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IDARA (INSTITUTING WATER DEMAND MANAGEMENT IN JORDAN)

ESTABLISHING NURSERIES SPECIALIZING IN DROUGHT
TOLERANT PLANTS - IDENTIFICATION AND ASSESSMENT OF
POTENTIAL PARTNERS

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ABBREVIATIONS AND ACRONYMS

CBOs	Community Based Organizations
GAM	Greater Amman Municipality
IDARA	Instituting Water Demand Management in Jordan
JVA	Jordan Valley Authority
JOHUD	The Jordanian Hashemite Fund for Human Development
NGO	Non-governmental Organization
PWCS	Productive Woman Cooperative Society
USAID	United States Agency for International Development
WEPIA	Water Efficiency for Public Information and Action

ESTABLISHING NURSERIES SPECIALIZING IN DROUGHT TOLERANT PLANTS - IDENTIFICATION AND ASSESSMENT OF POTENTIAL PARTNERS

Introduction

Instituting Water Demand Management in Jordan (IDARA) will be working with local nurseries to increase the availability of drought tolerant plants in the market to meet the growing demands of urban development in water-efficient ways. This task is part of a larger scope focused on demonstrating water demand initiatives to the public including training of municipal staff in the design of water-wise parks, the introduction of water-wise landscaping principles in university courses, and supporting pilot projects such as model parks and design competitions concerned with water efficiency.

After having completed an assessment of previous work conducted with nurseries supported by USAID's Water Efficiency for Public Information and Action Project (WEPIA), it was concluded that small nurseries established in rural areas are sustainable with great difficulty. Many challenges face the establishment of small-scale/small-capital nurseries in rural areas. These include: 1) low demand for ornamental plants in rural areas from both private and municipal sectors, 2) difficulty in reaching retail outlets in urban centers where the demand exists, 3) competition with established commercial nurseries operating at larger scales, and 4) difficulty in guaranteeing links with large consumers such as GAM due to competitive tendering processes¹.

Therefore, it was concluded that to effectively influence the prevalence of drought tolerant plants in the market, large consumers such as GAM and real estate developers should be targeted. Currently, the main consumers of ornamental plants are large municipalities and real estate developers in urban centers such as Amman and Aqaba. The unprecedented building developments in Amman such as the Abdali City Center, the new high density development zones identified in Amman's Metrogrowth Plan, and gated real estate developments, will create a significant demand for ornamental plants in the near future. These developments rely considerably on large landscaped areas in the design and planning of outdoor spaces. Local nurseries that can supply high quality plants at competitive prices could meet this demand since a high percentage of plants are currently imported from Italy and other international sources.

IDARA is therefore planning to focus on large urban areas and target large plant consumers. Targeting large consumers would entail working with government-owned nurseries and/or large commercial nurseries, and/or nurseries owned by development/real estate companies. This report identifies possible partners in this endeavor and summarizes IDARA's approach in fulfilling this task.

Improving Drought-Tolerant Plant Production at GAM Nurseries

The Greater Amman Municipality is one of the largest plant consumers in Jordan. Although GAM has an in-house production facility, it purchases large numbers of plants from the local, regional, and European markets every year. According to GAM's Nursery Department, GAM will consume over 280,000 trees, 490,000 shrubs, and 900,000 vines and ground covers in the next three years (2009-2011). See tables 1 -3 for more details.

¹ For further information refer to IDARA's assessment report of March 2008

	SCIENTIFIC NAME	COMMON NAME	LOCAL MARKET PRICE (JD)	CONSUMPTION (2006-2008)	ESTIMATED CONSUMPTION (2009-2012)
	Ailanthus altissima	Tree of Heaven	2.00	2000	6000
	Albizia lebeck	Silk Tree	2.0	500	3000
	Populous alba	White Poplar	1.50	3000	10000
	Populous nigra 'Italica'	Lombardy Poplar	1.50	3000	10000
	Salix babylonica	Willow	2.50	500	3000
	Acer negundo	Maple	2.0	2000	10000
	Melia azerderach	Chinaberry	4.0	12000	30000
	Lagerstroemia indica	Crape Myrtle	3.0	1000	3000
	Hibiscus syriacus	Rose of Sharon	1.0	0	6000
	Acacia cyanophylla		3.0	8000	40000
	Eucalyptus	Red Gum	2.0	6000	20000
	Cupressus sempervirens 'Stricta'	Italian Cypress	5.0	14000	40000
	Grevillea robusta	Silk Oak	6.0	30000	20000
	Cupressus macrocarpa	Monterey Cypress	2.50	0	6000
	Myoporum laetum	Lollypop Tree	1.0	0	40000
	Casuarina equisetifolia	Ironwood	2.50	2500	40000
TOTAL				84500	287000

