. Consequently, this report is only related to the LRI project and does not reflect data on sites planted by the NGO outside the scope of the LRI project. This report comes also as a continuation of the previous monitoring report developed at the end of Phase I of the LRI project. Together, the two reports summarize all planting activities conducted under the LRI project from 2010 to 2018. The villages included are spread across North Lebanon, Rachaya and Shouf. In addition, the report presents the planting, monitoring and inspection protocols on which these results were based and through which they were obtained.

B. Reforestation Practices

LRI's reforestation process is adapted from international best practices and tailored to local conditions per site. This multistep procedure sets the structure and timeline for monitoring and inspection while also optimizing conditions for seedling survival. The reforestation process is represented in Figure 1 below.

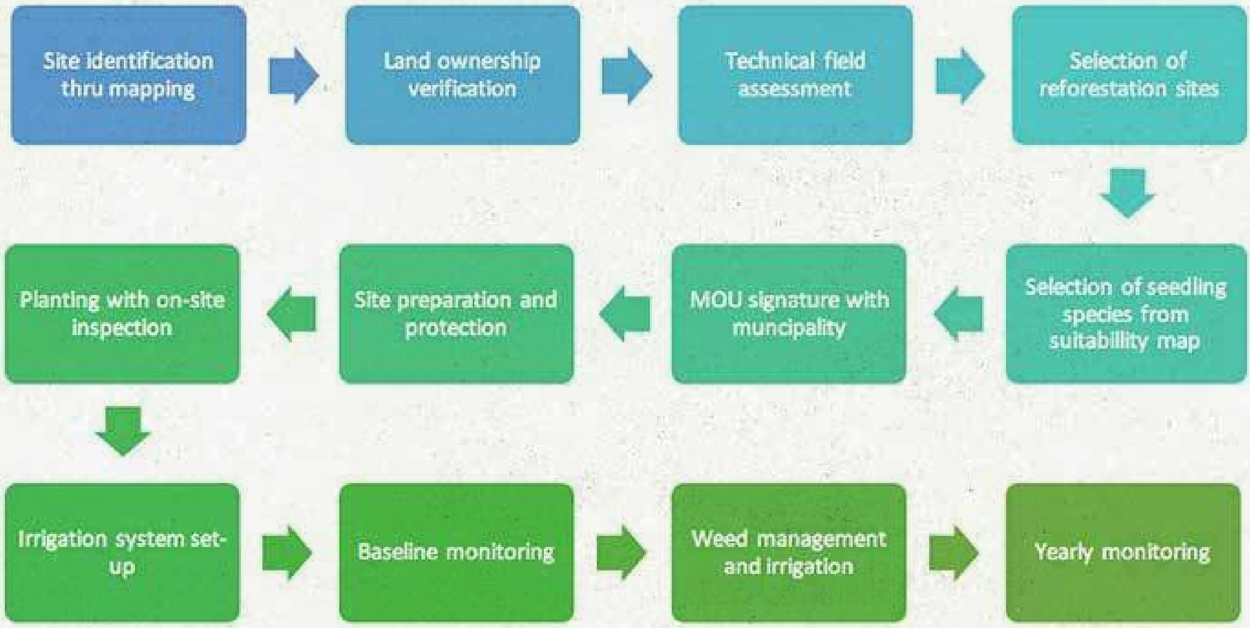

Figure 1: Detailed reforestation process

I) PLANTING CRITERIA AND PROCESSES

A. Site selection through mapping

Through LRI's interactive online forestry mapping platform, optimal sites for planting that offer the best ecological conditions for tree survivability and promote long-term reforestation success can be identified. Using a two-phase process, LRI relies on advanced satellite data, field verification, sophisticated computer modeling, and interactive web-mapping applications to produce updated maps of sites suitable for reforestation.
The first phase emphasizes various biophysical characteristics as key criteria for the selection of optimal reforestation sites, while the second highlights additional factors that respond to context specific reforestation priorities in Lebanon.

B. Land ownership verification

LRI concentrates most of its reforestation activities within public lands and religious endowments to ensure sustainability and protection of the reforested land as well as public benefit to the whole community. There are two types of public lands in Lebanon: private public lands, which are owned and managed by the local government (i.e., the municipality), and republic lands, which are owned by the Republic of Lebanon and managed by the local government under approval from the Lebanese Ministry of Finance. According to the land tenure, the appropriate approvals or permits are obtained from the concerned parties.

C. Technical field assessment

Once land ownership is verified and permits are acquired, a thorough site assessment is conducted. The site assessment is customized to the objectives of the reforestation activities, whether it is climate change adaptation, quarry restoration, expansion of green cover or strengthening of community governance and engagement. In a standard field assessment (Refer to annex I for the assessment form), the following criteria are evaluated and aid in the verification of the identified site's suitability:

- **Soil depth**: Successful seedling establishment requires a minimum of 40cm of soil. Shallower soils can lead to high mortality rates.
- **Vegetation cover and natural regeneration**: The purpose of reforestation is to restore pre-existing forests that have been cut or burned and could not regenerate on their own. If natural regeneration of native pre-existing species is occurring, reforestation is not needed, and the disturbance could be harmful to the natural environment.
- **Presence of security concerns**: This includes the presence of landmines, bases for armed forces, or proximity to conflict zones.
- **Rockiness and distribution of rocks**: shallow bedrocks make it harder for roots to grow. Continuous rock layers block root growth. The rockiness and distribution of rocks in each site dictates largely the density and distribution of planting spots.
- **Interest and level of engagement of the local community**: Engaging the community in the reforestation project since the beginning has proven to be key to the success of such a project. In all sites, LRI implemented its community engagement strategy, aiming at involving the community in all phases of the project, starting from planning to monitoring. As a first step, roundtables with major stakeholders were conducted in every community to gauge their interest in reforestation and find solutions to raised issues such as shepherds grazing areas and alternatives. Community members then form an environmental committee to follow on the process and others are trained and hired to conduct the field work. It is crucial that all community groups are represented in a way or another in the project to ensure long term ownership and sustainable management of the forest once handed over back to the community.
- **Site Access**: Access roads are needed if mechanical soil preparation is planned, for transportation of seedlings, and for transporting workers to the site. If access roads are not available, they are created prior to the planting season by the municipality, only when and where necessary.
- **Grazing pressure**: In parts of Lebanon, unregulated grazing presents serious challenges to successful reforestation. Estimating grazing pressure, including number of shepherds and herds and origins (local vs. foreign) can guide in the decision whether a fence is needed to protect seedlings.

D. Selection of Species

The selection of the species to be planted on site is a tailored and context-specific process that depends on site conditions, as the sites differ in altitudes, climate, topographies, exposures, humidity, types of soil and precipitation levels.

Therefore, the site assessment also evaluates the following criteria that are crucial in determining the appropriate species:

- Site elevation;
- Site slope;

- Aspect: North-facing slopes usually have better soil and more shade, which favors seedling growth. In contrast, south-facing slopes are dryer and more exposed to direct sunlight.
- Soil type and texture;
- Water availability: This determines the need for and type of irrigation system and the types of species that would survive in the available water conditions.

A first list of suitable species is then generated from the studies conducted by LRI on species suitability across Lebanon and the updated vegetation map of Lebanon. This list is then refined using the above-listed criteria to select the species suitable for each section of the site based on slope and exposure. The list is then discussed with the local community to take in consideration their preferences and superstitions, if any.

E. Site preparation

In preparation for the fall planting season, site preparation occurs in time to ensure that planting takes place within the planting window that allows for higher precipitation levels. The soil is prepared for planting using common soil preparation techniques, which include hand digging, excavators and augers. A combination of methods can be used in one site with varying site conditions.

- **Hand digging**: Hand digging is a suitable method for a range of site conditions but often used on sites that are inaccessible or too rocky for excavator preparation. Hand digging is conventionally done with 3 tools, the pickaxe and the spade used by the same worker or a team of 2 workers and a hoedad, not suitable for all sites, used by one worker. Cleaning the soil prior to planting helps in minimizing seedling root exposure to air during the process of refilling the planting hole.
- **Excavators**: Small excavators may be used on sites where rockiness prohibits the use of hand tools or where the planting window is too narrow and requires faster soil preparation. . The heavy weight of excavators can compact the soil, and sometimes disturb the site environment. Consequently, excavators are driven only on service roads and as few areas as possible around the site.
- **Augers**: Augers are used to create deep holes with a small diameter that guide the roots vertically deeper into the ground.

Augers are considered a fast and efficient soil preparation technique but are less useful in rocky sites. Auger holes are best prepared when the soil is slightly moist and right before planting to ensure the soil is soft during planting. In addition to the main deep hole, adjacent shallow holes are made as a source of soil during planting. Safety gear, including gloves, goggles and leg protection, should be worn anytime augers are used to prevent injuries.

F. Identifying Potential Threats

Any potential threats to the newly planted seedlings are identified prior to the commencement of activities and measures to respond to those threats are adopted in consultation with the local community and based on available resources. Common identified threats for reforestation sites and their appropriate measures are mentioned below:

- **Grazing** by domestic or wild animals: an agreement is reached between the local municipality and the shepherds either to provide them with alternative grazing areas or to involve them in the reforestation activities. If no such agreement is possible or alternatives are not available, fencing the reforestation site becomes a necessary procedure, despite its high cost. However, decisions on fencing must be taken in close coordination with the local municipality and community stakeholders. Fencing may be applied either as individual seedling fencing, cluster fencing or full site fencing.
- **Human activities**: such as off-road driving and winter activities in high elevation sites. Human activities can cause serious damage to the planted seedlings. All types of fencing can reduce the risk of human activities either by limiting access or by alerting individuals about the presence of planted seedling. In sit es with snow activities, warning signs are placed on tall poles that are positioned around the site to prevent entry.
- **Fire**: A combination of individual or cluster fencing with grazing can seriously reduce this threat. Access roads within the site during the site preparation phase can serve as fire breaks and limit the expansion of fires in case they happen and facilitate fire response activities. Fire prevention is also conducted through weed management techniques and community awareness activities.

G. Irrigation

Most seedlings currently planted in Lebanon are irrigated to improve survival. In case of irrigation, it is better to adopt manual irrigation systems to save capital cost and reduce maintenance cost on the long run. As well, a manual irrigation system is easily moved from one site to the other, and its design is flexible and remains useful unlike drip irrigation systems. For a good irrigation system in large reforestation sites, place your water tanks at the highest elevation of the site, and carefully design the system using pressure compensation valves to ensure all seedlings receive the right amount of water. However, irrigation systems and water are both very expensive. LRI is continuously testing ways to eliminate the need for irrigation by developing well-hardened tree seedlings with strong root structures and optimizing planting time and practices and moisture conservation, hoping to realize its long-term goal to establish forests without irrigation.

H. Vegetation control and moisture conservation

Vegetation control is a major component of a successful reforestation project. Vegetation control aims mainly at conserving moisture and giving the seedling a competitive advantage over other naturally growing vegetation until the planted seedling is strong enough and has a deep root system that can reach unlimited deep soil moisture. Scalping, mulching and shaping the planting hole are only few of the different vegetation control measures that can be applied. For a more extensive description, please refer to LRI's Guide for Reforestation Best Practices.

2) INSPECTION

Planting inspection serves many valuable functions (please refer to annex II for the inspection form), such as those listed below:

1 An organized approach to controlling the quality of seedlings received from the nursery, stored locally at the village and then sent to the planting site. The planting inspector can sort the seedlings both upon arrival at the storage area and at delivery to the planting crew. He/she can recommend and ensure actions are quickly taken (irrigation, aeration or other storage related measures) to address possible issues.
2 A process to rapidly correct planting mistakes and to provide continuous feedback to the planting crew, as well as to evaluate the quality of planting and worker productivity after they receive on-site training.
3 Quantifiable and up-to-date data for reporting to the managing organization and to continuously evaluate the planting operation in terms of planting quality, crew planting productivity, quality of seedlings received by the nursery, and the overall efficiency of operations.
4 A way to map planted areas and to calculate tree density.
5 Baseline records that can be used to help evaluate the planting over time including monitoring results and planting costs.

Following a well-organized and designed inspection protocol will considerably improve worker productivity and performance and result in higher planting quality and survival while reducing costs associated with failed outplanting efforts.

Examples of the kinds of information that inspections provide include:

- Percentage of seedlings planted well versus poorly.
- Percentage of seedlings with various planting defects.
- Seedling density and average spacing by daily planted area.
- Total number of trees planted by species and location within the planting site.
- Quantity and condition of seedlings from nursery including number of trees rejected due to poor quality.
- Weather conditions associated with each planting day.

3) MONITORING

Monitoring seedling survival is essential to evaluate reforestation project successes and failures. This process allows managers to learn from their work, identify necessary actions, and modify and improve practices. Monitoring data enables adaptive management, whereby changes can be made to practices in response to outplanting observations. For example, the survival rates and overall vigor of various species planted can help guide future planting decisions. This monitoring has even more utility if done in conjunction with planting inspections: low survival in an area can be traced back through inspection records to a factor that caused poor seedling performance (e.g., dry conditions, poor planting quality, bad seedling handling and storage).

Monitoring procedures are carried out by trained community members using ArcCollector. The survival rate of seedlings is calculated as monitors scope the land, 30 m at a time, and plot data points with identified dead and alive seedlings. This data is then collected by LRI and the survival rate is calculated accordingly. On smaller sites, the GPS plotting of seedlings is not necessary. Instead, the dead and alive seedlings on site are simply identified and counted.

II) LRI SITES

A. Corridor Sites Summary

Since 2015, LRI developed a forest connectivity corridor strategy and focused its reforestation efforts on filling gaps within three identified corridors to reconnect forests and improve habitat and safer pathways for birds and wildlife. LRI corridor sites are distributed across three geographic areas, the North of Lebanon, Rachaiya and Shouf. In each region LRI has worked closely with the municipality and local community. To solidify its efforts, LRI has developed a Corridor Planting Committee (CPC) for each of the North and Rachaya regions, that consist of municipality members and representatives from the local communities. Figure 2 below presents LRI sites across Lebanon and within the LRI Bio-corridor in which LRI is increasing forest continuity by implementing reforestation activities, while figures 3, 4 and 5 present respectively the Rachaya, North and Shouf corridor towns and planting sites.

