

The State and Challenges of Conservation Nurseries in Afghanistan

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Abstract: Afghanistan is a semi-arid, mountainous country with a climate similar to New Mexico. Unfortunately, much of the country has been deforested by unsustainable fuelwood harvesting, overgrazing, and even concerns over security. The senior author was invited to assess the Afghanistan forestry situation in 6 provinces as part of the Afghanistan Water, Agriculture, and Technology Transfer (AWATT) program. The objectives of the assessment were to evaluate the capabilities of the Afghanistan nursery industry sites identified for reforestation; identify potential improvements to seedling production; and propose nursery research and development programs. Most seedling production is dedicated to ornamental or fruit tree production, with only a small percentage of seedlings destined for reforestation or restoration projects. Nurseries often lack basic resources such as a reliable source of irrigation, electricity for heating and cooling, and fertilizer. Better access to publicly available information could greatly improve seedling production practices with little expense.

Keywords: restoration, polybag, arid lands, deforestation, foster mum program

Introduction

Afghanistan, a country about the size of Texas, has many similarities to New Mexico; much of the area is arid or semi-arid and mountainous. New Mexico is approximately 25% forested; the original forest cover of Afghanistan was estimated to be about 48%. The eastern part of the country was historically conifer and oak forests, while the interior mid-elevation lands had pistachio (*Pistacia vera*) and juniper (*Juniperus* spp.) woodlands (Figure 1). Currently less than 2% of Afghanistan is forested. To provide perspective, in 1979, there were nearly 2 million ha (4.9 million ac) of forestland, with 1.3 million ha (3.2 million ac) of conifer forest and about 450,000 ha (1.1 million ac) of pistachio woodland. Today, estimates of both have been halved (Figure 2) (FAO 2010).

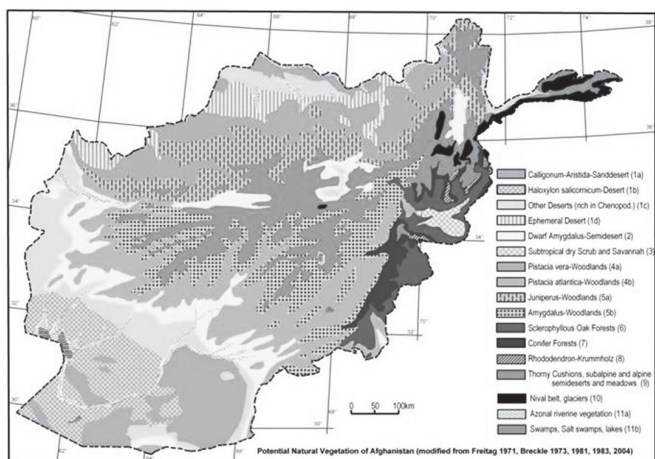


Figure 1. Vegetation types in Afghanistan.

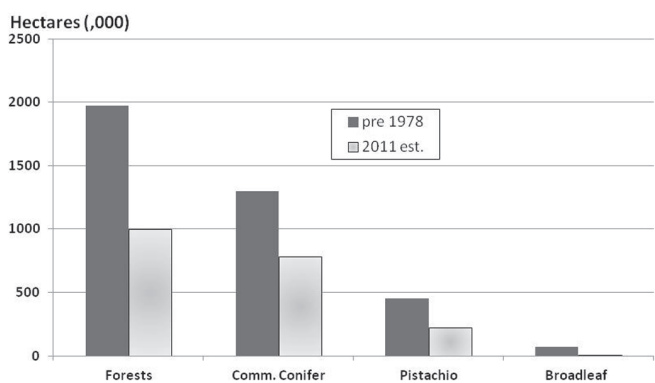


Figure 2. Land cover type in Afghanistan, pre-1978 and estimated for 2011.

While less than 2% of the country is classified as forest, approximately 45% has been classified as woodland/shrubland (FAO 2010). Poverty and conflict have contributed to deforestation of the country with few efforts toward sustainable forest management. Harvest for both industrial roundwood and fuelwood continues to increase despite decreased forest resources and the lack of a sustainable forest management strategy (Figure 3). In 2002, fuelwood harvest was over 40% of the total harvest; current estimates indicate over 80% of the total harvest is for fuelwood. In addition to unsustainable and illegal timber harvesting and excessive fuelwood harvesting, other factors contributing to deforestation include poor grazing practices that hamper natural regeneration and tree removal for security purposes (Figure 4).

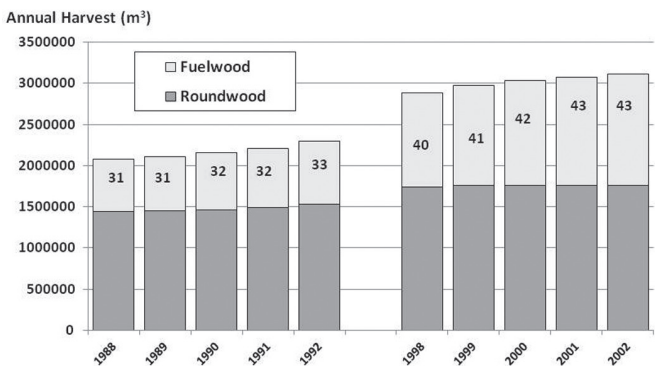


Figure 3. Change in industrial roundwood and fuelwood harvest for Afghanistan from 1988 through 2002 (FAO 2010). Number inside the bar is percentage fuelwood harvest of total harvest. 1 m³ = 35.3 ft³.