Table 1: Trees - GAM s estimated past and future consumption

	SCIENTIFIC NAME	COMMON NAME	LOCAL MARKET PRICE (JD)	CONSUMPTION (2006-2008)	ESTIMATED CONSUMPTION (2009-2012)
	Hibiscus malva	Swamp Rose	1	0	6000
	Pittosporum tobira	Pittosporum	0.50	0	20000
	Pittosporum tobira 'Nana'	Dwarf Pittosporum	1.0	6000	20000
	Cordyline australis	Cabbage Palm	2	2500	10000
	Duranta	Golden Dewdrop	2.5	3000	10000
	Duranta variegated	Golden Dewdrop	2.5	3000	10000
	Sambucus nigra	Elderberry	3	0	3000
	Myrtus communis	Myrtle	3	600	3000
	Rosa sp.	Roses	1		20000
	Berberis thunbergii	Barberry	1.5	16000	60000
	Adathoda vesica	Bee Flower	1	0	3000
	Buddleia davidii	Butterfly Bush	1	0	5000
	Lantana camara	Lantana	1.5	2000	10000
	Rosmarinus officinalis	Rosemary	0.2	0	100000
	Lavandula angustifolia	English Lavender	0.2	0	100000
	Santolina chamaecyparissus	Lavender Cotton	0.2	6000	20000

	SCIENTIFIC NAME	COMMON NAME	LOCAL MARKET PRICE (JD)	CONSUMPTION (2006-2008)	ESTIMATED CONSUMPTION (2009 -2012)
	Hebe sp.	Hebe	1	2000	10000
	Euonymus fortunei	Wintercreeper	0.5	6000	20000
	Juniperus horizontalis	Juniper	2	6000	40000
	Pelargonium domesticum	Geranium	1	0	10000
	Pelargonium graveolens	Scented Geranium	1	0	10000
TOTAL				44100	490000

Table 2: Shrubs - GAM s estimated past and future consumption

	SCIENTIFIC NAME	COMMON NAME	LOCAL MARKET PRICE (JD)	CONSUMPTION (2006-2008)	ESTIMATED CONSUMPTION (2009 -2012)
	Hedra helix variegated	English Ivy	1	0	70000
	Hedra helix	English Ivy	1.0	0	70000
	Lonicera japonica	Honeysuckle	1.0	0	30000
	Jasminum grandiflora	Jasmine	1	0	30000
	Plumbago capensis	Blue Jasmine	1	18000	70000
	Bougainvillea	Bougainvillea	3	3000	20000
	Campsis radicans	Trumpet Vine	2.5	2000	10000
	Parthenocissus quinquefolia	Virginia Creeper	3	0	10000
	Vinca major	Blue Periwinkle	0.5	0	30000
	Vinca minor	Periwinkle	0.5	0	30000
	Asparagus densiflorus	Ornamental Asparagus	1	0	10000
	Pelargonium peltatum	Ivy geranium	0.5	1000	20000
	Lantana montevidensis	Creeping Lantana	2	3500	50000
	Carpobrotus edulis	Ice Plant	0.2	0	100000
	Aptenia cordifolia	Baby Sun Rose	0.2	0	100000
	Verbena	Verbena	0.2	1000	50000
	Drosanthemum floribundum	Rosea Ice Plant	0.2	0	100000
	Achillea millifolium	Yarrow	0.2	750	100000
TOTAL				28500	900000

Table 3: Vines, perennials, and ground covers - GAM s estimated past and future consumption

IDARA has begun studying the potential for working with GAM in improving their production of drought tolerant plants. GAM currently produces its own stock of small shrubs, perennials, and tree seedlings at its main nursery sites in Qadisiyya, Ain Ghazal, and Abu Nuseir. The production facilities are of a high standard and the staff is trained and well informed.



Figure 1: Multi-span greenhouse at al-Qadisiyya Nursery



Figure 2: Production inside the greenhouse at al-Qadisiyya Nursery



Figure 3: Production inside the greenhouse at al- Qadisiyya Nursery



Figure 4: Shrubs and tree seedling production at Ain Ghazal Nursery

The nurseries at Ain Ghazal and al-Qadisiyya have a high production capacity. In the 2007-2008 production year, 100,000 tree seedlings were produced, as well as 468,000 shrubs and 1,200,000 annuals. The nurseries are also equipped with seeding machines, holding areas (16,000 square meters), and specialized staff (4 agricultural engineers, 86 workers, and one manager).

After conducting several meetings with the parks and nursery departments as well as field visits to the production sites, we have identified areas and strategies for collaboration. Below is a summary of our approach to developing GAM's nursery facilities.

Drought tolerant shrubs and perennials

The first step in improving the production of shrubs and perennials produced at the GAM nurseries is to increase the number and varieties of drought tolerant plants on the production list, and eventually eliminate water-thirsty varieties. Petunias and other water-thirsty plants should be propagated at a minimum and used sparingly in public parks and street medians.