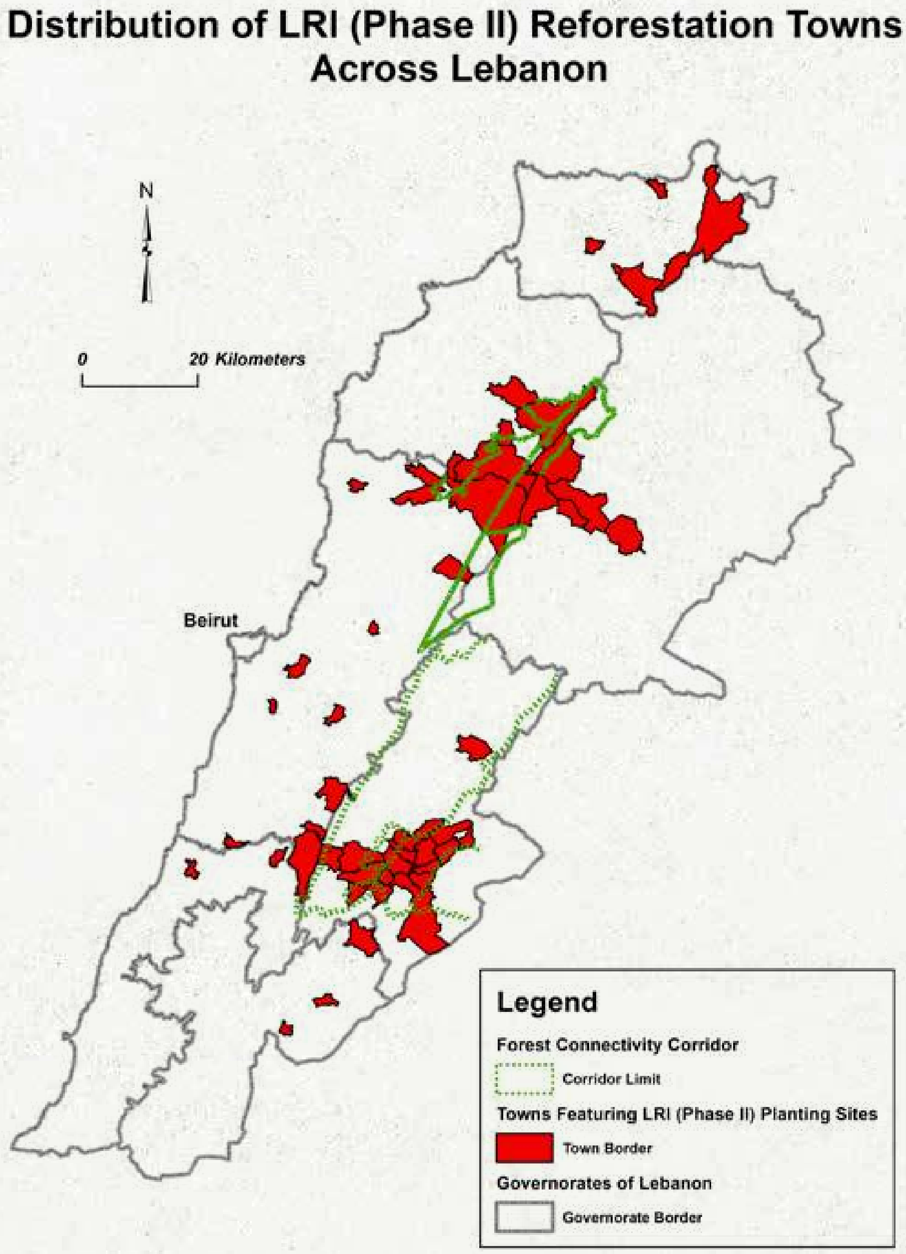

Figure 2: Distribution of LRI (phase II) Reforestation Towns Across Lebanon

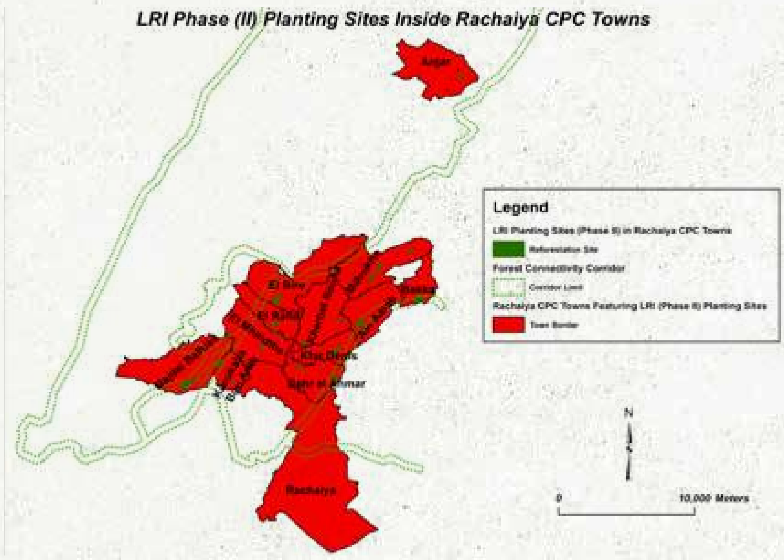

Figure 3: LRI Phase (II) Planting sites inside Rachaiya CPC towns

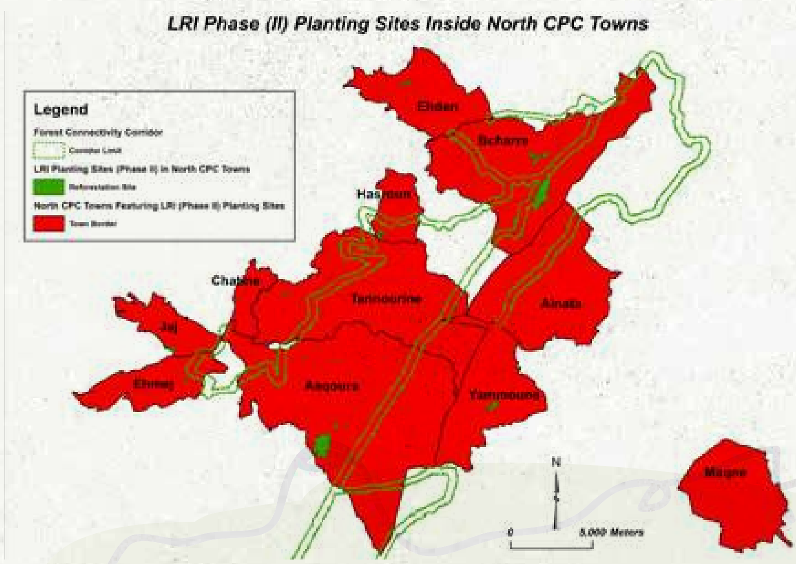

Figure 4: LRI Phase (II) Planting Sites inside North CPC towns

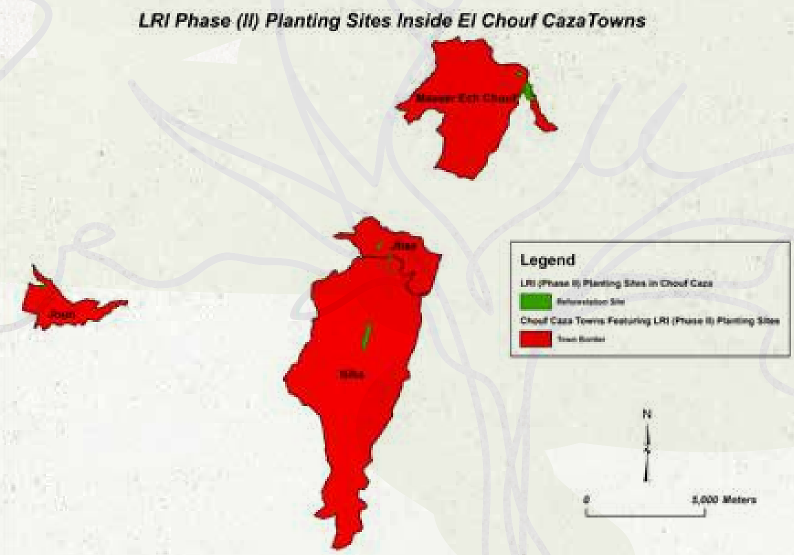

Figure 5: LRI Phase (II) Planting Sites inside El Shouf caza Towns

Table 1: Seedlings and hectares planted during LRI phase II

Village	Number of Seedlings	Hectares planted	Survival rate (2015-2016)	Survival rate (2016-2017)	Survival rate (2017-2018)	Total Seedlings/ Corridor
Rachaiya Sites						
Ain Arab	13610	21.82		41%		107,620
Bakka	9004	13.92			70%	
Bireh	8360	15.18		75%	81%	
Dahr El Ahmar	14231	10.7	30%	61%	89%	
Kawkaba Abou Arab	10360	6.72	61%	63%		
Kfar Denis	5500	13.43	75%	69%		
Kherbit Rouha	4270	12.54		66%		
Kfarmechki	5000	9.87			82%	
Majdel Balhis	11944	13.58	73%	74%	56%	
Mdoukha	15780	26.65		59%	82%	
Rafid	9561	8.52		40%	69%	
North Sites						
Ainata	750	1.38		91%	92%	63,976
Aaqoura	16564	42.59		53%	93%	
Bcharre	14601	26.82		86%		
Chatine	140	0.41			89%	
Ehden	3500	5.76			98%	
Ehmej	2940	2.54		83%	79%	
Gebrayel	1540	2.94		98%		
Hasroun	4645	8.99	74%	89%	97%	
Jaj	3671	6.9		22%	75%	
Tannourine	5100	3.28		53%	63%	
Yammouneh	10525	11.55	14%	78%	98%	
Shouf Sites						
Maaser El Shouf	7405	12.04		45%	66%	20,396
Niha	12991	82.09		47%	80%	

Table 1 below summarizes LRI's efforts within Phase II sites, including total planted seedlings per town, surface areas planted and survival rate. Species planted in each town are mentioned in annex III.

B. Sites Data

Throughout phase II, LRI conducted reforestation activities in more than 20 sites. Through its community-based approach, LRI worked to implement action plans developed by the North and Rachaiya Corridor planting communities in their respective regions. Unlike phase I sites, Reforestation Phase II sites consisted of small, medium and large-scale planting areas, that varied in topography, community needs and partnerships, threats posed to the seedlings, and environmental concerns. The sites vary from very rocky, sandy, steep to flat terrains. These variations led to the use of tailored planting and maintenance approaches that fit demands of the different site areas. For example, fencing was required in several sites to protect the seedlings from grazing, while in others outdoor activities posed the main threat and required coordination with the local tour guides. In addition, LRI partnered with local NGOs in some areas, and maintained exclusive coordination with municipalities in others. Sites located on higher and barren mountain areas faced risks of soil erosion, while others constituted important migrating bird hotspots. Finally, weather conditions differed throughout the span of the project and posed different irrigation requirements across the seasons of planting and maintenance, especially as the snow cover was largely limited during Phase II years.

The tables presented in this section provide a summary of the following:

- General Information per site.
- Inspection, planting quality and workers productivity data (Missing data is due to sites being new LRI planting areas or small in size, or due to time constraints.)
- Monitoring results map (Missing maps are in some cases due to the lack of consistency of monitoring protocols applied within the same site area, or due to the application of non-mappable techniques)

C. Rachaiya Sites

1. AIN ARAB

Table 2: Description and monitoring results of Ain Arab Site

Ain Arab Site Description			
Mouhafaza: Beqaa **Caza:** Rachaiya **Land tenure:** Public **Partners:** - Municipality of Ain Arab - Rachaya Corridor Planning Committee **GPS Coordinates:** 33°34'12.55"N 35°52'39.74"E **Elevation:** 1280 m – 1400 m **Slope:** Low to Medium **Rockiness:** Low to Medium **Soil Type:** Lithic Leptosols			
Monitoring Results	**Season 2015 - 2016**	**Season 2016 - 2017**	**Season 2017 -2018**
Number of seedlings planted	7700	3910 (replacement)	2000 (replacement)
Planting Start/End date	Nov 2015 – Dec 2015	Jan 2017 - Jan 2017	Feb 2018 – Feb 2018

Figure 6: Inspection results in 2015 in Ain Arab site

Figure 7: Inspection results in 2017 in Ain Arab site

2. BAKKA

Table 3: Description and monitoring results of Bakka site

Bakka Site Description	
Mouhafaza: Beqaa **Caza:** Rachaiya **Land tenure:** Public **Partners:** - Municipality of Bakka - Rachaya Corridor Planning Committee **GPS Coordinates:** 33°35'14.45"N 35°55'30.84"E **Elevation:** 1440 m – 1525 m **Slope:** Medium to High **Rockiness:** Medium to High **Soil Type:** Haplic Luvisols	
Monitoring Results	**Season 2016 – 2017**
Number of seedlings planted	9004
Planting Start and End date	Dec 2016 – Jan 2017

Figure 8: Inspection results in 2017 in Bakka site

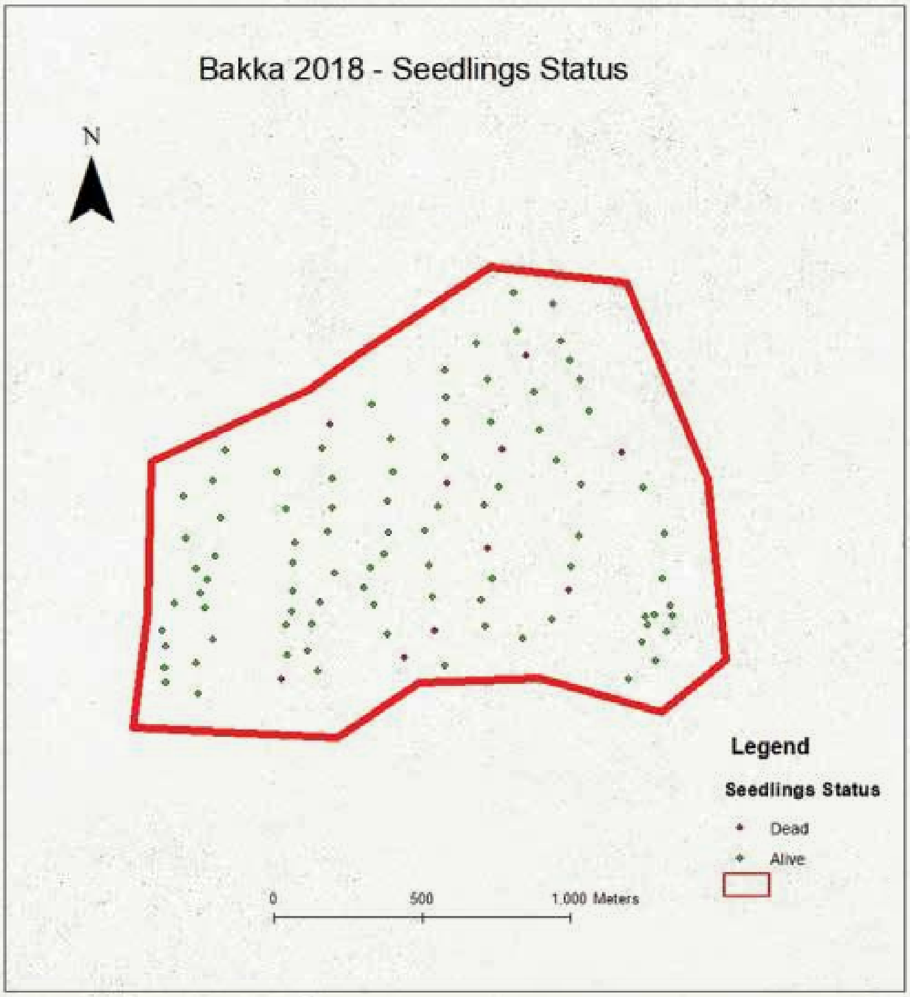

Figure 9: Bakka Monitoring Map Season 2017.2018 with 70% Survival Rate

3. **BIREH**

Table 4: Description and monitoring results of Bireh site

Bireh Site Description	
Mouhafaza: Beqaa **Caza:** Rachaiya **Land tenure:** Public **Partners:** - Municipality of Bireh - Rachaya Corridor Planning Committee **GPS Coordinates:** 33°34'59.11"N 35°48'39.71"E **Elevation:** 1250 m - 1285 m **Slope:** Medium to High **Rockiness:** Very high **Soil Type:** Haplic Calcisols, Lithic Leptosols, Leptic Luvisols and Eutric Luvisols	
Monitoring Results	**Year 2016**
Number of seedlings planted	8360
Planting Start and End date	Nov 2016 – Nov 2016

Figure 10: Inspection results in 2016 in Bireh site

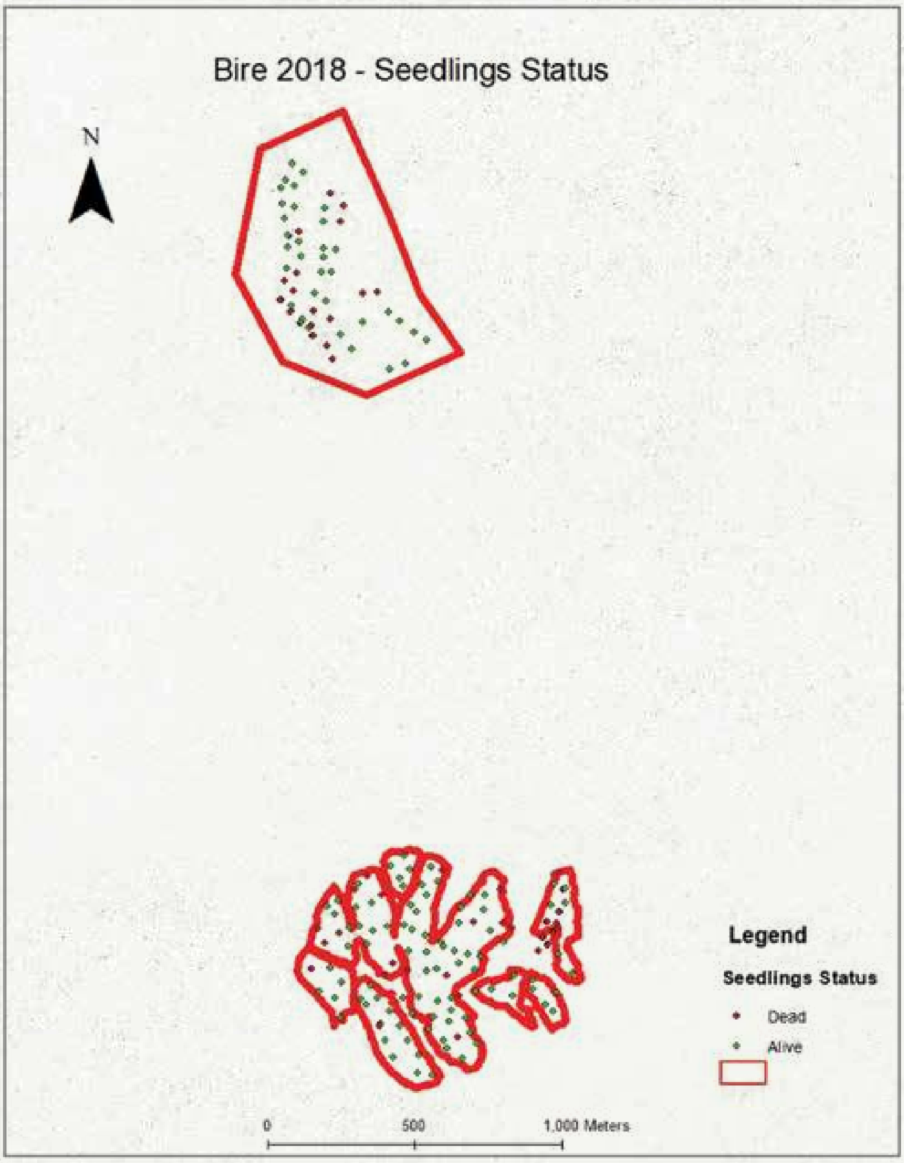

Figure 11: Bireh monitoring map season 2017.2018 with 81% survival rate

4. **DAHR EL AHMAR**

Table 5: Description and monitoring results of Dahr El Ahmar site

Dahr El Ahmar Site Description

Mouhafaza: Beqaa

Caza: Rachaiya

Land tenure: Plot 1: Public

Plot 2: Religious

Partners:

- Municipality of Dahr El Ahmar
- Rachaya Corridor Planning Committee

GPS Coordinates: 33°32'3.49"N 35°51'33.58"E

Elevation: 1050 m – 1180 m

Slope: Low to Medium

Rockiness: Low to Medium

Soil Type: Lithic Leptosols

Monitoring Results (Plot 1)	**Season 2015 – 2016**	**Season 2016 - 2017**
Number of seedlings planted	4180	5150 (replacement and extension)
Planting Start and End date	Dec 2015 – Feb 2016	Nov 2017 – Dec 2017

Monitoring Results (Plot 2)	**Season 2017 – 2018**
Number of seedlings planted	4901
Planting Start and End date	Nov 2017 – Dec 2017

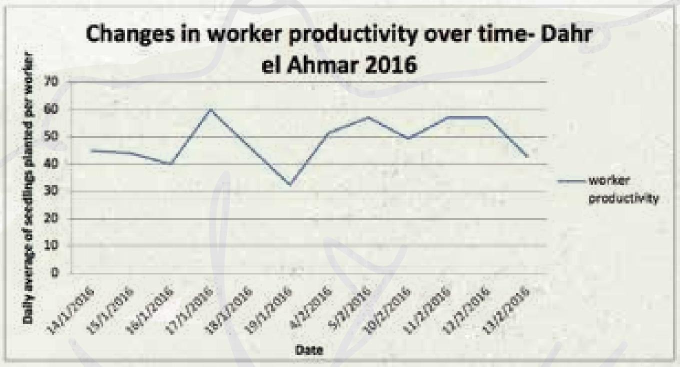

Figure 12: Workers productivity in 2016 in Dahr El Ahmar site

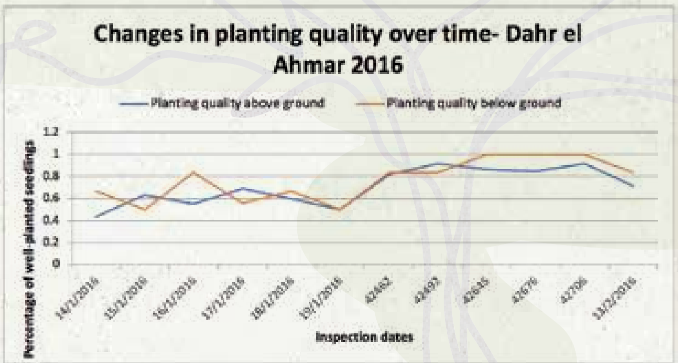

Figure 13: Inspection results in 2016 in Dahr El Ahmar

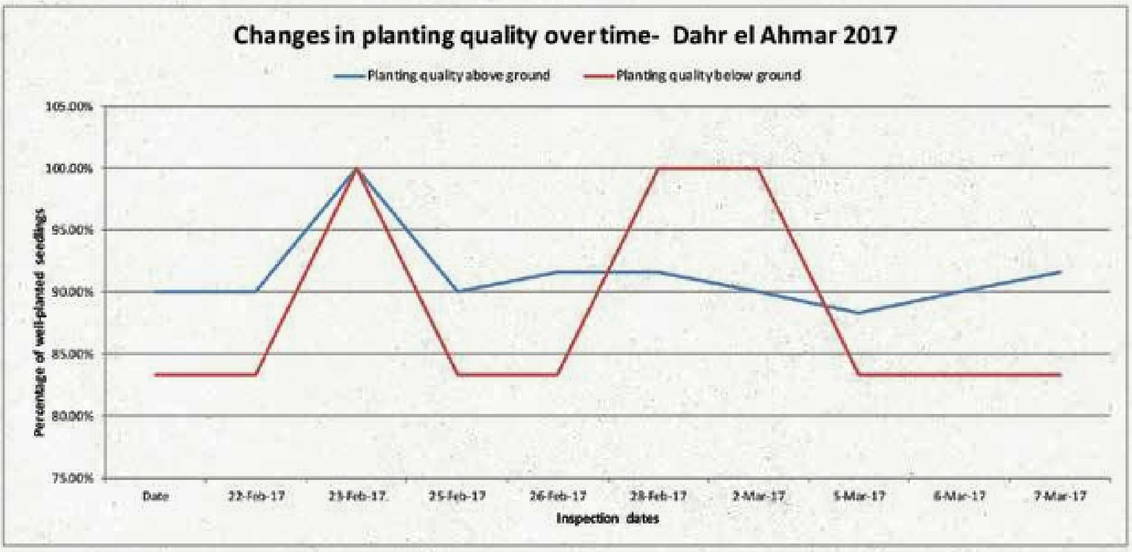

Figure 14: Inspection results in 2017 in Dahr Al Ahmar

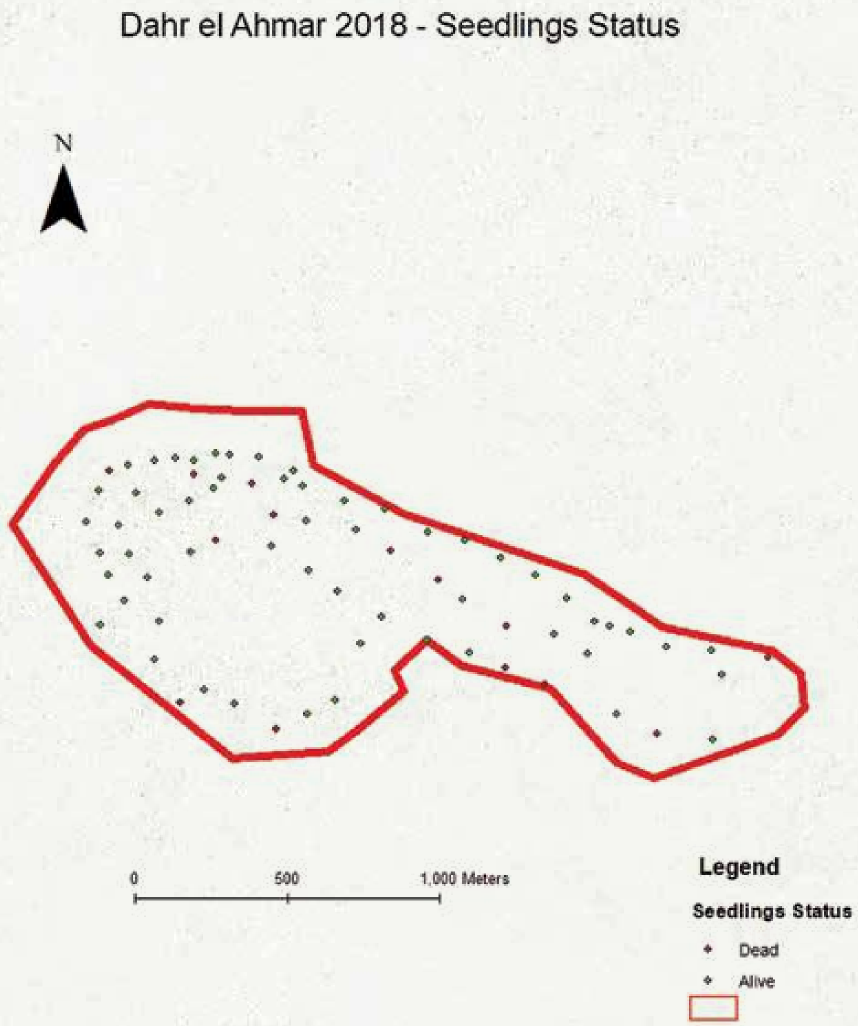

Figure 15: Dahr Al Ahmar monitoring map season 2017.2018 with 89% survival rate

5. **KAWKABA ABOU ARAB**

Table 6: Description and monitoring results of Kawkaba Abou Arab site

Kawkaba Abou Arab Site Description			
Mouhafaza: Beqaa **Caza:** Rachaiya **Land tenure:** Public **Partners:** - Municipality of Kawkaba Abou Arab - Rachaya Corridor Planning Committee **GPS Coordinates:** 33°32'27.05"N 35°46'2.86"E **Elevation:** 1040 m – 1140 m **Slope:** Medium to High **Rockiness:** Low to Medium **Soil Type:** Humi-Eutric Cambisols			
Monitoring Results	**Season 2015 - 2016**	**Season 2016 - 2017**	**Season 2017 - 2018**
Number of seedlings planted	4920	4440	1000 (replacement)
Planting Start and End date	Oct 2015 – Dec 2015	Feb 2017 – Mar 2017	Dec 2017 – Feb 2018