One of the main handicaps according to the Head of the Nursery Department is the process by which the production list is identified. The current practice entails the compilation of plant orders from the various district managers and parks department staff who tend to order commonly adopted plant types, some of which are not appropriate.

A master list should be developed in coordination with parks and nursery departments and then circulated to the districts for placing orders. The nursery team is well informed and is on board, but is seeking IDARA's help in working with GAM in adopting this policy.

IDARA should also extend its training efforts to the various GAM districts and offer presentations and technical information to promote this new list of plants with district engineers. Many of these engineers have already attended the municipal water-wise landscaping course, but may need specific guidance on plants not covered in the training.

Drought tolerant trees

GAM currently produces a small supply of tree saplings at Ain Ghazal. IDARA's team has reviewed the sapling production and concluded that it is well selected in terms of drought-tolerance. However, the trees consumed by GAM are much less in number and much larger in size than what is produced at the nursery. Our initial study indicates that GAM could greatly benefit from establishing an in-house tree-growing nursery to complement their existing production at Ghazal and al-Qadisiyya, by saving on the cost of purchasing and shipping larger trees from the local market, regional, and international sources.

Part of the technical requirements for establishing a tree-growing nursery are currently met by GAM's production facility, but some are not. Below is a summary of the opportunities and constraints facing the establishment of this type of nursery:

Opportunities:

- *Appropriate set-up for specialized production of seedlings:* GAM already produces a supply of drought-tolerant tree seedlings required to start any tree nursery. This is usually done by specialized nurseries which then supply tree growers. Thus, GAM has already established this specialized technical facility. Additionally, seedlings are available at the Ministry of Agriculture nurseries free of charge.
- *Low capital and minimal labor requirements:* Setting up a tree-growing nursery is not capital intensive, if land and a cheap source of water are available. No greenhouses or shading structures are needed, although a proper irrigation system is required. The labor cost is also relatively lower than nurseries of similar size, specializing in propagation. Only 2 laborers are needed for every 10,000 m² and one supervisor per 40,000 m².
- *Growing demand and expanded jurisdiction:* As indicated earlier in tables 2-3, GAM will need large amounts of plants to meet the demand of its expanded park building and street planting activities. Moreover, as of 2007, GAM's municipal borders cover an area of 1,662 square kilometers (compared to 680 square kilometers in 2006). GAM's jurisdiction now encompasses under developed areas such as Sahab, Al-Mouwaqer, Al-Jeeza, Marj al-Hamam, Na'our, Um Besalteen, and Hesban. These areas will be needing park services and upgraded street-scaping currently unavailable to residents in these respective areas.
- *Market void and cost saving:* The availability of large supplies of good quality large trees is limited in the current market. Very few nurseries grow their own supply of trees, and fewer grow them to standard sizes. Standard trees², which are ideal for streets, parks, and other pedestrian-friendly areas, are often imported from Italy and sold locally at high prices. GAM often imports standard trees from Italy or Syria for high visibility projects such as the King Hussein Gardens. There are significant savings associated with growing a local in-house supply for GAM, see comparison table below:

² Trees grown to a standard size with a trunk height of 2 meters

	SCIENTIFIC NAME	COMMON NAME	SIZE (CALIPER IN CM)	COST IF IMPORTED (JD)	COST IF GROWN IN-HOUSE (JD)	SAVING (%)
	Albizia lebbeck	Silk Tree	8-10 cm	JD 46	JD 20.00	57%
	Robinia psuedoacacia	Honey Locust	10-12 cm	JD 28	JD 20.00	29%
	Sophora japonica	Japanese Pagoda	10-12 cm	JD 46	JD 20.00	57%
	Melia azerderach	China Berry	10-12 cm	JD 48	JD 20.00	58%

Table 4: Cost comparison - imported vs. locally grown trees

Table 4 is based on the following assumptions:

- Plot size (growing area): 10,000 square meters
- No. of trees per meter square: 5 trees
- Total no. of trees per 10,000 square meters: 2000 trees
- No. of years required to grow trees to 10-12 cm caliper: 3.5
- Amount of water per tree per year: 1.6 cubic meters
- Cost of water per cubic meter: JD 0.60
- Rental cost of plot per year: JD 1500
- No. of laborers required: 2
- Salary of laborers per year: JD 4,800
- No. of supervisors: 0.25
- Salary of supervisor per year: JD1,650
- Cost per seedling: JD 0.50
- Total labor cost per tree: JD 11.30
- Total water cost per tree: JD 3.36
- Total plot rental per tree: JD 2.63
- Total cost of tree overheads (rent, water, and labor): JD 17.30
- Cost of seedling: JD 0.50
- 10% contingency due to disease or death: JD 1.7
- **Total cost per tree: JD 19.50**

Constraints:

- *Availability of Land:* Although an agricultural water supply is available at zero cost at the Ain Ghazal facility, suitable ground for tree planting is not available. GAM has to seek other locations for establishing this type of nursery. Recent discussions with GAM have indicated that GAM does not currently own suitable land with an agricultural water supply, and thus should consider renting a plot for this purpose.
- *New direction:* Proposing an in-house tree nursery is a new direction for GAM's operational capacity and some resistance to the idea may be encountered.
- *Financial commitments:* Financial commitments have to be made by upper GAM management

For more information regarding the technical requirements for establishing a tree nursery, refer to Appendix 1.

IDARA s input in working with GAM:

- Development of master production list with the GAM team
- Work with GAM in the adoption of production policy
- Present tree-growing nursery plans to GAM upper management
- Provide technical assistance where needed

Working with Private Nurseries and NGOs

Private nurseries, especially retail outlets on “nursery lane”³, attract other large consumers of plants; that being large garden owners in Amman. The high-end market constitutes a significant portion of the market for ornamental plants. The demand in this sector is quite different from that of municipalities. Plants catering to this consumer profile should have a high ornamental value and high profit margins. This can be met by introducing new varieties into the market to provide a wide range of options for various tastes.

NGOs, especially ones with an environmental focus, are also interested in establishing nurseries to fulfill their own needs (if they develop park or forestry areas) or to generate income for affiliated community based organizations.

Demo-garden at Ur Garden Center

Preliminary discussions have been held with the Ur Garden Center, located on King Abdullah II road between retail outlets in Amman and the road to Baqa’a, to develop a small demo-garden showcasing new and interesting drought-tolerant plants. The demo-garden would be part of an outdoor show room featuring special water-wise plants to be installed by Ur Garden.

The center has adequate areas for this activity and is willing to cost share with IDARA. Ur Garden is also affiliated with X-Plant Nurseries, a nursery that already specializes in the production of drought tolerant plants. For a complete list of available plants at Ur Garden Center and X-Plant Nurseries refer to Appendix 2.



Figure 5: Area to be developed into a water-wise show area at Ur Garden

³ King Abdullah II Street

This effort maybe expanded in year three of the project to other private nurseries if other willing partners are located.

IDARA s input in working with private nurseries:

- Provide technical assistance in the design and selection of plants for the demo-garden.
- Provide small funds for the production of signage for the plants and other water-saving features.

Establishing a Native Plant Nursery at (FoEME)

IDARA has been approached by Friends of the Earth Middle East, an NGO concerned with protecting environmental heritage, to provide technical assistance in setting up an in-house native tree nursery. FoEME which is very active in the Jordan Valley, has been given use of 290 dunom of land by the Jordan Valley Authority (JVA), to establish an ecological recreational park. The park will eventually cover 1,090 dunom of land bordering the Ziglab Reservoir in the Municipality of Pella.

FoEME is in the process of ecological remediation of the area which includes providing protection from grazing, planting of drought-tolerant and native trees, as well as monitoring and management of plant succession. FoEME currently gets most of its tree sapling supply from the Ministry of Agriculture nurseries. However, some of the native species endemic to the Jordan Valley area are not propagated by the Ministry of Agriculture, nor are they available in the market. FoEME is therefore interested in propagating its own stock of native trees to plant in the allotted park area.

FoEME could also benefit from selling the stock after the completion of the planting activities to support some of the running cost of the park management.

IDARA s input in working with FoEME nurseries:

- Provide technical assistance in propagation and nursery set-up.

Supporting the Productive Woman Cooperative Society Nursery Marka

The Productive Woman Cooperative nursery (PWCS) is a CBO-run nursery established by USAID's WEPIA project through a community grants program in October 2003. The project was further supported by USAID in November 2004, and September 2006.

A thorough assessment of the PWCS nursery was conducted by IDARA in March 2008⁴. It was concluded that although the production facilities were improved, the product range was diversified, and marketing assistance was provided, the project had a very high operating cost and could only be sustainable if the following could be provided:

- A more economic source of water,
- low-cost transportation,
- a full time employee (current income is not sufficient to hire full time staff),
- Marketing and connections with a permanent outlet in Amman or Baq'a for year-round sales.

IDARA furthered this assessment by studying the potential of overcoming these challenges in a cost effective way. Below is a summary of this study:

- An economic water source is not available in the area. Tanker water is not cost effective and significantly increases the running costs. Rainwater harvesting well with a capacity of 65 cubic meters is available on site, but is in need of repair. However, this is not sufficient for the needs of the nursery and will not contribute significantly to reduce water expenses.

⁴ For further information refer to IDARA's assessment report of March 2008

- The site conditions continue to be extremely unfavorable for a nursery project. Extremely high temperatures in summer, and dry hot strong prevailing winds, as well as exposure to dust from the near by stone quarries have taken a toll on the current stock of field-grown trees. Hence the quality of the product is quite poor and therefore cannot compete with plants in the market. The current drought conditions of winter 2009 will further exacerbate the problem and continue to take a toll on the tree stock.
- Also due to the extremely harsh conditions, mother plants are not sustainable on the site and therefore, seeds and cuttings would have to be purchased every year for continued production of small ornamental plants.