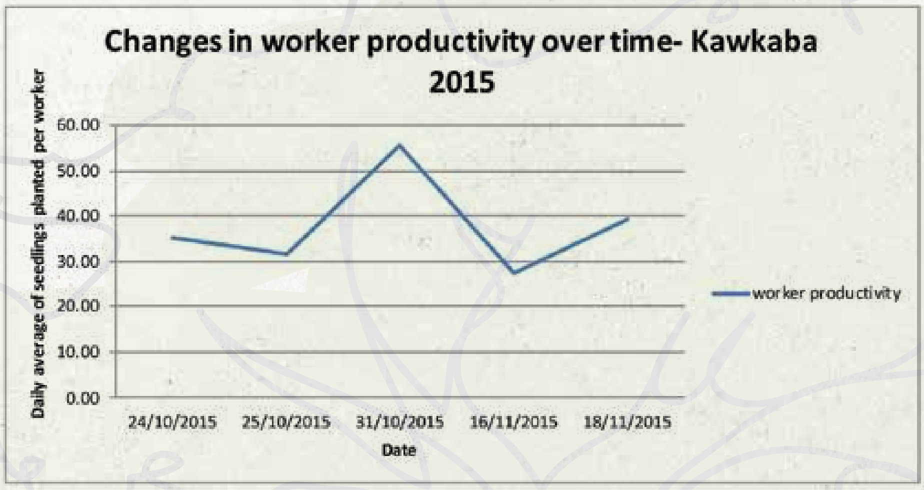

Figure 16: Workers productivity in 2015 in Kawkaba Abou Arab site

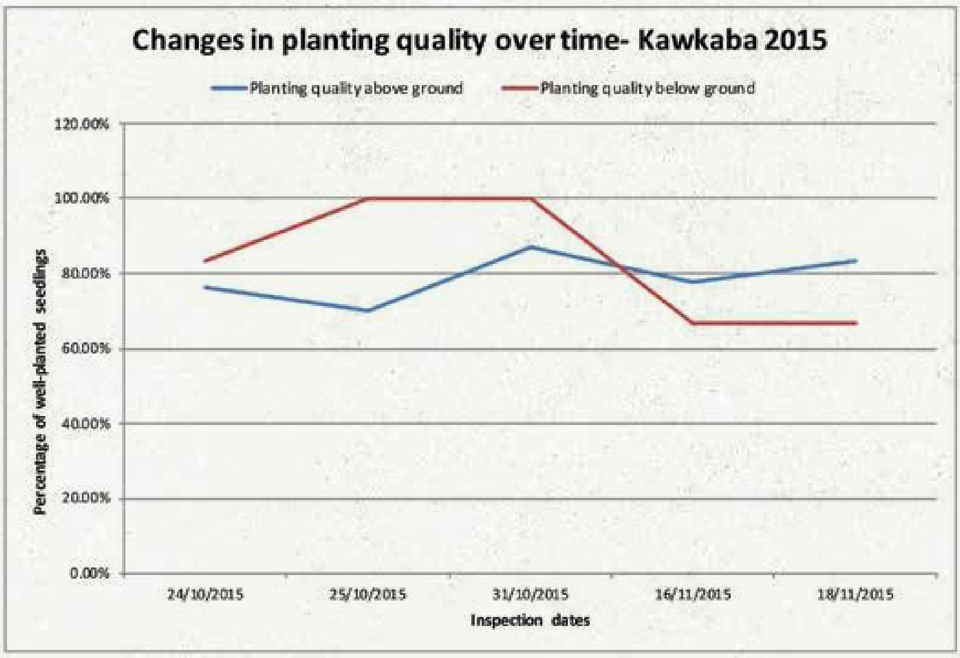

Figure 17: Inspection results in 2015 in Kawkaba Abou Arab site

6. **KFAR DENIS**

Table 7: Description and monitoring results of Kfar Denis site

Kfar Denis Site Description		
Mouhafaza: Beqaa **Caza:** Rachaiya **Land tenure:** Public **Partners:** - Municipality of Kfar Denis - Rachaya Corridor Planning Committee **GPS Coordinates:** 33°33'3.93"N 35°51'36.58"E **Elevation:** 1170 m – 1250 m **Slope:** Medium to High **Rockiness:** Low to Medium **Soil Type:** Lithic Leptosols		
Monitoring Results	**Season 2015 - 2016**	**Season 2016 - 2017**
Number of seedlings planted	4500	1000
Planting Start and End date	Sep 2015 – Apr 2016	Feb 2017 – Feb 2017

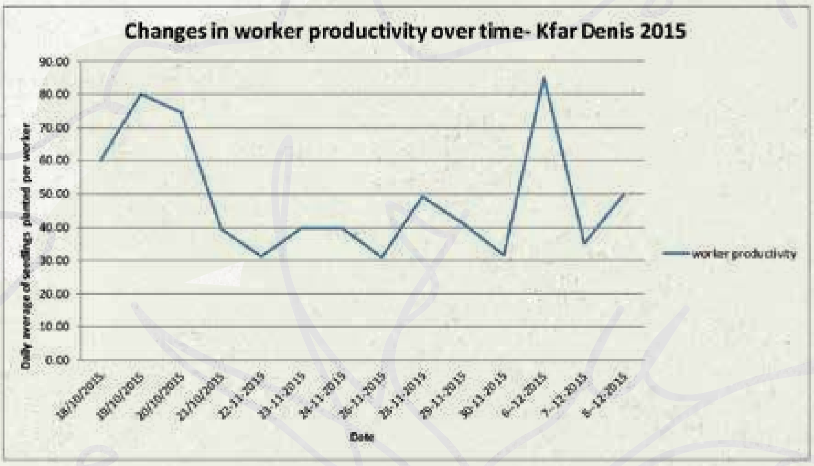

Figure 18: Workers productivity in 2015 in Kfar Denis site

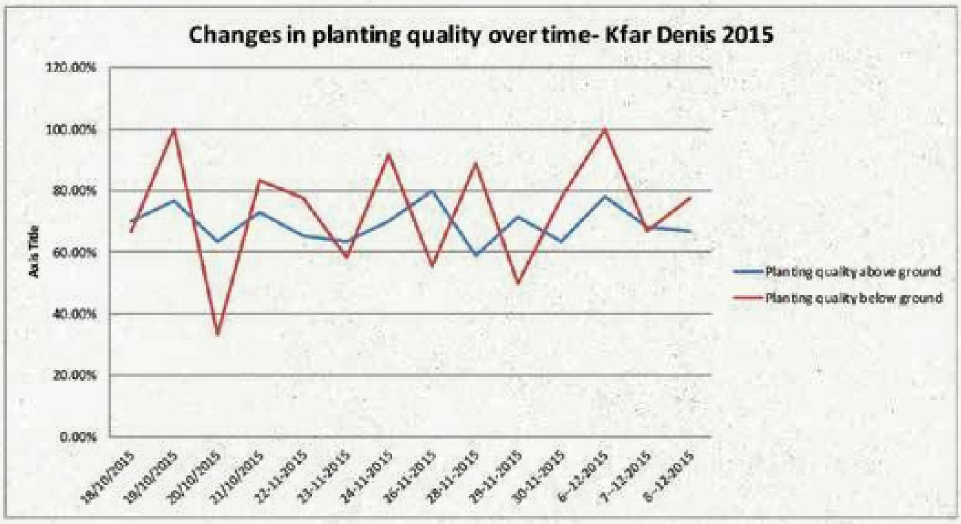

Figure 19: Inspection results in 2015 in Kfar Denis Site

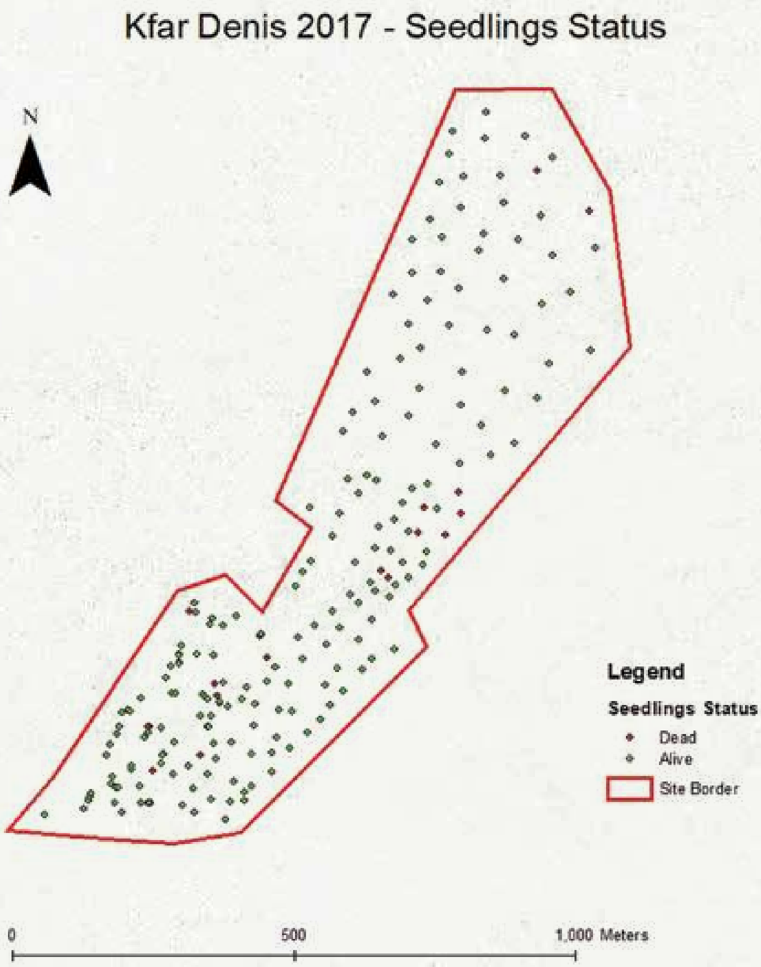

Figure 20: Kfar Denis monitoring map season 2016.2017 with 69% survival rate

7. **KFARMECHKI**

Table 8: Description and monitoring results of Kfarmechki site

Kfarmechki Site Description	
Mouhafaza: Beqaa **Caza:** Rachaiya **Land tenure:** Public **Partners:** - Oaks and Cedars NGO (plot 1) - Municipality (plot 2) **GPS Coordinates:** 33°31'18.58"N 35°45'38.15"E **Elevation:** 1050 m – 1180 m **Slope:** Medium to High **Rockiness:** Medium to High **Soil Type:** Humi-Eutric Cambisols	
Monitoring Results (plot 1)	**Season 2017 -2018**
Number of seedlings planted	2500
Planting Start and End date	Dec 2017 – Feb 2018
Monitoring Results (plot 2)	**Season 2017 -2018**
Number of seedlings planted	2500
Planting Start and End date	Dec 2017 – Feb 2018

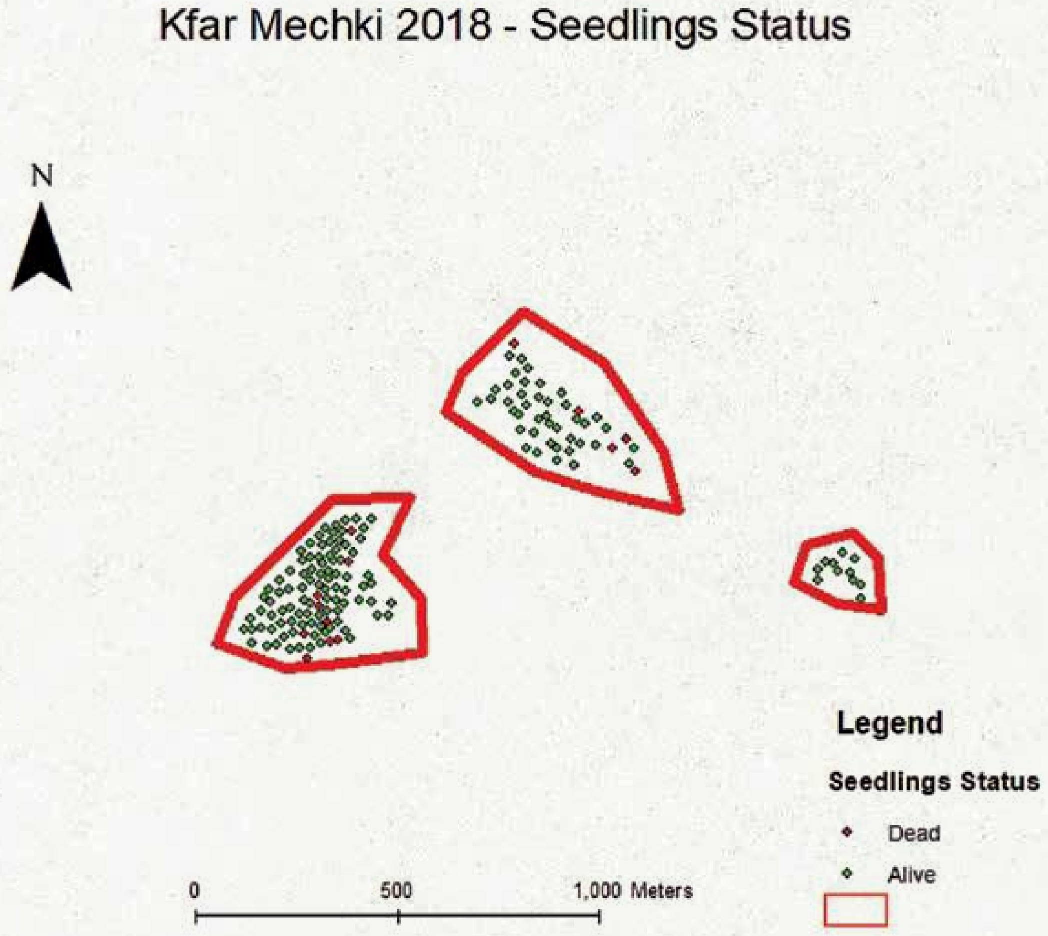

Figure 21: Kfar Mechki monitoring map season 2017.2018 with 82% survival rate

8. **KHERBIT ROUHA**

Table 9: Description and monitoring of Kherbet Rouha site

Kherbit Rouha Site Description	
Mouhafaza: Beqaa **Caza:** Rachaiya **Land tenure:** Plot 1: Religious Plot 2: Public **Partners:** - Municipality of Khirbet Rouha - Islamic Endowments Department in Bekaa - Rachaya Corridor Planning Committee **GPS Coordinates:** 33°34'19.88"N 35°51'46.81"E **Elevation:** 1220 m – 1290 m **Slope:** Medium to High **Rockiness:** Low to Medium **Soil Type:** Eutric Regosols and Lithic Leptosols	
Monitoring Results (plot 1)	**Season 2016 - 2017**
Number of seedlings planted	2000
Planting Start and End date	Nov 2016 – Nov 2016
Monitoring Results (plot 2)	**Season 2016 - 2017**
Number of seedlings planted	2270
Planting Start and End date	Nov 2016 – Nov 2016

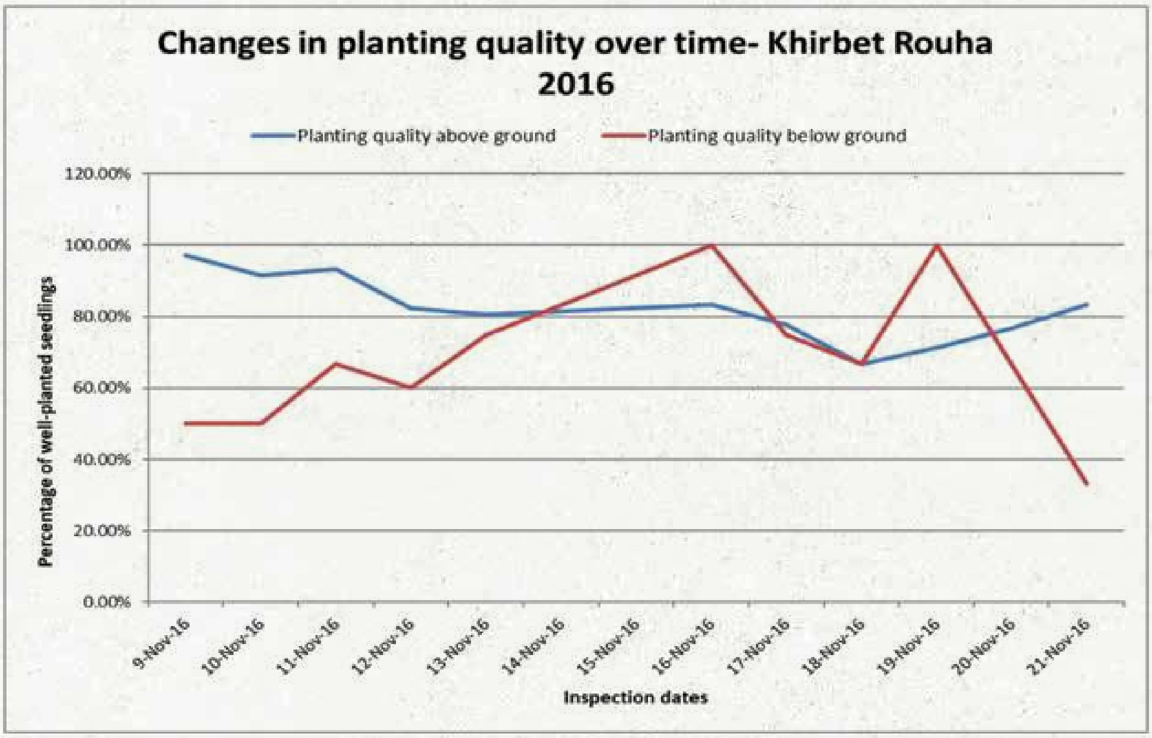

Figure 22: Inspection results in 2016 in Kherbet Rouha site

9. **MAJDEL BALHIS**

Table 10: Description and monitoring results of Majdel Balhis site

<table>
<tr><td colspan="4">Majdel Balhis Site Description
Mouhafaza: Beqaa
Caza: Rachaiya
Land tenure: Public
Partners:
- Municipality of Majdel Balhis
- Lebanese Army Forces
- Rachaya Corridor Planning Committee
GPS Coordinates: 33°31'32.22"N 35°44'24.95"E
Elevation: 975m – 1100 m
Slope: Medium to High
Rockiness: Low to Medium
Soil Type: Humi-Eutric Cambisols</td></tr>
<tr><td>Monitoring Results</td><td>Season 2015 - 2016</td><td>Season 2016 - 2017</td><td>Season 2017 - 2018</td></tr>
<tr><td>Number of seedlings planted</td><td>5000</td><td>4800</td><td>2144 (replacement)</td></tr>
<tr><td>Planting Start and End date</td><td>Nov 2015 – Dec 2015</td><td>Feb 2017 – Feb 2017</td><td>Feb 2018 – Feb 2018</td></tr>
</table>