IDARA also conducted a thorough audit of the books. Below is a summary of the findings:

- The percent of current sales versus profitable sales over the past two and a half years is 17%
- In order to achieve a 30% profit, average total sales per year should be a minimum of JD 8000. This figure is impossible to achieve with the prevailing conditions. Refer to tables 6-8 for more details;

In conclusion it will be difficult to justify the continued support for the PWCS Nursery since it is impossible to produce competitively priced good quality plants.

	TYPE OF COST	RUNNING COST (JD)			YEARLY AVERAGE RUNNING COST (JD)
		2006	2007	Jun-08	
	Polystyrene	51.2	0	0	20.48
	Plastic Bags	266.5	0	0	106.6
	Pots	57.2	107	31	78.08
	Peatmoss, Hormone, Perlite, Manure & Fertilizers	458	138.5	18	245.800
	Irrigating water	710	420	150	512
	Labor	1649	1024.23	429.28	1241.0
	Tools Equipment and others	106.5	53.53	0	64.012
	Miscellaneous	0	85.95	157	97.18
	Plants	0	1561.7	115	670.68
TOTAL COST		3298.40	3390.91	900.28	3035.836

Table 5: Running costs PWCS nursery

	TYPE OF COST	RUNNING COST(JD)			YEARLY AVERAGE OPERATING COST(JD)
		2006	2007	Jun-08	
	Transportation	866	775.5	230	748.6
	Electricity	0	12.9	0	5.16
	Rent	100	100	50	100
	Losses	0	0	624	249.6
TOTAL		966	888.4	904	1103.36

Table 6: Operating costs PWCS nursery

	ITEM	DATE OF PURCHASE	INITIAL VALUE	DEPRECIATION			TOTAL DEPR. COSTS	ACTUAL VALUE
				2006	2007	Jun-08		
	Green House	2004	3000	500	500	250	1250	1750
	Incubators for cuttings	2006	646	215.3333	215.333	107.666	538.3323	107.6677
	Irrigation system	2006	253.8	253.8	0	0	253.8	0
	Top soil	2006	560	560	0	0	560	0
	Fence	2006	1045	209	209	104.5	522.5	522.5
	Top soil	2007	340	0	340	0	340	0
	Irrigation system	2007	3000	0	1000	500	1500	1500
TOTAL				1738.1333	2264.333	962.166	4964.6323	2130.1677

Table 7: Depreciation costs PWCS nursery

	YEARLY AVERAGE SALES	INVENTORY 2008	YEARLY AVERAGE RUNNING COST	YEARLY AVERAGE OPERATING COST	YEARLY AVERAGE DEPR COST	NET PROFIT
	1392.54	2684.75	3035.864	1103.36	1985.85	-2047.784

Table 8: Profit PWCS nursery

Next Steps

- PWCS nursery will not be supported by IDARA's grants program
- Approach upper GAM management and present approach and gain support/approval
- Begin technical support for starting a tree nursery at GAM and FoEME
- Begin discussions for the design of a Demo-garden with Ur Garden Center
- Approach developers in Amman and Aqaba to locate potential partners

Milestone	Start Date	Finish Date	Comments
Assess nurseries established by WEPIA	July 2007	January 2008	Completed
PWCS Nursery			
Prepare business plan in conjunction with the PWCS nursery and determine type and scale of assistance	March 2008 <i>New milestone</i>	December 2008	Completed
Provide assistance to PWCS nursery <u>if justified</u> by analysis in business plan	December 2008	November 2009	Assistance not justified
New Nurseries : Government-owned, NGO-owned or Commercial			
Identify new nurseries and explore potential for drought tolerant plant product line	March 2008	January 2009	Completed
Assess potential nurseries	July 2008	March 2009	Completed
Approach upper GAM management and present approach and gain support/approval	March 2009 <i>New Milestone</i>	May 2009	
Begin technical assistance to GAM nurseries	March - 2009 <i>New Milestone</i>	Years 3 & 4	
Begin technical assistance to FoEME	March 2009 <i>New Milestone</i>	Years 3 & 4	
Begin discussions for the design of a Demo-garden with Ur Garden Center	March - 2009 <i>New Milestone</i>	Year 3	
Expand efforts (developers and other commercial nurseries)	Years 3	Year 4	
New CBO Nurseries Associated with NGOs			
Approach NGO's and evaluate potential sustainability of CBO nursery projects based on developed criteria	March 2008 <i>New milestone</i>	July 2008	JOHUD approached - evaluation not positive
Assess new CBO sites <u>if evaluation is positive</u>	June 2010	----	
Begin Technical assistance to CBO nurseries	Years 3 & 4	Years 3 & 4	

APPENDIX 1: Technical Report - Establishing a Tree Nursery

The objective of this report is to provide a technical study for establishing a tree nursery whereby young seedlings are grown into trees that can be planted as shade or street trees, or used in park landscaping of GAM projects.

By definition a tree nursery is a place where large quantities of trees are grown from one size into another, or looked after until sold or delivered to the end user. The function of this tree nursery should not be to propagate trees or to produce seedlings. A clear distinction should be made between propagating and growing trees.

Seedlings can be acquired from nurseries that are specialized in propagation of such plants. Seedlings are started either from seeds or by planting cuttings acquired from healthy, true to type and disease free mother stock trees. Or even can be purchased from local suppliers or imported from different countries.

Once seedlings are ready, they should be planted in the ground in rows or blocks that are close to each other (relatively speaking and depending on the variety). This should be done in the winter season, and seedlings should be grown for one year. No planting of young seedlings should be performed during the summer months as this will affect the performance of trees later on.

This method of planting seedlings close to each other serves two purposes; one is to save on space and efficiency of the nursery, the other is to force trees to grow taller and with strait trunks in a short period of time, since plants will try to compete for light, they will grow taller than if plants were further apart.

During this year, trees should be cared for to prevent any disease infection or any mechanical damage. Standard nursery care procedures should be applied. Watering schedule should be studied carefully and implemented properly in order to acclimatize trees to the harsh conditions they will be subjected to in their final locations.

During the second winter season, all plants should be uprooted, soil worked with fertilizers and organic matter, and trees should be replanted in the ground, again in rows or blocks with spacing further apart (depending on the species), for another year. During which, standard nursery care procedures should be applied.

This process can and should be repeated every year until these young trees reach the required size in terms of height and caliber. In general, such seedlings, if cared for properly, they should be ready in three to five years, and again depending on the species.

Once trees have reached the required size and height; they should be uprooted and planted in their final location on sidewalks or parks. They can be removed from the ground and transported to the final location either as bare-root trees or root-balled trees (depending on the species). This process can and should only be performed in the winter season when trees have become dormant.

Ready trees can also be transplanted into containers if and only if they will be planted in their designated space during the summer months. Trees should not be transplanted into containers to be grown into larger sizes, simply because they will not grow as fast and the operating cost for their maintenance will be much higher than trees planted in the ground.

The size and specifications of trees should be standardized in order to assist the nursery manager to determine when trees are ready for delivery. In my opinion, the ideal specification of trees for GAM territories should be of circumference 8-10 or 10-12 and not more. Maximum height should not exceed an average of three meters. These specifications are strictly designed for shade and street trees and they conform to the international standards. Other specifications can be applied for trees of different functions.

Once some trees have been delivered and an area at the nursery has been cleared from trees, new seedlings should be brought in for planting. This will insure that all spaces are always filled and the efficiency of such nursery is at its maximum capacity. Three years after establishing the nursery, it will have trees ready for delivery on a yearly basis.

Regarding the requirements and cost of establishing such a nursery, it must be established that land and water are available. Other elements that are needed would be the cost of purchasing the young seedlings, the cost of laborers who will be working and caring for the trees, and the running cost of caring for the trees; such as pesticides, fertilizers and tools.

The manpower needed for managing and operating such a nursery are as follows: two laborers per ten thousand square meters, and one supervisor per nursery of forty thousand square meters.

No green houses or shading structures are needed for such operation. However, a proper irrigation system is of utmost importance. Office space, fencing, rest areas, toilets, and a storage space for tools and chemicals are also needed. Simple agricultural roads also will help in the proper operation and can ease delivery and other practices of such operation. Depending on how large the operation becomes, a tractor and trolleys may also be needed.

APPENDIX 2: List of Available Plants at X-Plant Nurseries and Ur Garden Center

PLANT NAME	DROUGHT TOLERANT
Abelia grandiflora 'Klondike'	X
Abelia x grandiflora 'Edward Goucher'	X
Abies normandiana	
Acacia cyanophylla	X
Acanthus mollis	
Acer atropurpurea	
Acer palmatum 'Seiryu'	
Achillea millefolium	X
Acorus gramineus	
Aeonium arboreum	X
Agapanthus africanus	X
Albizia julibrissin	X
Albizia julibrissin 'Umbrella'	X
Aloe	X
Alternanthera tenella	X
Alternanthera tenella (Yellow)	X
Anisodonteia capensis	X
Aralia elegantissima	
Aralia sieboldii	
Arbutus unedo	X
Aucuba japonica 'Crotonifolia'	
Bambusa aurea	
Bambusa metake	
Bambusa nigra	
Bambusa Semiarundinaria fastuos	
Bauhinia forficata	
Berberis intermedia 'Wallich's Purple'2008	X
Berberis ott. 'Superba'	X
Berberis thunbergii 'Atropurpurea'	X
Berberis thunbergii 'Bagatelle'	X
Berberis thunbergii 'Elmond's Pillar'	X
Brachychiton acerifolius	X
Brugmansia x hybrid	
Buddleia nanhoensis blue	X
Buddleia nanhoensis red	X
Buxus macrophylla Faulkner	
Buxus macrophylla 'Rotundifolia	
Buxus macrophylla Faulkner ball	
Buxus pyramid shape	