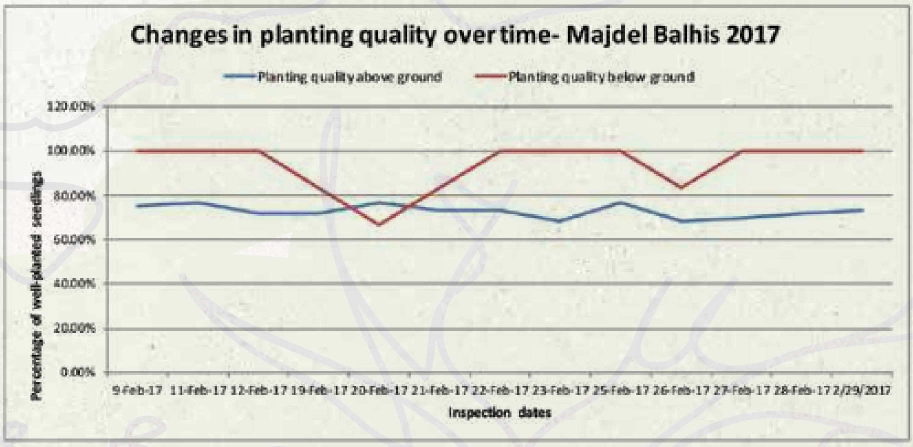

Figure 23: Inspection results in 2017 in Majdel Balhis site

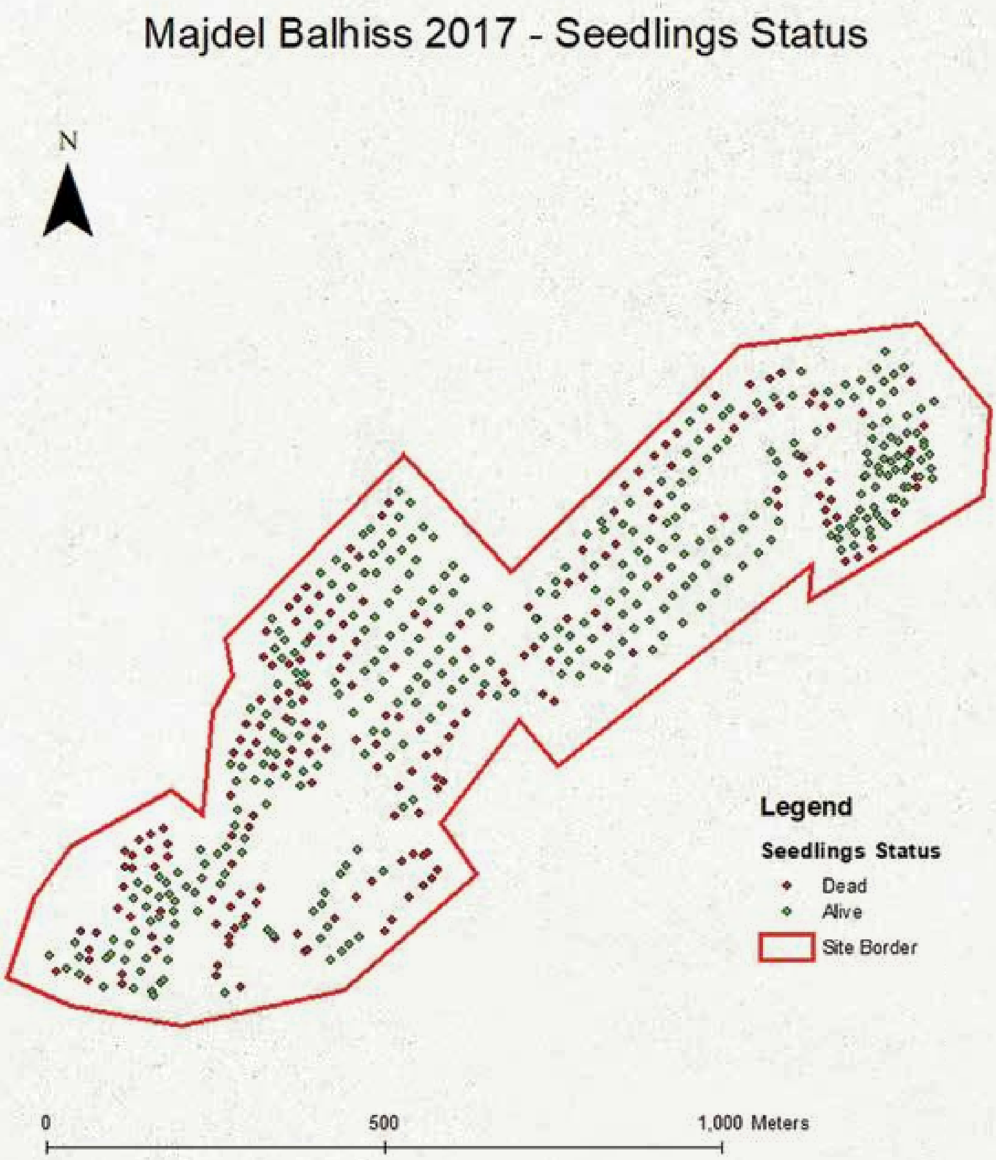

Figure 24: Majdel Balhiss Monitoring Map Season 2016.2017 with 74% Survival rate

10. **MDOUKHA**

Table 11: Description and monitoring results of Mdoukha site

Mdoukha Site Description		
Mouhafaza: Beqaa **Caza:** Rachaiya **Land tenure:** Public **Partners:** - Municipality of Mdoukha - Rachaya Corridor Planning Committee **GPS Coordinates:** 33°36'6.31"N 35°53'14.25"E **Elevation:** 1120 m – 1200 m **Slope:** Medium to High **Rockiness:** Very High **Soil Type:** Lithic Leptosols		
Monitoring Results	**Season 2016 – 2017**	**Season 2017 - 2018**
Number of seedlings planted	9980	3250
Planting Start and End date	Nov 2016 – Nov 2016	Feb 2018 – Mar 2018

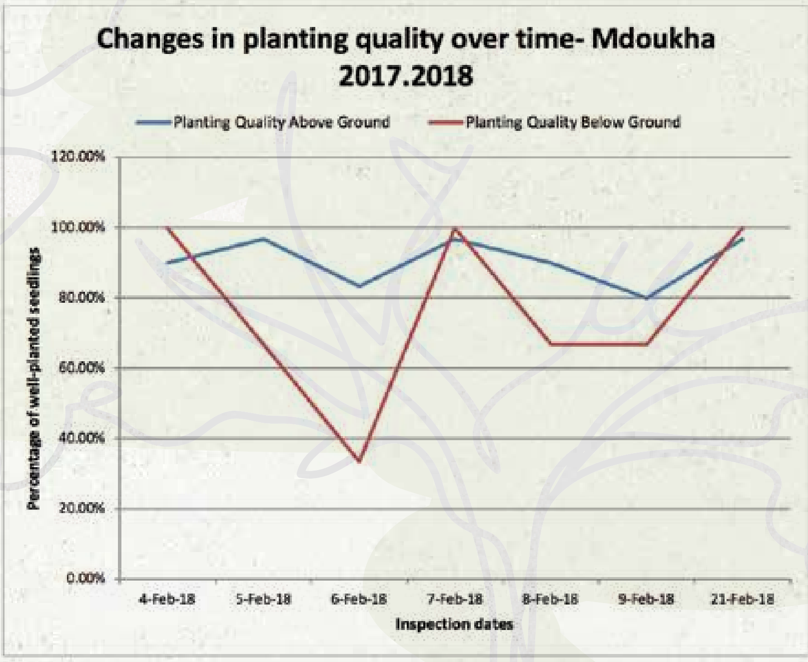

Figure 25: Inspection results in 2018 in Mdoukha site

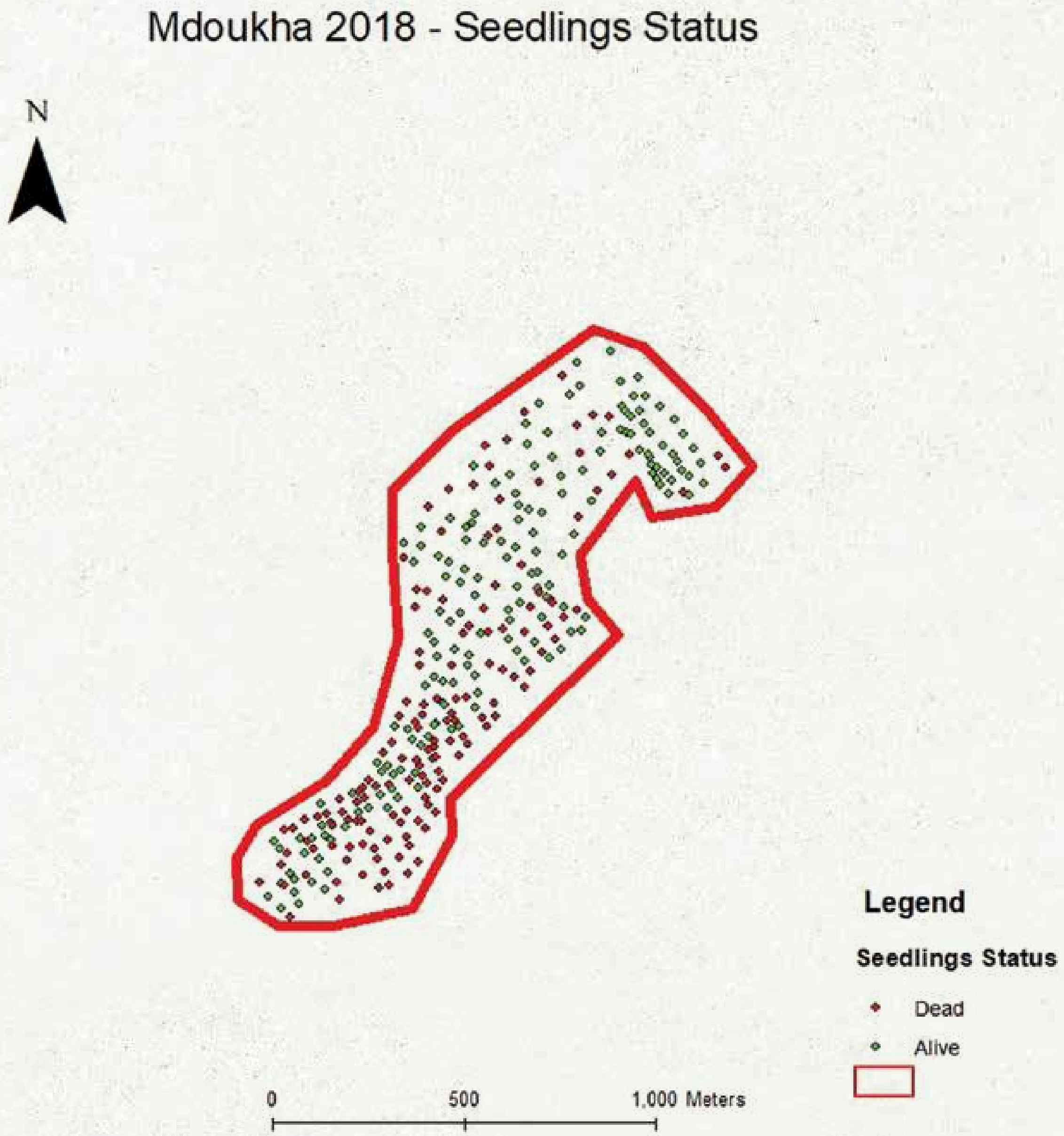

Figure 26: Mdoukha monitoring map season 2017.2018 with 82% survival rate

11. RAFID

Table 12: Description and monitoring results of Rafid site

Rafid Site Description	
Mouhafaza: Beqaa **Caza:** Rachaiya **Land tenure:** Public **Partners:** - Municipality of Rafid - Rachaya Corridor Planning Committee **GPS Coordinates:** 33°34'4.16"N 35°48'32.03"E **Elevation:** 1200 m – 1250 m **Slope:** Medium to High **Rockiness:** Very High **Soil Type:** Haplic Calcisols and Calcaric Regosols	
Monitoring Results	**Season 2016 – 2017**
Number of seedlings planted	9561
Planting Start and End date	Nov 2016 – Nov 2016

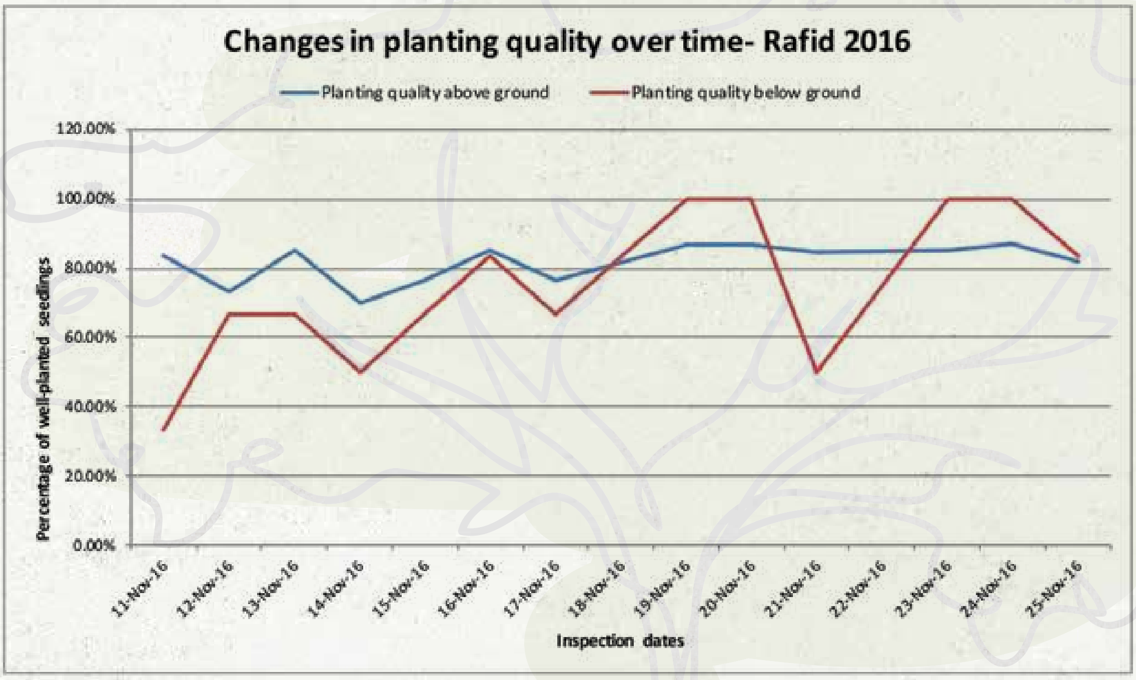

Figure 27: Inspection results in 2016 in Rafid site

D. North Sites

1. AINATA

Table 13: Description and monitoring results of Ainata site

Ainata Site Description	
Mouhafaza: Baalbek-El Hermel **Caza:** Baalbek **Land tenure:** Public **Partners:** - Darb Al Ain NGO - Municipality of Ainata - North Corridor Planning Committee **GPS Coordinates:** 34°12'8.87"N 36° 6'5.57"E **Elevation:** 1780 m – 1790 m **Slope:** Medium **Rockiness:** Medium **Soil Type:** Areno-Eutric Leptosols	
Monitoring Results (Plot 1)	**Year 2017 - 2018**
Number of seedlings planted	750
Planting Start and End date	Dec 2017 – March 2018

2. AAQOURA

Table 14: Description and monitoring results of Aaqoura site

Aaqoura Site Description		
Mouhafaza: Mount Lebanon **Caza:** Jbeil **Land tenure:** Public **Partners:** - Municipality of Aaqoura - North Corridor Planning Committee **GPS Coordinates:** 34° 5'48.78"N 35°55'40.46"E **Elevation:** 1850 m – 1950 m **Slope:** Low to Medium **Rockiness:** Medium to High **Soil Type:** Lithic Leptosols, Leptic Luvisols, Eutric Luvisols, Rendzic Leptosols and Calcaric Leptosols		
Monitoring Results (Plot 1)	**Year 2016 - 2017**	**Year 2017 - 2018**
Number of seedlings planted	12500	4064
Planting Start and End date	Nov 2016 – Nov 2016	Nov 2017– Nov 2017