PLANT NAME	DROUGHT TOLERANT
Caesalpinia gilliesii	X
Callistemon laevis	X
Callistemon laevis 1/2 STD	X
Callistemon laevis2008	X
Callistemon lanceolatus 'Captain Cook'	X
Calluna vulgaris	X
Canna indica 'green'	X
Canna pretoria 'Variegated'	X
Carex tenniculmis	
Carissa macrocarpa	X
Caryopteris x clandonensis	X
Ceanothus 'Gloire de versaille'	X
Ceanothus pall. Marie simon	X
Ceanothus thyrs. 'Concha'	X
Ceanothus thyrs. 'Repens'	X
Cedrus atl. 'Glauca'	X
Cedrus deodara 'Blue Triumph'	X
Ceratonia siliqua	X
Ceratostigma wilimottianum2008	
Cercis silquastrum	X
Chaenomeles 'Supe Red'	
Chamaerops humilis	X
Cistus albidus	X
Cistus loreti	X
Citrus aurantium	X
Citrus limon	X
Convolvulus cneorum	X
Coreopsis grandiflora	X
Cortaderia seloana	X
Cotoneaster dammeri 'Ice Cool'	X
Cotoneaster franchettii	X
Cottoneaster horizontalis	X
Crassula ovata	X
Cuphea hyssopifolia	
Cupressocyparis leylandii	
Cupressocyparis leylandii 'Castlewellan'	
Cupressocyparis semp. 'Pyramidalis'	
Cupressocyparis leylandii 1/2	
Cupressocyparis leylandii 3 balls	
Cupressocyparis leylandii castle	
Cupressocyparis leylandii spiral	
Cupressus leylandii Castle Gold 1/2 STD	
Cupressus leylandii Castle Gold pon pon	
Cupressus leylandii Castle Gold spiral	

PLANT NAME	DROUGHT TOLERANT
Cupressus leylandii spiral	
Cupressus sempervirens Pyramidalis	X
Cupressus sempervirens Totem	X
Cupressus sempervirens	X
Cupressus sempervirens' American Blue'	X
Cupressocyparis leylandii	
Cymbopogon citratus	
Cymbopogon citratus	
Cyperus alternifolius	
Cytisus scoparius hollandia Rosso'	X
Deutzia gracilis	
Diospyros kaki	
Dodonea viscosa purpurea	X
Dracaena indivisa	X
Dracaena indivisa 'Purpurea'	X
Durantha erecta 'Variegata'	X
Echeveria elegans	X
Eleagnus ebb. Limelight'	X
Eleagnus ebb. Limelight' 2008	X
Erica carnea 'Viola'	
Eriobotrya japonicaCoppertone	
Erythrina caffra	
Escallonia x 'Red Dream'	
Escollania reupestris	
Eucalyptus gunnii	
Euonymus fort. 'Coloratus'	
Feijoa sellowiana	X
Festuca glauca	X
Ficus binnendijkii (Ali)	
Ficus Pumila	
Ficus repens	
Ficus rubiginosa australis	
Forsythia x intermedia	
Fortunella crassifolia	
Fraxinus excels Pendula	X
Fuschia	
Gardenia floribunda	
Genista lydia	X
Goldstar	
Grevillea robusta	X
Grevillea juniperiana	X
Grevillea rosmarinifolia	X

PLANT NAME	DROUGHT TOLERANT
Hebe green	
Hebe vareigata	
Hemerocallis in varieta	X
Hibiscus mutabilis	
Hibiscus rosa-sinensis	
Hibiscus syriacus'Diana'	X
Hydrangea macrophylla	
Hypericum calycinum	
Ilex aquifolium argenteomargina	
Iris 'blue'	X
Isotoma flaviatilis	
jacaranda mimosifolia	X
Jasminum nesnii	
Jasminum officinalis	
Juniperus conf 'Blue Pacific'	X
Juniperus horizontalis 'green'	X
juniperus media 'Old Gold'	X
Juniperus Mint. Julep.	X
Juniperus scopulorum 'Skyrocket'	X
kalanchoe blossfeldiana	X
Kniphofia uvaria	X
Koelreuteria paniculata	
Kolkwitzia amabilis	
Lagerstroemia indica	X
Lantana camara(White)	X
Lantana montevidensis/ Pink	X
Lantana montevidensis/ White	X
Lantana montevidensis/ Yellow	X
Laurus nobilis	
Lavandula dentata	X
Lavandula angustifolia	X
Lavandula pinnata	X
Leonotis leonurus	X
Leptospermum scoparium	X
Leripe muscari	
Leuchophyllum	X
Leucophyllum frutescens'Green Cloud'	X
Ligustrum rexanum 'silver star'	X
Ligustrum texanum	X
Ligustrum texanum	X
Liquidambar styraciflua	X
Liquidambar styraciflua	X
Liriodendron tulipifera	