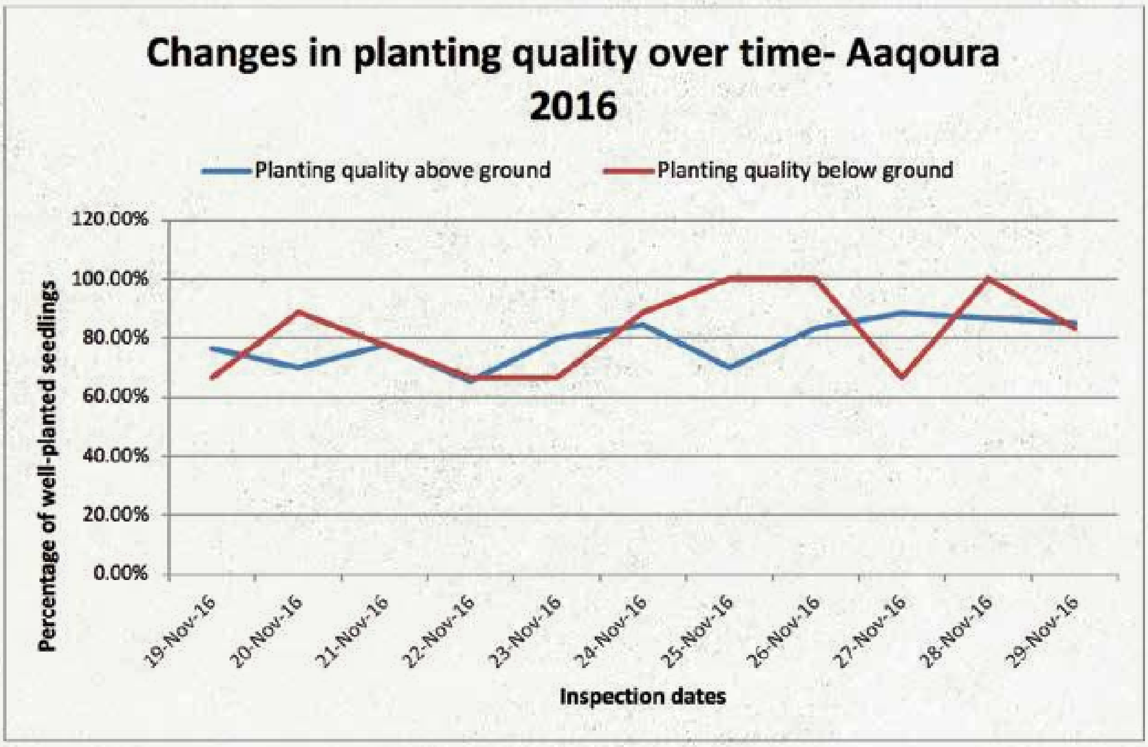

Figure 28: Inspection results in 2016 in Aaqoura site

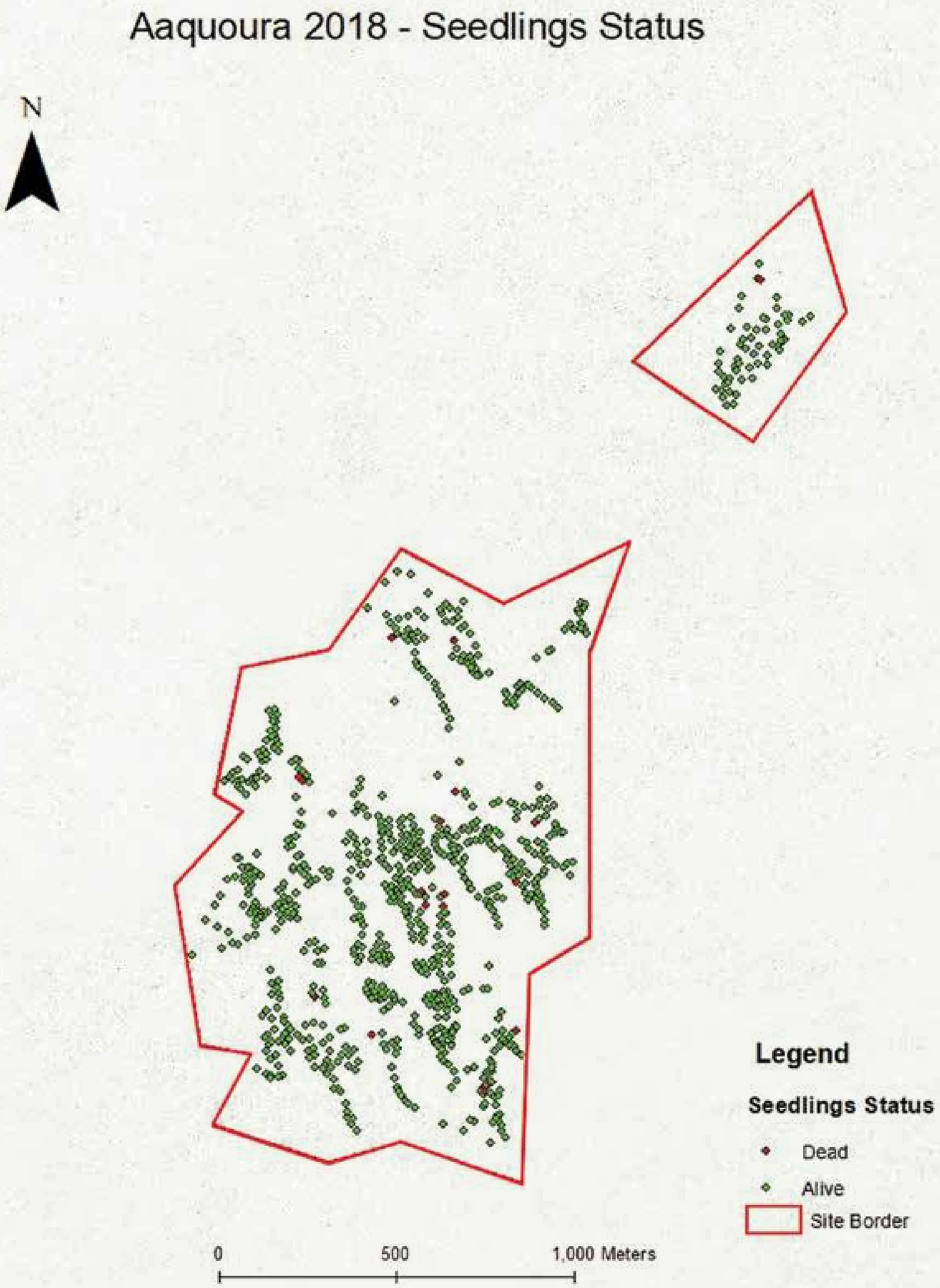

Figure 29: Aaqoura monitoring map season 2017.2018 with 92% survival rate

3. BCHARRE

Table 15: Description and monitoring of Bcharre site

Bcharre Site Description		
Mouhafaza: North Lebanon **Caza:** Bcharre **Land tenure:** Public **Partners:** - Municipality of Bcharre - Friends of the Cedar Committee of Bcharre - North Corridor Planning Committee **GPS Coordinates:** 34°15'35.36"N 36° 3'56.09"E **Elevation:** 2000 – 2400m **Slope:** Very High **Rockiness:** High **Soil Type:** Eutric Regosols and Lithic Leptosols		
Monitoring Results (Plot 1)	**Year 2016 - 2017**	**Year 2017 - 2018**
Number of seedlings planted	9600	5001
Planting Start and End date	Nov 2016 – Nov 2016	Nov 2017– Nov 2017

4. CHATINE

Table 16: Description and monitoring of Chatine site

Chatine Site Description	
Mouhafaza: North Lebanon **Caza:** Batroun **Land tenure:** Public **Partners:** - Municipality of Chatine - Ministry of Foreign Affairs- Lebanese Diaspora Energy - North Corridor Planning Committee **GPS Coordinates:** 34°10'34.45"N 35°52'7.62"E **Elevation:** 1500 m - 1580 m **Slope:** Very High **Rockiness:** High **Soil Type:** Lithic Leptosols	
Monitoring Results	**Year 2017 - 2018**
Number of seedlings planted	140
Planting Start and End date	Nov 2017 – Nov 2017

5. EHMEJ

Table 17: Description and monitoring results of Ehmej site

Ehmej Site Description		
Mouhafaza: Mount Lebanon **Caza:** Jbeil **Land tenure:** Public **Partners:** - Municipality of Ehmej - North Corridor Planning Committee **GPS Coordinates:** 34° 7'42.41"N 35°50'17.85"E **Elevation:** 1550 m – 1650 m **Slope:** Medium to High **Rockiness:** Medium to High **Soil Type:** Eutric Luvisols, Leptic Luvisols, Lithic Leptosols and Areno-Eutric Leptosols		
Monitoring Results	**Season 2016 – 2017**	**Season 2017 – 2018**
Number of seedlings planted	2450	490
Planting Start and End date	Nov 2016 – Nov 2016	Feb 2018 – Mar 2018

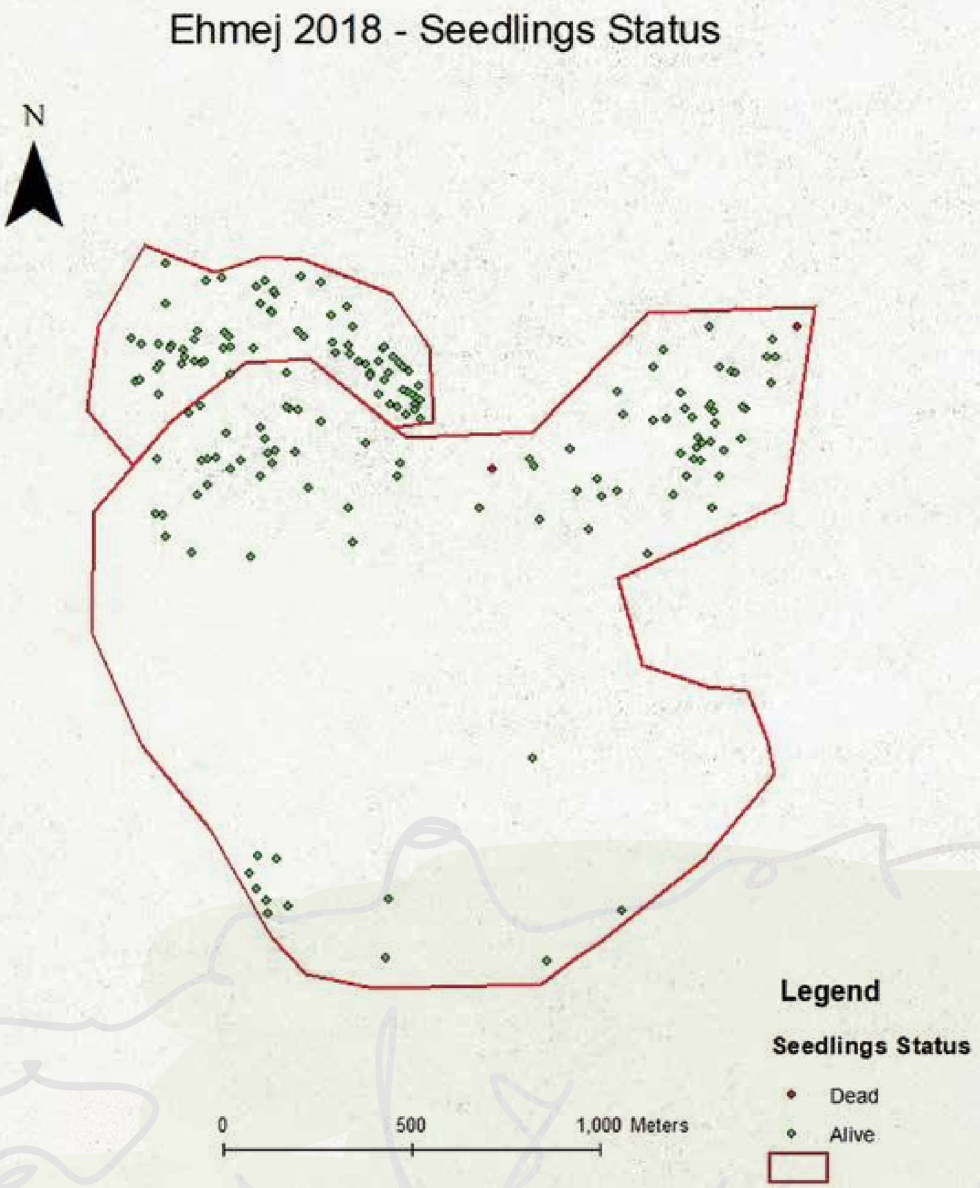

Figure 30:Ehmej monitoring map season 2017.2018 with 79% survival rate

6. GEBRAYEL

Table 18: Description and monitoring results of Gebrayel site

Gebrayel Site Description	
Mouhafaza: Akkar **Caza:** Akkar **Land tenure:** Public **Partners:** - Municipality of Gebrayel - Lebanon Rural Development **GPS Coordinates:** 34°31'45.43"N 36° 7'27.03"E **Elevation:** 460 m – 500 m **Slope:** Low **Rockiness:** Low **Soil Type:** Rhodic Luvisols, Haplic Cambisols and Leptic Luvisols	
Monitoring Results	**Season 2016 – 2017**
Number of seedlings planted	1540
Planting Start and End date	Mar 2017 – Mar 2017

7. HASROUN

Table 19: Description and monitoring results of Hasroun site

Hasroun Site Description			
Mouhafaza: North Lebanon **Caza:** Bcharri **Land tenure:** Public **Partners:** - Municipality of Hasroun - North Corridor Planning Committee **GPS Coordinates:** 34°12'57.15"N 35°57'40.51"E **Elevation:** 2000 m – 2100 m **Slope:** Medium to High **Rockiness:** Medium to High **Soil Type:** Rendzic Leptosols, Calcaric Leptosols, Calcaric Leptosols, Haplic Leptosols and Skeletic Regosols			
Monitoring Results	**Season 2015 - 2016**	**Season 2016 - 2017**	**Season 2017 - 2018**
Number of seedlings planted	2800	1505	340 (replacement)
Planting Start and End date	Apr 2016 – Apr 2016	Apr 2016 – Nov 2016	Nov 2017 – Nov 2017

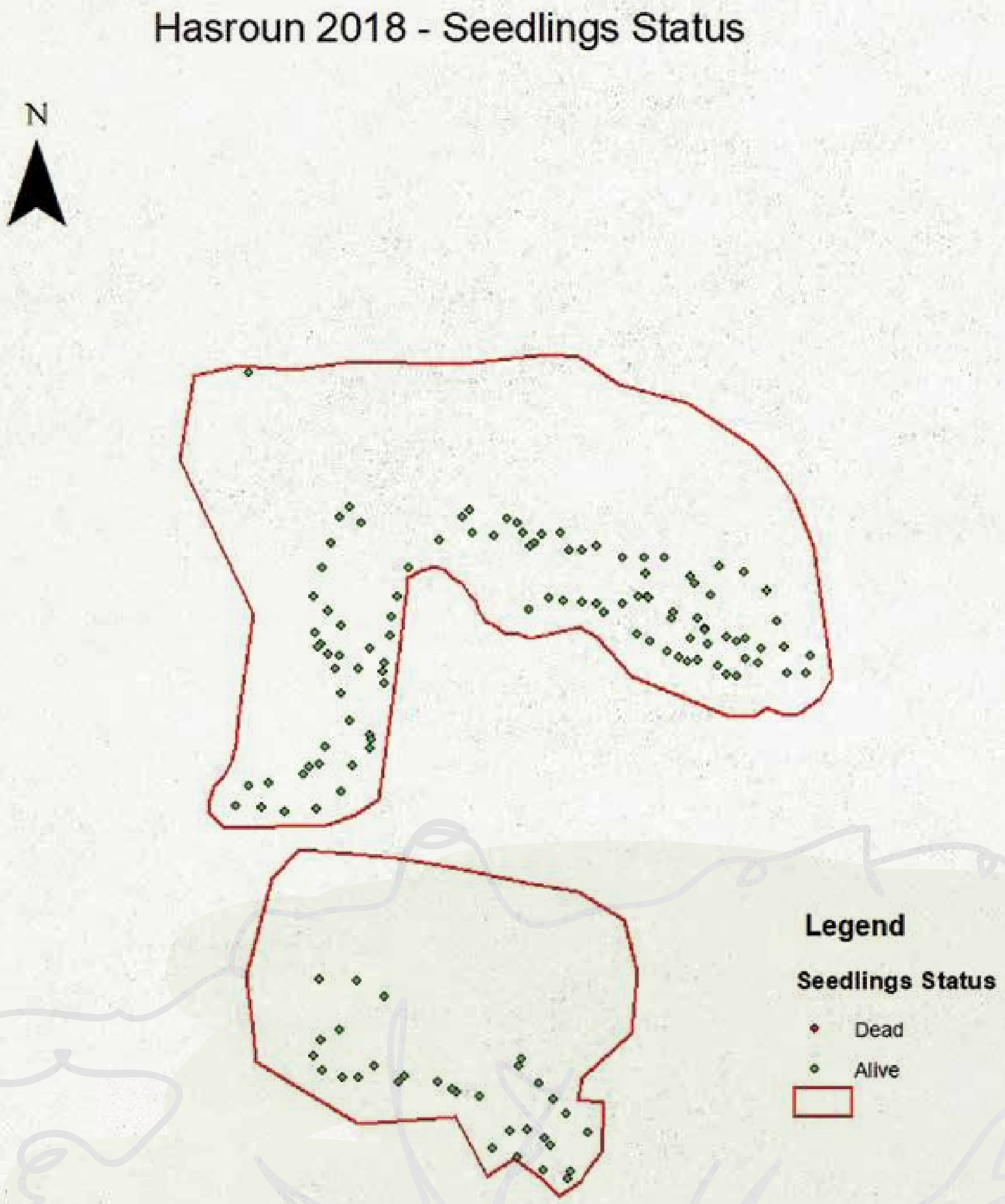

Figure 31: Hasroun monitoring map season 2017.2018 with 97% survival rate

8. JAJ

Table 20: Description and monitoring results of Jaj site

Jaj Site Description		
Mouhafaza: Mount Lebanon **Caza:** Jbeil **Land tenure:** Public **Partners:** - Municipality of Jaj - North Corridor Planning Committee **GPS Coordinates:** 34° 8'51.48"N 35°49'36.25"E **Elevation:** 1580 m – 1690 m **Slope:** Very High **Rockiness:** Very High **Soil Type:** Eutric Luvisols, Leptic Luvisols and Lithic Leptosols		
Monitoring Results	**Season 2016 – 2017**	**Season 2017 - 2018**
Number of seedlings planted	2016	1655
Planting Start and End date	Nov 2016 – Dec 2017	Nov 2017 – Nov 2018

9. TANNOURINE

Table 21: Description and monitoring results of Tannourine site

Tannourine Site Description		
Mouhafaza: Mount Lebanon **Caza:** Batroun **Land tenure:** Public **Partners:** - Municipality of Tannourine - North Corridor Planning Committee **GPS Coordinates:** 34°10'50.80"N 35°54'18.02"E **Elevation:** 1410 m to 1515 m **Slope:** Very High **Rockiness:** Medium **Soil Type:** Lithic Leptosols, Areno-Eutric Leptosols and Calcaro-Hortic Anthrosols		
Monitoring Results	**Season 2016 – 2017**	**Season 2017 - 2018**
Number of seedlings planted	600	4500
Planting Start and End date	Nov 2016 – Apr 2017	Nov 2017 – Dec 2017

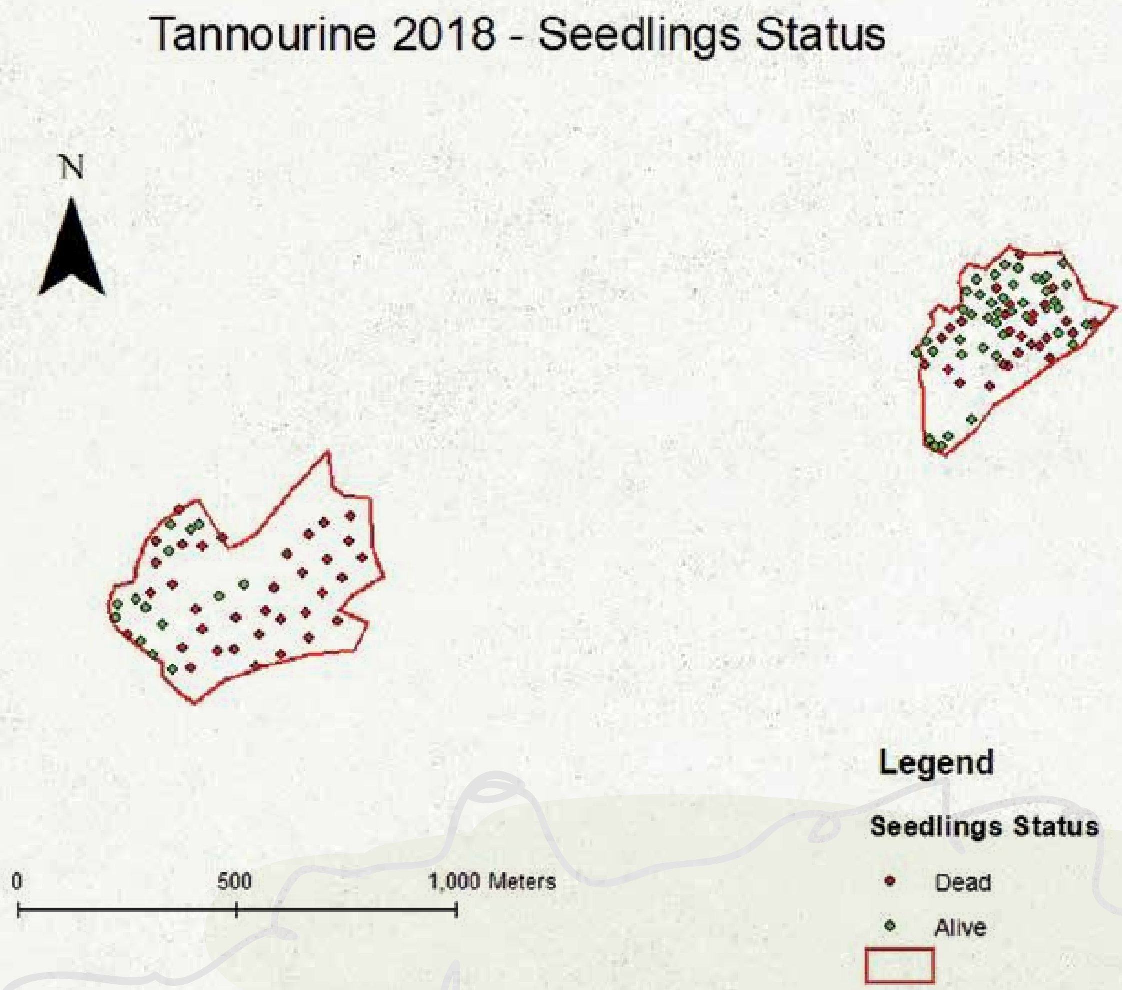

Figure 32: Tannourine monitoring map season 2018.2019 with survival rate of 63%

10. YAMMOUNEH

Table 22: Description and monitoring results of Yammouneh site

Yammouneh Site Description			
Mouhafaza: Beqaa **Caza:** Baalbek-Hermel **Land tenure:** Public **Partners:** - Municipality of Yammouneh - Youth Cultural Club of Yammouneh - North Corridor Planning Committee **GPS Coordinates:** 34° 7'18.92"N 36° 2'20.57"E **Elevation:** 1380 m – 1450 m **Slope:** Low to Medium **Rockiness:** Low **Soil Type:** Calcaric Leptosols, Leptic Luvisols and Areno-Eutric Leptosols			
Monitoring Results	**Season 2015 - 2016**	**Season 2016 - 2017**	**Season 2017 - 2018**
Number of seedlings planted	6525	3000	1500
Planting Start and End date	Nov 2015 – Dec 2015	Nov 2016 – Nov 2016	Feb 2018 – Feb 2018

E. Shouf Sites

1. MAASER EL SHOUF

Table 23: Description and monitoring results of Maaser El Shouf site

Maaser El Shouf Site Description		
Mouhafaza: Mount Lebanon **Caza:** Shouf **Land tenure:** Public **Partners:** - Shouf Biosphere Reserve **GPS Coordinates:** 33°40'5.59"N 35°41'57.48"E **Elevation:** 1700 m – 1900 m **Slope:** Very High **Rockiness:** Very High **Soil Type:** Lithic Leptosols		
Monitoring Results	**Season 2016 – 2017**	**Season 2017 – 2018**
Number of seedlings planted	5000	2405
Planting Start and End date	Nov 2016 – Nov 2016	Nov 2017 – Feb 2018

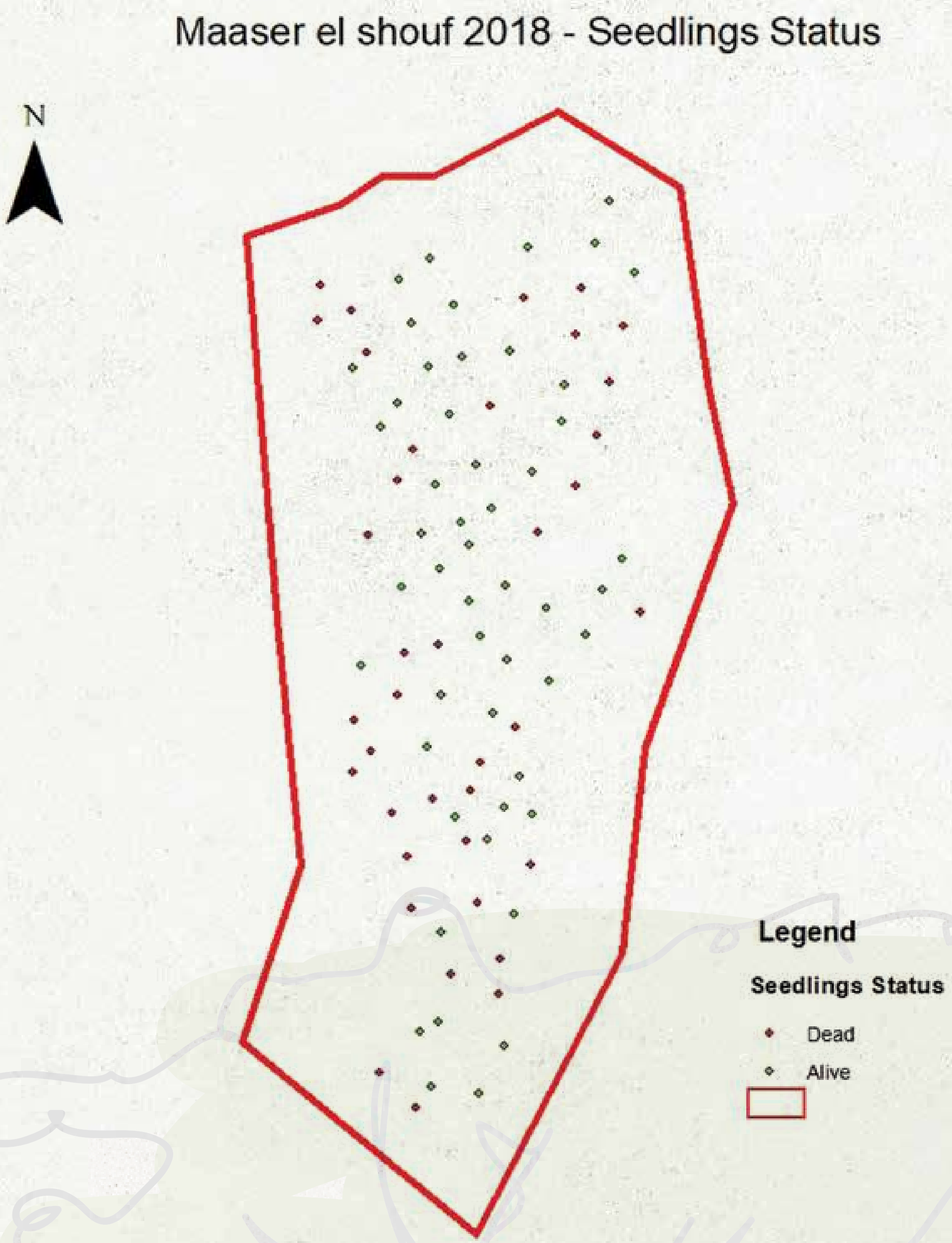

Figure 33: Maaser el Shouf monitoring map season 2017.2018 with 66% survival rate

2. NIHA

Table 24: Description and monitoring results of Niha site

Niha Site Description		
Mouhafaza: Mount Lebanon **Caza:** Shouf **Land tenure:** Public **Partners:** - Shouf Biosphere Reserve **GPS Coordinates:** 33°34'22.96"N 35°37'49.76"E **Elevation:** 1240 m – 1340 m **Slope:** Medium to High **Rockiness:** Low to Medium **Soil Type:** Eutric Arenosols		
Monitoring Results	**Season 2016 – 2017**	**Season 2017 – 2018**
Number of seedlings planted	7756	5235
Planting Start and End date	Nov 2016 – Dec 2016	Feb 2018 -

Figure 34: Niha monitoring map season 2017.2018 with 80% survival rate

III) PRIVATE SECTOR ENGAGEMENT

Table 25: Number of seedlings and hectares planted through a private sector contribution

Private Sector Donor	Site Location	Partner	Ha Planted	Number of seedlings
Advanced Car Rental	Aanjar	LRI	6.35	2800
MIC2	Aitanit	LRI	4	2500
	Qaraoun	LRI	1.57	2401
	Tannourine	LRI	0.89	600
	Ehmej	LRI	1.9	1950
LLWB	Dahr Al Ahmar	LRI	3	1950
Hilton	Deir el Ahmar	LRI	0.46	100
Holcim	Ehden	LRI	0.88	2200
	Hadchit	LRI	3	1300
USEK/USAID	Ehmej	LRI	0.26	240
Strategy &	Jaj	LRI	0.2	140
DHL	Rachaya	LRI	0.75	980
Advanced Car Rental	Jbaa	LRI	33.07	14400
USAID/Byblos Bank	Maaser El Shouf	LRI	23	15000

IV) EXPERIMENTS AND TRIALS

Reforestation projects are increasing in Lebanon and the demand for quality seedlings is high. However, the costs of reforestation are still considered high with the available resources, and this is mainly due to irrigation costs. Focus is increasingly placed on decreasing the cost of planting, to sustain reforestation efforts at all stakeholder levels. Therefore, several experiments were conducted to mitigate the costs and optimize planting conditions in areas with difficult access to irrigation.

A. Pruning and Biochar

This experiment was conducted in collaboration with Native Nurseries and the Lebanese University Faculty of Agricultural and Veterinary Sciences. The purpose of this experiment was to evaluate the effect of pruning seedlings and the impact of biochar on the survival and growth of *Amygdalus spp.* seedlings in reforestation projects in Lebanon, under no irrigation vs. irrigation conditions. The experiment was conducted in two different sites, Fraydees and Mhaydthe.

In Mhaydthe, the highest survival rates were observed under the biochar treatments, for both irrigated and non-irrigated plots. There was no significant difference between the pruning and no pruning treatments. In general, the survival rate was higher in the irrigated plots, however, the minimum survival rate in the non-irrigated plot was 58.33%, indicating that more than half of the planted seedlings survived.

Table 26: Initial survival rate results in Mhaydthe

Treatment	Sub-treatment	Total seedlings planted	Healthy seedlings	Dead seedlings	% survival
No irrigation	Pruning	36	21	15	58.33%
	No pruning	36	21	15	58.33%
	Biochar	36	25	11	69.44%
Irrigation	Pruning	36	27	9	75%
	No pruning	36	32	4	88.89%
	Biochar	36	34	2	94.44%

In Fraydees, the highest survival rates were also observed with the biochar treatments, for both irrigated and non-irrigated plots. There was no significant difference between the pruning and no pruning treatments in the irrigated plots. However, there was a clear difference between pruning and no pruning treatments in the non-irrigated plots, with higher survival rates observed with the no pruning treatment (72.22%). In general, the survival rate was higher in the irrigated plots. However, the minimum survival rate in the non-irrigated plot was 52.78%, more than half of the planted seedlings. Higher survival rates were observed in Fraydees mainly due to the higher precipitation levels. Fraydees has an average yearly precipitation of 1140 – 1475 mm and Mhaydthe having a lower average precipitation level of 760 – 1140 mm.

Table 27: Initial survival rate results in Fraydees

Treatment	Sub-treatment	Total seedlings planted	Healthy seedlings	Dead seedlings	% survival
No irrigation	Pruning	36	19	17	52.78%
	No pruning	36	26	10	72.22%
	Biochar	36	28	8	77.78%
Irrigation	Pruning	36	35	1	97.22%
	No pruning	36	33	3	91.67%
	Biochar	36	36	0	100%

The destructive sampling showed that all treatments had a shoot to root ratio of less than 1, indicating initially that there was good root development throughout the monitoring period. Good root development in deeper soil promotes the uptake of soil moisture and nutrients, resulting in the lower mortality rates under no irrigation observed in Mhaydthe and Fraydees.

Table 28: Mhaydthe average dry shoot and root weights

Treatment	Sub-treatment	Dry shoot weight g	Dry root weight g
No irrigation	Pruning	1.58	4.38
	No pruning	2.17	4.95
	Biochar	1.9	4.53
Irrigation	Pruning	1.42	4.5
	No pruning	1.76	4.39
	Biochar	1.34	4.6

Table 29: Fraydees average dry shoot and root weights

Treatment	Sub-treatment	Dry shoot weight g	Dry root weight g
No irrigation	Pruning	1.28	4.6
	No pruning	1.83	5.08
	Biochar	2.07	5.83
Irrigation	Pruning	1.5	4.26
	No pruning	2.3	6.17
	Biochar	2.73	5.98

Seedlings under the pruning treatments were pruned two weeks before outplanting. The limited time between pruning and outplanting could have been a cause of the lower survival rates observed, similar to the no pruning treatments. Several reasons that caused stress on seedlings post-planting could have developed from heavy pruning two weeks before planting: food storage and energy depletion, stimulation of side branches growth requiring larger amounts of soil moisture per seedling and/or lower photosynthetic capacity of seedlings that limit overall growth of seedlings and survival rates. It could be recommended for future experimental trials to time the pruning a month before outplanting to 1) decrease the stress of heavy pruning mentioned above before planting and still 2) control shoot mass before planting to decrease water stress post-planting resulting from high transpirational demand. Overall, the experiment showed promising results for the use of biochar as well as a potential for planting without irrigation in locations comparable to Mhaydthe and Fraydees.

B. Deep pipe

The Deep Pipe Experiment was an experimental attempt to improve reforestation efforts in Lebanon by reducing irrigation costs. The concept of Deep Pipe irrigation consists of installing plastic pipes during the planting of the seedlings, so that the pipes are placed as close as possible to their root system. Irrigation would then occur through the pipe, whereby controlled volumes of water are allocated to the seedlings over a scheduled irrigation plan. The water will then be directly and efficiently channeled to the root system. When compared to the surface irrigation methods that are typically applied in reforestation activities, the Deep Pipe technique limits the quantity of irrigation water per seedling while minimizing water loss via evaporation and permits an efficient release of the irrigation water as per the seedling needs. Consequently, the precise irrigation needs of the seedlings can be tailored by adjusting the deep pipe volumes and setting a defined irrigation schedule. Two sites were included in this experiment, Maqne and Kawkaba Abou Arab.

Figure 35: Deep Pipe experiment in Maqne

A. Results of Maqne site

In Maqne, seedlings in all treatments did not survive. This is supposedly due to many factors: late plantation, heavy drought, stony soil unable to retain water, water quantity and the length of intervals between irrigations. Therefore, results of Maqne site were excluded from the interpretation of the results.

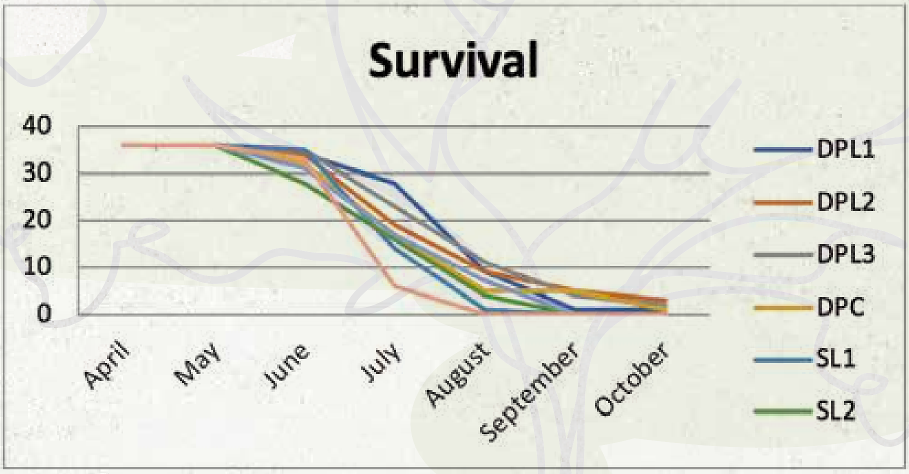

Figure 36: Survival evolution of the seedlings in Maqne site from April till October and for the different treatments (DPL1: Deep Pipe volume 1L; DPL2: Deep Pipe volume 2L; DPL3: Deep Pipe volume 3L; DPC: Deep Pipe Control; SL1: Surface irrigation volume 1L; SL2: Surface irrigation volume 2L)

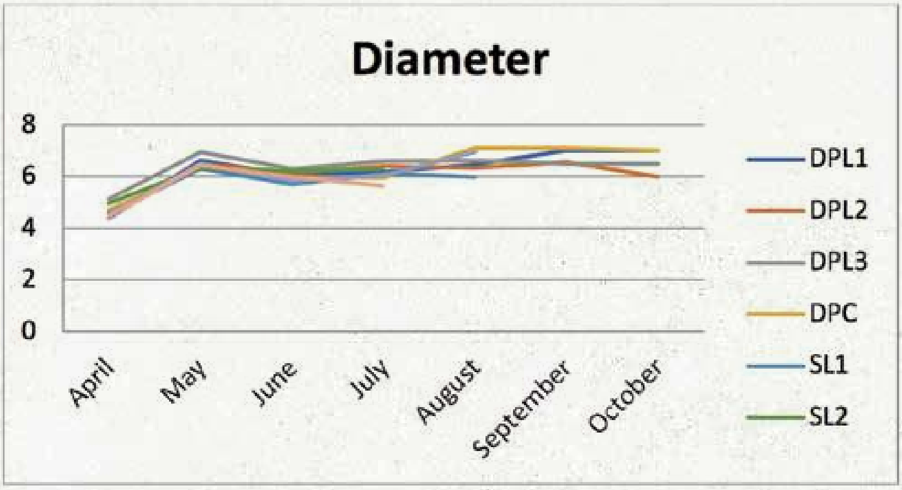

Figure 37: Diameter measurements of the seedlings in Maqne site from April till October and for the different treatments (DPL1: Deep Pipe volume 1L; DPL2: Deep Pipe volume 2L; DPL3: Deep Pipe volume 3L; DPC: Deep Pipe Control; SL1: Surface irrigation volume 1L; SL2: Surface irrigation volume

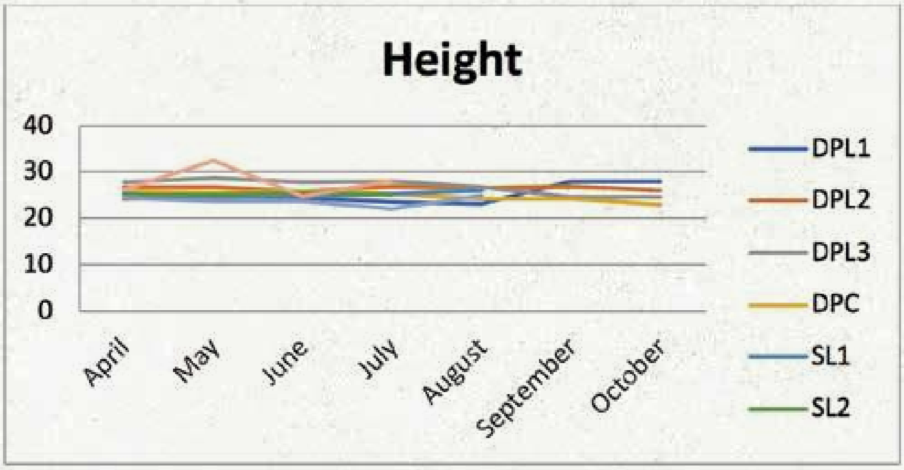

Figure 38: Height measurements of the seedlings in Maqne site from April till October and for the different treatments (DPL1: Deep Pipe volume 1L; DPL2: Deep Pipe volume 2L; DPL3: Deep Pipe volume 3L; DPC: Deep Pipe Control; SL1: Surface irrigation volume 1L; SL2: Surface irrigation volume 2L)

B. Results of Kawkaba Abou Aarab site

The chart below demonstrates the survival percentages under different treatments. The observed results indicate that the survival rates of non-irrigated seedlings started decreasing drastically starting June and continued until they were all dead in October.

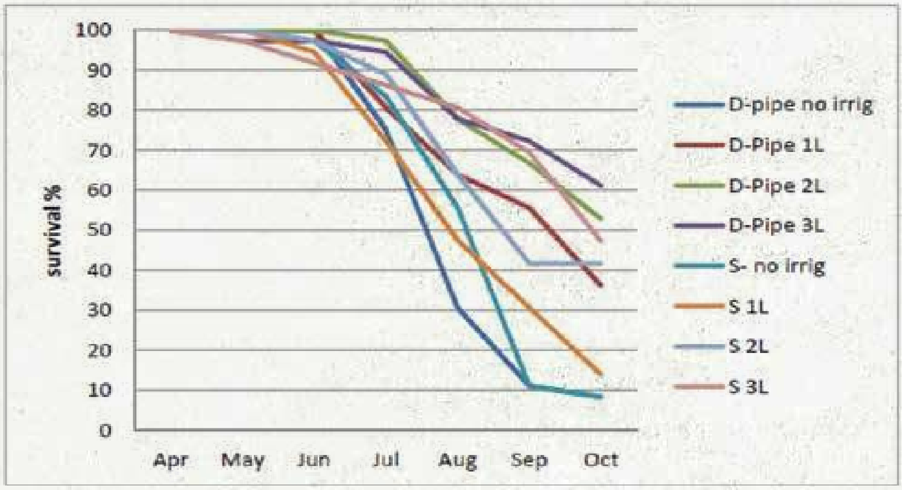

Figure 39: Survival evolution of the seedlings in Kawkaba site from April till October and for the different treatments (DPL1: Deep Pipe volume 1L; DPL2: Deep Pipe volume 2L; DPL3: Deep Pipe volume 3L; DPC: Deep Pipe Control; SL1: Surface irrigation volume 1L; SL2: Surface irrigation volume 2L

The treatments had a very significant effect on the survival ratio as shown in the below figure where the highest number of surviving seedlings occurred under the treatment irrigated with 3L ($\mu=10$ plants). In turn, the results of the 3L treatment is significantly different from the 0L results ($\mu=3$ plants; $p<0.001$) and 1L ($\mu=6$ plants; $p<0.001$) and survival of seedlings receiving the 2L treatment ($\mu=7$ plants; $p=0.002<0.01$). These results show that the quantity of irrigation affects the survival of the seedlings, because drought causes water stress and therefore leads to its mortality. Drought and insufficient irrigation decrease soil moisture and consequently disturb physiological processes, damage the plantlets and slow down its growth and in harshest conditions results in mortality.