PLANT NAME	DROUGHT TOLERANT
Lonicera pileata	
Lonicera jap. 'Halliana'	
Lonicera japonica	
Lonicera nitida	
Lonicera nitida Budgens Gold	
Lonicera pileata	
Lonicera pileata 'Lemon Beauty'	
Lonicera xylosteum	
Magnolia grandiflora 'Gallisoniensis'	
Mahonia media charity	
Malus comm. 'Golden Delicious'	
Malus comm. 'Stark Delicious'	
Melia azedarach	X
Metrosideros robustus	X
Miscanthus sinensis 'Zibrenus'	
Miscanthus sinensis green	
Morus alba 'Pendula'	
Morus alba 'Platanifolia'	
Myrsin africana	X
Myrtus communis	X
Myrtus tarentina	X
Nandina domestica	
Nandina domestica Fire Power'	
Nerium oleander "nana"	X
Oenothera speciosa 'Rosea'	X
Olea europea	X
Ophiopogon planiscapus Nigrescens'	
Pennisetum villosum 'Atropurpureum'	X
Pennisetum viridescas	X
Perovskia atriplicifolia	X
Perovskia blue spire	X
Phalaris arundinacea picta	
Phlomis fruticosa	X
Phormium tenax 'Variegatum'	X
Phormium purpurea	X
Phormium tenax	X
Phormium tenax green	X
Photinia fras. 'Compacta Nana'	
Photinia fraseri little Red Robin	
Photinia R.R. 1/2 Std	
Photinia x fraseri 'Red Robin'	
Pinus mugo 'Mughus'	

PLANT NAME	DROUGHT TOLERANT
Pinus pinea	
Pistacia lentiscus	X
Pittosporum heterophyllum	X
Pittosporum tobira	X
Pittosporum tobira 'Nanum'	X
Pittosporum 'Crassyfolium'	X
Pittosporum heterophyllum	X
Pittosporum ten. Silver Queen	X
Pittosporum tobira 'Variegata'	X
Pittosporum tobira 'Nana'	X
Platanus acerifolia	
Platanus orientalis2007	X
Plumbago capensis	X
Polygala myrtilloides	
Populus alba	X
Prunus armeniaca 'Precoce d'Imola'	
Prunus avium 'Lapins'	
Prunus avium 'Ferrovia'	
Prunus avium 'Lapins'	
Prunus avium 'Sunburst'	
Prunus cerasifera 'Pissardii'	
Prunus domestica 'Burmosa'	
Prunus laurocerasus	
Prunus nettarina 'Snow Queen'	
Prunus persica 'Flavor Crest'	
Prunus persica 'Red Haven'	
Prunus pissardi nigra	
Prunus serr. 'Kiku Shidare Sakura'	
Punica granatum	X
Pyrus communis	
Quercus ilex	X
Rhyncospermum jasminoides	X
Ribes 'black' mix and red	
Robinia pseudo 'Umbraculifera'	X
Robinia pseudo 'Casque Rouge'	X
Rosmarinus officinalis	X
Rosmarinus officinalis 'prostra'	X
Salix caprea pendula	
Salvia microphylla	
Sedum spectabile	X
Sedum spurium 'Red Carpet'	X
Sempervivum tectorum	X
Solanum crispum	X

PLANT NAME	DROUGHT TOLERANT
Solanum jasminoides	
Solidago hybrids 'Goldenmosa'	
Sophora jap. 'Pendula'	X
Sophora japonica Local	X
Spartium junceum	X
Spirea japonica 'Shirobana'	
stachys byzantina	X
Sterlitzia nicoli	
Syagrus romanzoffiana	
Symphoricarpus albus	
Symphoricarpus Hau Kook	
Tamarix tetr rubra	X
Tecoma stans	X
Tecomaria capensis	X
Teuchrium fruticans	X
Thulbagia violacea	X
Thymus fushis	X
Thymus Timo Limon	X
Thymus Variegeta	X
Thymus Vulgaris	X
Trachaelospermum jasminoides	X
Ulmus montana 'Pendula'	X
Ulmus motana Local	X
Vibrunum lucidum	
Viburnum opolus 'Sterile'	
Viburnum tinus 'Lucidum'	
Vitex angus-castus	X
Weigelia hybrids 'Bristol Ruby'	
Westringia fruticosa	X
Wisteria in variety	X
Yucca elephantipes	X