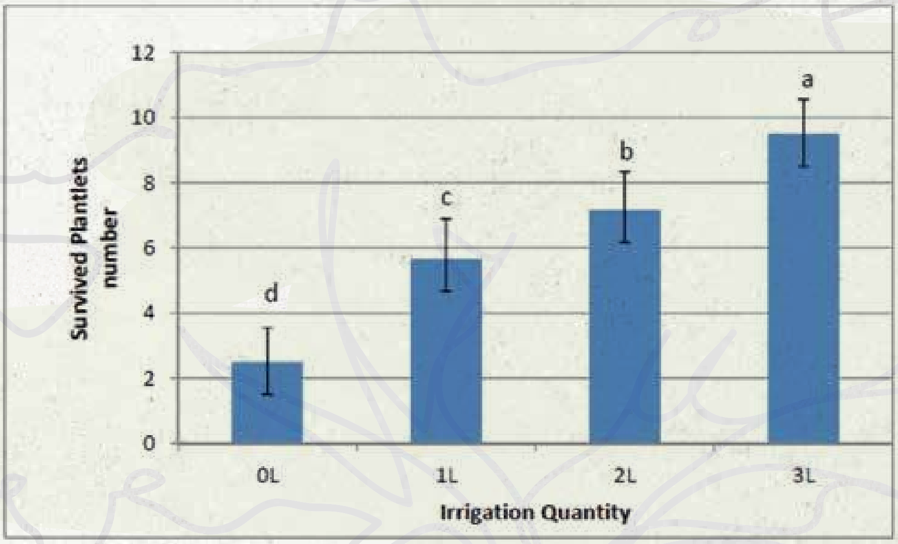

Figure 40: The number of survived plantlets according to the irrigation quantity

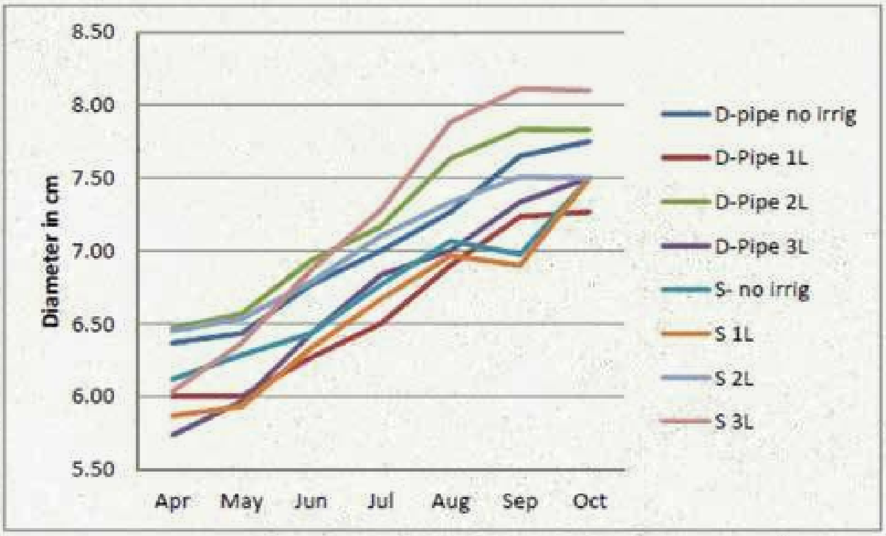

Figure 41: Diameter measurements of the seedlings in Kawkaba site from April till October and for the different treatments (DPL1: Deep Pipe volume 1L; DPL2: Deep Pipe volume 2L; DPL3: Deep Pipe volume 3L; DPC: Deep Pipe Control; SL1: Surface irrigation volume 1L; SL2: Surface irrigation volume 2L)

Figure 41 shows that the evolution of the growth of the diameter is not affected by neither the type nor the quantity of irrigation. The figure below shows the greatest plant diameter growth in the treatment irrigated with 3L ($\mu=2$ mm) with a very significant difference compared to 0L ($\mu=1$ mm; $p<0.001$) and a highly significant difference compared to the treatment receiving 1L ($\mu=1.26$ mm; $p=0.004<0.01$) and 2L($\mu=1.33$ mm; $p=0.008<0.01$). Drought is a limiting factor on tree diameter growth and diameter growth parameter is hence significantly affected by the water abundance during irrigation.

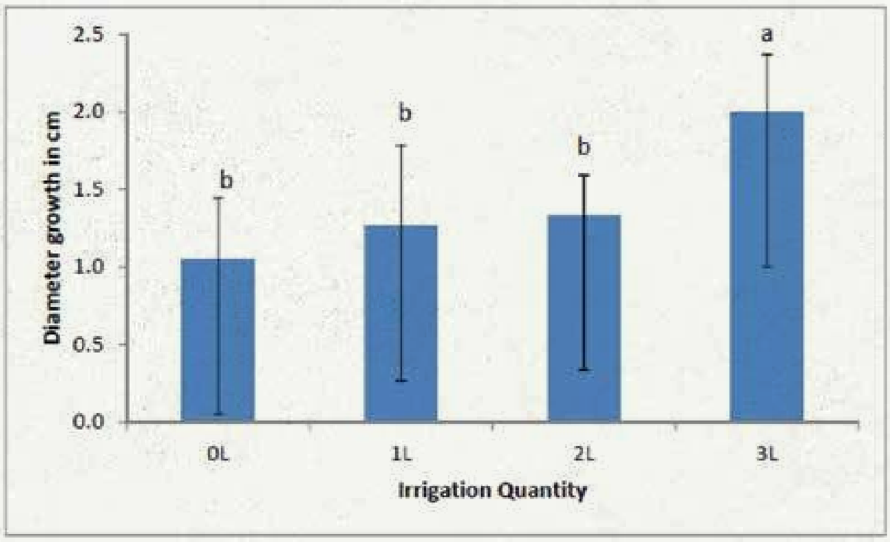

Figure 42: Diameter growth according to the irrigation quantity

The chart below shows that the growth in height of the seedlings differed slightly between treatments. It is obvious that in D-pipe 2L and 3L the height increased more than in the other treatments. For the D-pipe 1L, surface 2L and 3L the height increased slightly and there is no important difference between these 3 treatments. Very slight growth is noticed for the non-irrigated seedlings and the ones irrigated by 1L through surface irrigation.

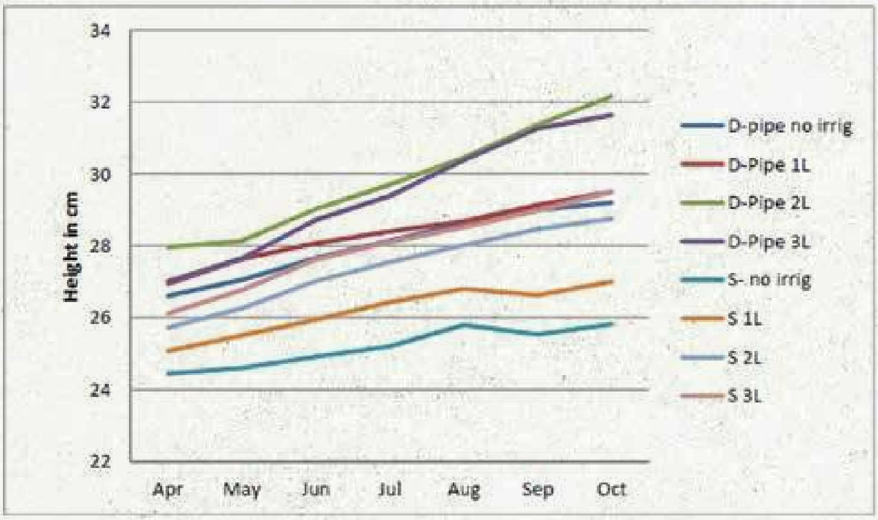

Figure 43: Height measurements of the seedlings in Kawkaba site from April till October and for the different treatments (DPL1: Deep Pipe volume 1L; DPL2: Deep Pipe volume 2L; DPL3: Deep Pipe volume 3L; DPC: Deep Pipe Control; SL1: Surface irrigation volume 1L; SL2: Surface irrigation volume 2L)

The figure below shows the highest plant height growth in the treatment irrigated with 3L (μ=4.35 cm) with a very high significant difference compared to 0L (μ=1.93cm; $p<0.001$) and 1L (μ=2.43 cm; $p<0.001$) and a significant difference compared to the treatment receiving 2L (μ=3.62 cm; $p=0.045<0.05$). The results below show that the height growth is affected by the irrigation quantity.

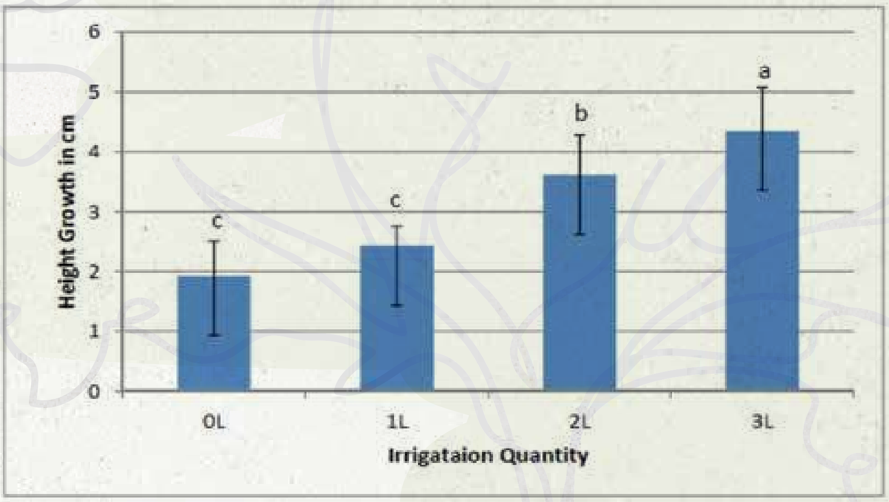

Figure 44: Height growth according to the irrigation quantity

C. Conclusions and Recommendations

The deep pipe irrigation is a low-cost method, requiring the least maintenance and using less water than surface irrigation (no wasted water), but cannot cover the climatic deficiency of very arid area such as Maqne with a rainfall average of 200mm in which the seedlings did not survive the dry season. The same deep pipe irrigation system worked well in Kawkaba Abou Arab, that experienced an average rainfall of 800mm. In this region, the results showed that deep pipe irrigation had the highest survival rate with a very significant difference compared to non-irrigated treatments and a significant difference compared to treatments irrigated using surface irrigation. As for the growth of the seedlings, the deep pipe method had no significant effect on the seedling diameter growth but had a highly significant effect on the plant height growth.

In conclusion the deep pipe is surely more efficient than surface irrigation, because it ensures better survival rate and growth of the seedlings. Deep pipe limits competition between the seedlings and weeds that grow under surface irrigation methods. Moreover, by having the water directly reaching the deep root zone, the deep pipe method enlarges the root volume allowing the surviving plant to reach a better autonomy after irrigation is stopped.

It is important to note that despite the observed results, the deep pipe method is being newly studied and experimented; therefore, more studies spanning longer periods of time should be conducted to conclude more solid results. This is especially true for coniferous species. Finally, planting within the optimal planting window - winter season - might alter the results of this technique, as the seedlings would benefit from a good period of rainfall irrigation.

C. Polyter

The Polyter Experiment was an attempt to reduce irrigation costs by replacing traditional irrigation practices with a water retaining substance called Polyter. Polyter is an innovative, biodegradable and high-performance technology that acts as a growth activator, and hydro retentive fertilizer. The above characteristics enticed LRI's choice to experiment with Polyter, and eventually expand its use to the reforestation activities if positive results are obtained. Some characteristics of Polyter:

- It saves the need for 50% to 80% of water consumption.
- It increases the root system cover area which reduce the need for water intake.
- Is can be used on all types of soils and species.
- It is eco-friendly
- It stabilizes and loosens soil and restructures the humus.
- It has an effective life of three to five years.

The Polyter experiment was conducted in the Barouk area in Shouf. One hundred and eight, one-year old *Cedrus libani* species were planted. The experiment aimed to study the effect of polyter and compare it to that of phosphate, which is a root development substance. The one hundred and eight seedlings were divided into three replicates. Each replicate contained 36 seedlings, and three rows of the three different treatments. Each treatment row consisted of 12 seedlings. The treatments were the following:

- Polyter: 10g of polyter were added to the bottom of the hole of the planted seedling. Irrigated only during planting.
- Phosphate: 150g of phosphate were added to the bottom of the hole for the planted seedling. No irrigation occurred during or after planting.
- Control: Seedlings were planted with no additions. Planting seedlings with no add on. No irrigation occurred.

The seedlings were planted in February 2018. Monitoring of the seedlings started from "reading 1" in February 2018 and continued till November 2018. Nine readings in total were recorded, and that measured the following:

- Height of seedlings;
- Width of the stem;
- Alive/Dead status.

LRI aims to finalize and analyze the results by the end of the September 2019. Nonetheless, the current results indicate the better development and survival rate of the polyter treated seedlings.

The following two tables present the results of the first and last readings of the polyter experiment. "Reading 1" (taken on 07.02.2018) and "Reading 9" on (06.11.2018)

Reading 1						
Bloc1/Replica 1						
Experiment	P1		TSP1		C1	
Parameters	Width (cm)	Height (cm)	Width (cm)	Height (cm)	Width (cm)	Height (cm)
Seedling 1	0.5	13.2	0.5	18.5	0.5	17
Seedling 2	0.5	18.5	0.5	17	0.5	15
Seedling 3	0.5	16.5	0.5	12	0.4	17
Seedling 4	0.45	19	0.5	14.5	0.4	13
Seedling 5	0.5	12.5	0.4	15	0.4	14.5
Seedling 6	0.4	18.5	0.5	14.5	0.5	14.5
Seedling 7	0.4	15	0.5	14	0.5	15
Seedling 8	0.4	19	0.5	15	0.5	14.5
Seedling 9	0.4	15	0.5	15.5	0.4	15
Seedling 10	0.5	19.5	0.4	14.5	0.5	17
Seedling 11	0.5	16	0.4	18	0.6	14
Seedling 12	0.5	20	0.4	13	0.5	12.5

Bloc2/ Replica 2						
Experiment	P2		TSP2		C2	
Parameters	Width (cm)	Height (cm)	Width (cm)	Height (cm)	Width (cm)	Height (cm)
Seedling 13	0.5	13	0.45	15	0.5	15.5
Seedling 14	0.5	16	0.5	14	0.4	12.5
Seedling 15	0.5	14	0.45	13.5	0.4	19
Seedling 16	0.6	16.5	0.45	15	0.5	14.5
Seedling 17	0.5	13.5	0.5	17	0.5	13
Seedling 18	0.5	11.5	0.4	16	0.5	12.5
Seedling 19	0.4	14.5	0.5	16	0.4	16
Seedling 20	0.5	14	0.55	13	0.5	17
Seedling 21	0.5	13.5	0.45	15.5	0.4	13
Seedling 22	0.5	16	0.4	15	0.5	17
Seedling 23	0.45	14	0.5	15	0.4	16
Seedling 24	0.5	13	0.6	16	0.5	17

Bloc3/ Replica 3						
Experiment	P3		TSP3		C3	
Parameters	Width (cm)	Height (cm)	Width (cm)	Height (cm)	Width (cm)	Height (cm)
Seedling 25	0.5	15.5	0.5	17.3	0.5	16
Seedling 26	0.45	13.5	0.5	16.2	0.4	14.5
Seedling 27	0.5	13.5	0.4	12.8	0.4	11.5
Seedling 28	0.45	14	0.5	16.2	0.4	14
Seedling 29	0.5	15.5	0.5	12.5	0.5	17.5
Seedling 30	0.5	16	0.45	15.7	0.5	19
Seedling 31	0.5	16	0.5	13.8	0.4	13.5
Seedling 32	0.5	12.3	0.5	12	0.5	13
Seedling 33	0.4	12.5	0.45	15.8	0.4	14.5
Seedling 34	0.55	13	0.6	13.8	0.4	17
Seedling 35	0.5	14.5	0.65	17.8	0.5	16
Seedling 36	0.4	13.9	0.45	14.4	0.5	18.5

Table 30: Results of the reading 1 of the polyter experiment in Barouk taken on 07.02.2018, P = Polyter treatment, TSP = Phosphate Treatment, C = Control

Reading 9						
Bloc1/Replica 1						
Experiment	**P1**		**TSP1**		**C1**	
Parameters	Width (cm)	Height (cm)	Width (cm)	Height (cm)	Width (cm)	Height (cm)
Seedling 1	0.831	25.5	0.653	25.2	0.65	26
Seedling 2	0.859	30	0.534	23.5	0.759	31
Seedling 3	0.897	28	0.594	20.5	0.605	26
Seedling 4	0.657	29.5	0.704	28	0.522	23
Seedling 5	0.68	22	0.625	13	0.683	22
Seedling 6	0.803	28	0.547	22.3	0.644	24
Seedling 7	0.792	20.5	0.589	22.5	0.648	24.5
Seedling 8	0.927	25.5	0.617	20	0.86	24
Seedling 9	0.498	23.5	0.765	25.2	0.628	23
Seedling 10	0.89	27.5	0.643	23.6	0.439	22.5
Seedling 11	0.647	26.4	0.612	26.5	dead	dead
Seedling 12	0.678	27	0.503	20.5	0.592	18
Bloc2/ Replica 2						
Experiment	**P2**		**TSP2**		**C2**	
Parameters	Width (cm)	Height (cm)	Width (cm)	Height (cm)	Width (cm)	Height (cm)
Seedling 13	0.785	28.5	0.59	22	0.582	24.5
Seedling 14	0.579	17.5	0.535	19.5	0.538	20.5
Seedling 15	0.571	25	0.513	19.5	0.578	22.8
Seedling 16	0.705	17	0.69	21.5	0.682	23
Seedling 17	0.586	23	0.607	25.9	0.688	20
Seedling 18	0.713	25.5	0.59	24	0.565	28.4
Seedling 19	0.651	24.9	0.587	23	0.526	23
Seedling 20	0.674	27	0.582	20.6	0.491	23.6
Seedling 21	0.709	21.9	dead	dead	0.572	21.4
Seedling 22	0.717	22.2	dead	dead	0.659	28.5
Seedling 23	0.665	25	0.675	23.5	0.604	24
Seedling 24	0.653	21	dead	dead	0.598	26.7
Bloc3/ Replica 3						
Experiment	**P3**		**TSP3**		**C3**	
Parameters	Width (cm)	Height (cm)	Width (cm)	Height (cm)	Width (cm)	Height (mm)
Seedling 25	0.697	24.7	0.484	24	0.575	26.3
Seedling 26	0.86	23.5	dead	dead	0.458	19.5
Seedling 27	0.61	23	0.502	22	0.578	18.6
Seedling 28	0.702	25.4	0.614	24.5	0.439	21.9
Seedling 29	0.797	25.8	0.634	23.5	0.54	25
Seedling 30	0.528	20.5	0.415	24.5	0.581	24.5
Seedling 31	0.64	20.2	0.502	22.5	0.474	22
Seedling 32	0.615	20.5	0.526	20	0.551	21
Seedling 33	0.575	23.5	0.544	27.5	0.5	22.5
Seedling 34	0.649	24	0.608	23	0.477	24
Seedling 35	0.575	24.5	0.505	27.5	0.591	24.6
Seedling 36	0.55	25.5	0.698	24.6	0.473	25

Table 31: Results of the reading 9 of the polyter experiment in Barouk taken on 06.11.2018, P = Polyter treatment, TSP = Phosphate Treatment, C = Control

The table below presents the average of each indicator from Reading 1 and Reading 9, in order to compare the preliminary effect of each treatment on the seedlings:

Table 32: Average measurements of the three treatments

Experiment	P			TSP			C		
Parameters	Surviva l Rate	Avg Width (cm)	Avg Height (cm)	Surviva l Rate	Avg Widt h (cm)	Avg Height (cm)	Surviva l Rate	Avg Widt h (cm)	Avg Height (mm)
Reading 1	100%	0.4791	15.0666	100%	0.481 9	15.022 2	100%	0.461 1	15.1944 4
Reading 9	100%	0.6934	24.25	91%	0.586 8	22.898 9	97%	0.583	23.5916

The results obtained so far are not conclusive. During 2019, another set of readings will be taken and at the end of September 2019 the results will be analyzed in order to conclude a final result. However, as of yet, Polyter treated seedlings have showed better stem and height growth, with zero seedling mortality.

D. Pruning

Although the summer season increases the need for irrigation, and therefore irrigation costs, seedlings with newly germinating buds and leaves demand the highest amounts of irrigation water. In order to mitigate this high demand for water, seedlings can be pruned to reduce the number of leaves, buds and part of the seedling's shoot. The pruning experiment tested the effect of pruning of broadleaved seedlings of *Pistacia palaestina* in non-irrigated reforestation sites of Lebanon, Maqne and Mrusti.

In Mrusti, the seedlings showed a high mortality level in August, for the pruned seedlings (61%) in comparison to the non-pruned seedlings (36%). These mortality levels increase to 86% for the pruned seedlings and 72% for the non-pruned.

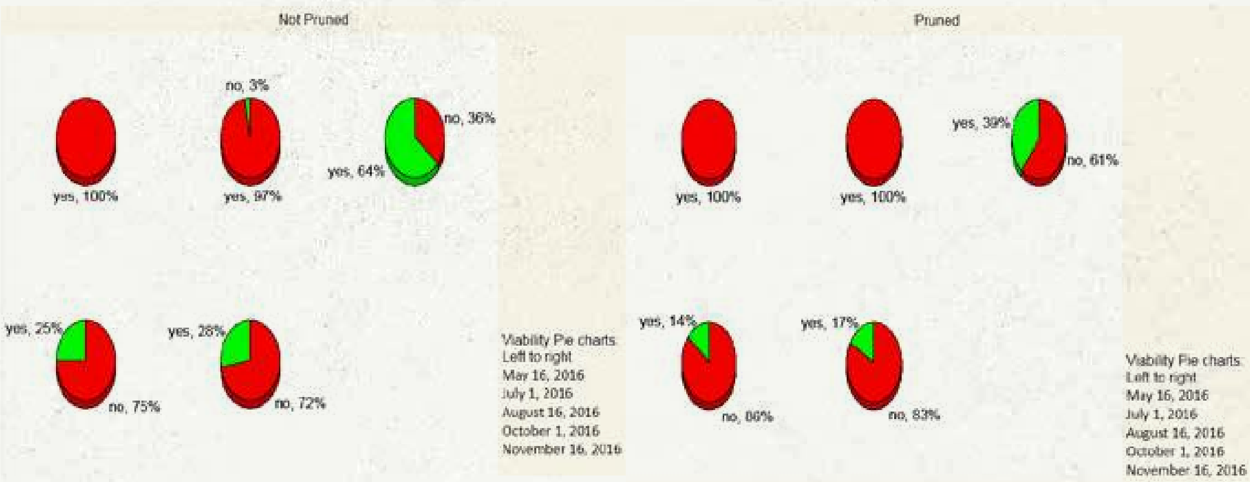

Figure 45: Average seedlings' mortality level in Mrusti site (pruned seedlings on the right, non-pruned seedlings on the left)

The average growth of diameter was slightly higher in the non-pruned seedlings compared to the pruned ones, which reflects that the treatment does not have any relevant effect on the diameter growth (Table 33 and Figure 46). The interaction time x treatment was not significant as well. The below table reflects the fact that the average diameter declined over the time. This significant decline is due to one of 2 factors: the surviving seedlings were small ones and then had small values of diameter, and consequently needed more water to survive; or an error in the measurement may have occurred, where the seedlings were not constantly measured at the same level.

Table 33: Average diameter measurement (in mm) of the Pistacia palaestina seedlings in Mrusti

Treatment	May 16, 2016	July 1, 2016	August 16, 2016
Non-pruning	5.15 ± 0.92	4.28 ± 0.82	4.51 ± 0.48
Pruning	5.16 ± 0.44	4.42 ± 0.91	3.92 ± 0.88

The difference in height between treatments was significant between treatments but not over time, which justifies the fact that the non-irrigated seedlings cannot show significant growth in 5 months, especially that *Pistacia palaestina* is a medium-growing species. The difference in height between treatments is due to the pruning fact, as the pruned seedlings were standardized to 7 cm (Table 34 and Figure 47).

Table 34: Average height measurement (in cm) of the Pistacia palaestina seedlings in Mrusti

Traitement	May 16, 2016	July 1, 2016	August 16, 2016
Non-taillées	12.42 ± 0.28	12.07 ± 0.33	12.12 ± 0.11
Taillées	7	7	7

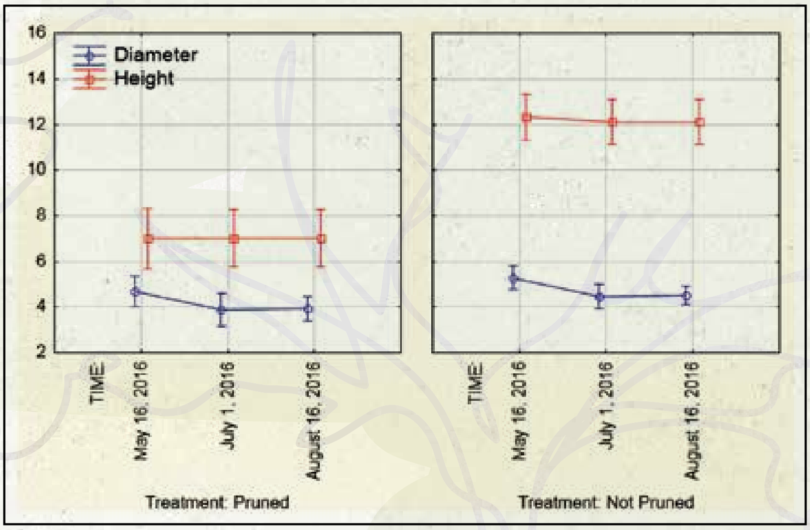

Figure 46: Comparison of diameter and height average measurements between pruned Pistacia palaestina seedlings (left) and non-pruned Pistacia palaestina seedlings (right)

In the 2 sites experiments, a major significant difference in the survival rate of seedlings was highlighted. While a total seedlings death was noted in Maqne due to the planting delay and the extreme dry conditions, the pruning experimentation recorded significant results in Mrusti, and extracted major lessons for improvement. The mortality levels of the pruned seedlings reached 86% while the non-pruned seedlings recorded 72%. The average diameter was slightly larger under the non-pruning and the difference in height was significantly different between treatments due to the pruning, and stable over the time.

This experiment allowed the extraction of the below lessons for the improvement of further pruning trials:

- Pruning of the seedlings in the nursery, 2-3 weeks before the planting day, to avoid the seedlings from undergoing the pruning stress on the site, and to adapt/harden to this condition pre-plantation.
- Plantation should be conducted in December, as the seedlings can benefit from the maximum amount of rainfall and moist soils to develop extensive and profound root systems.
- Choice of the site must consider the fact that the seedlings will be spared from any irrigation, and hence, a humid site is more favoured for the adequate results of this experiment.
- Data collection should be conducted by one person, or in a standard common approach, to avoid the human error factor.
- Choice of seedlings could take into consideration a more drought-tolerant species such as *Ceratonia siliqua*.

V) CONCLUSIONS AND RECOMMENDATIONS

The main purpose of this Outplanting, Monitoring and Inspection report II is to determine major factors that influence the early growth and survival of planted seedlings at every phase of their development. After the first outplanting report was produced "Outplanting, Monitoring, and Inspection report I" LRI worked on improving and tackling identified issues within its planting processes and that were affecting the survival rates. Some of the improved processes are mentioned below:

Workers productivity: workers productivity became more uniform due to the development of new training material for planting best practices and having the LRI planting crews adopt them across all LRI sites.

Inspection/Monitoring data collection: data collection forms and methods are continuously adjusted to improve user friendliness, enhance accuracy and efficiency with improved data collection tools and technology.

Most of the challenges related to these factors were overcame, but as our knowledge increases in reforestation, more challenges unfold. The purpose of this report is to focus on identifying new challenges and presenting recommendations for each.

Through the large scope of its reforestation activities in Phase II, LRI was able to plant in more than 20 villages, and therefore gain the experience and knowledge of a large number of varying sites. LRI has thus tailored its approaches to deal with these different conditions, whether in terms of landscape, community or even species selection.

LRI was able to identify five major factors that affected reforestation survival rate and seedlings growth throughout Phase II:

- Soil properties
- Weed control
- Planting height
- Time
- Species

A. Soil Properties

Soil has three properties that can directly affect seedlings health: Alkalinity, Infiltration and Nutrients. No major studies were conducted by LRI to precisely quantify the impact of soil health on the planted seedlings. However, through site surveys and monthly follow up reports, LRI was able to trace soil degradation that occurred through past overgrazing, elimination of green cover, and the loss of organic matter and therefore the moisture of the soil. These factors have directly affected the seedlings as they allowed for less water and nutrients to support their growth especially the root development. In addition, seedlings became less tolerant to heat and frost stress. This in turn was translated into earlier stress on seedlings and the need to irrigate more frequently.

B. Weed Control

Weed control has been shown to increase growth and survival. One of the main threats posed on seedlings in LRI sites has been the competition of weed growth with the planted seedlings, for water. Weeds are more likely to influence seedling growth and survival through competition for nutrients and light. In several observations, there was significantly greater growth and survival in plots receiving hand weeding than plots receiving no weeding. Frost reduction was also observed in weeded sites, due to the sun exposure received by bare soil. Hand weeding resulted generally in higher growth, and higher survival rates than in sites in which no weeding occurred. Hand weeding involved removing the above ground layer of weeds and leaving their roots intact. However, although this process reduced competition for light, it did not reduce competition for nutrients.

C. Planting Height

Through inspection and monitoring observations, LRI has found that the survival of Cedar seedlings planted in a depth of less than 15cm to be significantly less than that of seedlings planted deeper than 30cm. This was mainly observed in high altitude sites where there is snow cover for part of the year and harsher conditions exist due to longer hours of sun exposure, degraded soil and windy conditions. Cedar seedlings that were smallest at planting (under 10cm) had significantly less survival than those that were largest at planting (around 20cm).

D. Time

The growth of seedlings happens in early summer and spring from March till end of August. This varies depending on the seedlings planted. This growth time period is crucial in LRI's planting plans and allows the flexibility of benefitting from the winter rain for the planting season. Lebanon has recently experienced unusual climatic conditions, such as late precipitation, lower levels of precipitation, and unexpected frost. LRI is increasingly facing challenges in coping with these variables, in that the access to some sites would become blocked due to sudden precipitation which would make the roads muddy and the soil unfit to plant in. Thus, LRI is focusing on adapting to these climatic conditions by conducting reforestation projects while taking into consideration climatic variability. Therefore, LRI is training and increasing the productivity of workers, to optimally profit from the moisture content of the soil in the winter months and aiding seedlings to establish strong root system before the dry period approaches. LRI currently finalize preliminary site selection and planting plan, as well short-listing list of workers by end of early September.

E. Species

Species selection has become more specialized and specific due to extended studies of species suitability by LRI mapping team and due to LRI's outplanting team's increased experience. In addition, enhanced and improved seedlings production by the Cooperative of Native Tree Producers of Lebanon L.L. – CNTPL, has made seedlings quality more uniform. All these factors have played major role in increasing the survival rate on LRI sites and allowed for the selection of more adaptive species that are suitable for their environment.

Some of the factors listed above are in need or further research. For example, quantifying or estimating soil organic matter would help estimate potential water content and moisture level, which in turn would better help plan irrigation schedules and interventions. Optimal species height would require study per species. This is as it is preferable to plant 1-year old seedlings yet for some species, 2 years old seedlings are exhibiting better results.

Finally, LRI aims to reduce reforestation costs and optimize irrigation procedures as well as to develop planting techniques that will require no irrigation at all. One of the fields that LRI recommends to start investigating is Mycorrhiza. A mycorrhiza is the symbiotic association between a green plant and a fungus. The plant captures the energy coming from the sun by means of its chlorophyll and supplies it to the fungus, and the fungus supplies water and mineral nutrients taken from the soil to the plant. Mycorrhizas are found in the roots of the plant. If it is possible for mycorrhiza to be developed in the nurseries or inserted during the planting process, it could reduce seedlings water needs provide more nutrient and protection to the seedlings, as well as indirectly increase root volume. More research would be useful to further understand specific requirements of seedlings especially in the relation to mycorrhiza and for the requirements of better root development.

Annex I – Field Assessment Form

FIELD ASSESSMENT REPORT

FOREST INFORMATION

Contact Person	Position	Tel #	Completion of Data Entry
--------------------	------------------------	--------------------	----/----/------
--------------------	------------------------	--------------------	Filled By ____________________

Site Description		
Mohafaza:	Caza:	Municipality:
Mayor:	Religious Figures:	
Plot ID:		
X:	Y:	
Coordinates ref pt:	Coordinates system:	
Altitude:	Rainfall:	
Slope:	Total Area:	
Soil Type:	Suitable Container:	
Soil Depth		

Site history

Presence of mines / UXO: ☐ YES ☐ NO Date demined: --

Previous fire history: ☐ YES ☐ NO Dates of fires: --

Previous quarries: ☐ YES ☐ NO Type and date of activity: --

Previous/current land use if any: --

Socio-economic aspects

Main income activity --

Grazing: ☐ YES ☐ NO If yes,

- Number of shepherds/herds: --
- Type of animals (Goats, sheep, cows): --

Charcoal Production ☐ YES ☐ NO Explain if any: --

Previous reforestation projects with dates and organizations involved: --

----

Suggested Partners: --

Municipality Cost Share: --

Water Resources and Infrastructures

Water source: ☐ YES ☐ NO If yes,

- Location of closest water source: --
- Type of existing water source: --

Infrastructure: ☐ YES ☐ NO If yes, type of infrastructure: --

Needed water infrastructure: ☐ Ponds ☐ Reservoirs ☐ Outlets ☐ Other

If yes, Suggested number and location: --

Forest/Land cover

Access to the site
☐ Main Roads ☐ Side Roads ☐ Trails ☐ Agricultural Roads ☐ No Roads

Neighbouring Land use
☐ Industrial :
☐ Urban :
☐ Agricultural:
☐ Other:

Vegetation Types			
Type	*Density*		
☐ Pine	☐ High	☐ Medium	☐ Low
☐ Oak	☐ High	☐ Medium	☐ Low
☐ Cedar	☐ High	☐ Medium	☐ Low
☐ Fir	☐ High	☐ Medium	☐ Low
☐ Mixed	☐ High	☐ Medium	☐ Low
☐ Shrubs and annuals	☐ High	☐ Medium	☐ Low
Others (Specify)			

Local Forest Management Plan

Exist: ☐ YES ☐ NO Implemented by:

Available Attach Papers: ☐ YES ☐ NO

Fire Management

Area Fire Risk : ☐ Very High ☐ High ☐ Moderate ☐ Low

Establishment of fire breaks: ☐ Possible ☐ Impossible

Existing land features that can be used as fire breaks: ☐ Agricultural land ☐ Roads

☐ Other (Specify):--

Problems

Land Tenure conflicts: ☐ YES ☐ NO

Land Security Issues: ☐ YES ☐ NO If Yes, Explain:---

Available Seedling Storage: ☐ YES ☐ NO

Domestic Waste Disposal in or near forested Area: ☐ YES ☐ NO

Comments and observations

Annex II – Inspection Form

LRI Daily Planting Report						
Planting Site: ______________________				Crew Size: _____ # Hrs: ________		
Inspector: __________________________				Weather conditions:_______________		
Date: ____________						
GPS track name: ____________________						
Seedling Inventory						
Species		1	2	3	4	5
Nursery						
# Seedlings In stock						
# Seedlings Planted						
# Seedlings Remaining						
Quality: Wet Roots?		Yes/No	Yes/No	Yes/No	Yes/No	Yes/No
Inspection Summary						
Above ground	# Seedlings Inspected:	***Comments:***				
	#"Good" Seedlings:					
Below ground	#Seedlings Inspected:	***Comments:***				
	#"Good" Seedlings:					
Density	Average distance between seedlings:	***Comments:***				
Notes:						

Annex III – Species planted per site

Village	Species
Rachaiya Sites	
Ain Arab	*Pinus pinea, Rhus coraria, Laurus nobilis, Juniperus excelsa, Pinus halepensis, Cercis siliquastrum, Quercus infectoria, Quercus calliprinos.*
Kawkaba Abou Arab	*Pinus pinea, Juniperus excelsa, Pinus halepensis, Cupressus sempervirens, Spartium junceum, Amygdalus communis, Laurus nobilis, Pinus brutia, Pyrus syriaca.*
Kfar Denis	*Juniperus excelsa, Spartiun junceum, Amygdalus communis, Crataegus azarolus, Laurus nobilis, Pinus brutia, Pinus pinea.*
Bakka	*Pinus pinea, Prunus amygdalus, Pyrus syriaca, Acer hermoneum, Acer tauricolum, Prunus mahaleb, Cedrus libani, Crataegus monogyna, Laurus nobilis, Cupressus sempervirens, Pinus brutia, Pistacia palestina.*
Bireh	*Pinus brutia, Pinus pinea, Sorbus flabilifolia, Pyrus syriaca, Crataegus azarolus, Acer syriacum, Amygdalus communis, Pinus halepnesis, Cupressus sempervirens, Prunus mahaleb, Quercus calliprinos, Cedrus libani, Ceratonia siliqua, Quercus infectoria.*
Dahr El Ahmar	*Cedrus libani, Crataegus azarolus, Pinus brutia, Pinus halepensis, Pinus pinea, Prunus amygdalus, Quercus calliprinos, Quercus infectoria, Rhus coraria, Cupressus sempervirens, Juniperus excelsa, Spartium junceum, Amygdalus communis, Cercis siliquastrum, Laurus nobilis, Pyrus syriaca.*
Kherbit Rouha	*Pinus brutia, Prunus ursina, Pinus pinea, Prunus amygdalus, Acer tauricolum.*
Kfarmechki	*Pinus brutia, Pinus halepensis, Pinus pinea, Rosa canina, Amygdalus communis, Pistacia palaestina, Quercus calliprinos, Quercus infectoria.*
Majdel Balhis	*Pyrus syriaca, Laurus nobilis, Pinus pinea, Cedrus libani, Prunus amygdalus, Acer tauriculum, Cercis siliquastrum, Fraxinus ornus, Pinus brutia, Pinus halepensis, Prunus mahaleb, Spartium junceum, Crataegus azarolus.*
Mdoukha	*Amygdalus communis, Rosa canina, Spartium junceum, Prunus amygdalus, Pinus pinea, Crataegus azarolus, Pyrus syriaca, Cupressus sempervirens, Pinus brutia, Quercus brantii, Cedrus libani, Laurus nobilis, Styrax officinalis, Pistacia palaestina, Rhus coriaria.*

Rafid	*Pinus pinea, Amygdalus communis, Acer tauricolum, Acer syriacum, Sorbus torminalis, Pyrus syriaca, Sorbus flabilifolia, Quercus calliprinos, Acer tauricolum, Fraxinus angustifolia, Cedrus libani, Crataegus azarolus, Cupressus sempervirens, Pinus brutia, Prunus amygdalus, Quercus calliprinos, Quercus infectoria.*
North Sites	
Ainata	*Cedrus libani, Juniperus excelsa*
Aaqoura	*Acer tauricolum, Cedrus libani, Crataegus monogyna, Quercus cerris, Juniperus excelsa.*
Bcharre	*Cedrus libani, Cotonaester nummularia, Quercus infectoria, Sorbus torminalis, Sorbus flabilifolia, Amygdalus communis, Arbutus andrachne, Crataegus azarolus, Juniperus excelsa, Malus trilobata, Quercus calliprinos, Cercis siliquastrum, Celtis australis.*
Chatine	*Cedrus libani, Abies cilicica.*
Ehden	*Cedrus libani, Quercus infectoria, Crataegus monogyna, Prunus amygdalus.*
Ehmej	*Acer tauricolum, Cedrus libani, Juniperus excelsa, Malus trilobata, Pyrus syriaca.*
Gebrayel	*Laurus nobilis, Pinus pinea*
Hasroun	*Cedrus libani*
Jaj	*Acer tauricolum, Cedrus libani*
Tannourine	*Crataegus monogyna, Acer tauricolum, Pinus pinea, Cedrus libani, Malus trilobata, Pyrus syriaca.*
Yammouneh	*Cedrus libani, Juniperus excelsa, Pinus pinea, Laurus nobilis, Quercus brantii.*
Shouf Sites	
Maaser El Shouf	*Cedrus libani, Crataegus azarolus, Sorbus torminalis.*
Niha	*Arbutus andrachne, Celtis australis, Cedrus libani, Pinus pinea, Sorbus flabilifolia, Laurus nobilis, Crataegus monogyna, Fraxinus ornus, Prunus amygdalus, Prunus mahaleb, Rhus coriaria, Sorbus torminalis, Cercis siliquastrum, Pistacia palaestina, Prunus dulcis, Spartium junceum, Styrax officinalis.*

GROW FORESTS,

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/LebanonReforestationInitiative
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