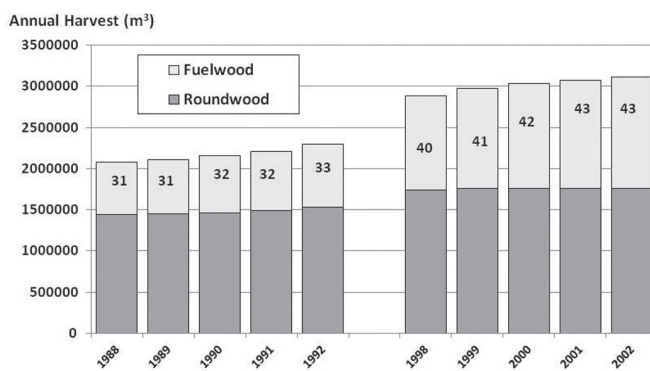


Figure 4. Impediments to forest restoration include: A) uncontrolled livestock grazing pressure; B) fuelwood harvest; and C) timber harvesting (likely illegal).

The senior author was invited to assess the Afghanistan forestry situation as part of the Afghanistan Water, Agriculture, and Technology Transfer (AWATT) program. The scope of work included review of existing nursery and planting conditions in AWATT project areas; providing technical expertise to develop an integrated conservation tree nursery program/network; and development of training materials for the improvement or development of nurseries. The assessment, consulting, and training occurred in 6 provinces, mostly in the eastern part of the country (Figure 5).



Figure 5. AWATT locations in Afghanistan for J Harrington, 2010 to 2011.

Afghan Nurseries—an Overview

Twelve nurseries in eastern Afghanistan were visited (Table 1), and information was provided on an additional 18 nurseries in Kabul province (Table 2). Nurseries in Afghanistan are small; most produce less than 100,000 seedlings/year, and only two produce more than 500,000 seedlings/year. The target market for Afghan nurseries is primarily horticultural, specifically providing large seedlings for urban forestry and home gardening. The majority of the stocktypes are 2- to 3-year-old deciduous, bareroot seedlings, with prices ranging from 15 AFN (~US\$ 0.30) to 400 AFN (~US\$ 8.00). Bagged seedlings that are analogous to ball and burlap (BB) nursery stock in the United States are produced in some nurseries. Both deciduous and conifer seedlings produced in polybag containers are a third category of plant material produced at five nurseries.

A small percentage of planting stock is used for reforestation. Although most nurseries target their product to landscaping or agroforestry, one non-governmental organization (NGO) nursery did indicate that up to 50% of their plant material is used for reforestation. In

Table 1. Production characteristics of nurseries evaluated during the assessment. (1 ha = 2.5 ac)

Location (Province)	Nursery	Ownership	Size (ha)	Species	Bareroot	Ball and Bag	Container	Annual Production (estimate)
Kabul	Bibi Mahrow	MAIL/DAIL	<1	8	+	+	-	na
	Paghman	MAIL/DAIL	15	20	+	+	+/-	150,000
	Paghman	NGO-CDP-K	3.2	6	+	-	-	182,000
	11th Street	NGO-CDP-K	1.2	4	+	-	+	600,000
Balkh	Takhta Pul	MAIL/DAIL	8	12	+	+	+/-	270,000
	PDHP	PDHP	1.2	13	+	+	-	20,000
	PDHP-Mother Plant	PDHP	<1	na	+	+	-	na
	Private	Private	na	na	na	na	na	na
Nangarhar	Bagh-e-Ghulam Haidar	MAIL/DAIL	4	15	+	+	+	na
	Qurya e Jadid	MAIL/DAIL	4	20	+	+	+	na
	IF HOPE	NGO-IF HOPE	85	8	+	+	+	2,000,000
Hirat	Odoro Bagh	MAIL/DAIL	4	8	+	+	-	40,000
	Private	MAIL/DAIL	4	7	+	+	-	40,000

Table 2. Attributes of private Kabul nurseries, courtesy of CDP—Kabul (Community Development Program—Kabul).

District	Nurseries (number)	Production					Total
		Conifer	Deciduous	Riparian	Range		
					Min	Max	
Mirbachakot	8	130,300	85,200	63,500	200	150,500	279,000
Paghman	4	2,500	2,000	12,000	2,200	9,000	16,500
Farza	2	0	50	200	100	150	250
Estalif	1	0	1,500	0			1,500
Istalif	1	3,000	61,300	18,000			82,300
Qarabagh	1	500	2,900	6,500			9,900
Shkar dara	1	3,000	1,000	0			4,000
TOTAL	18	139,300	153,950	100,200			393,450

all but the 3 NGO nurseries, the majority of plants are being sold for the urban greening and fruit tree/agroforestry sectors. These horticultural markets require a larger product that commands a higher price than reforestation planting stock. Larger reforestation stock, however, can be less susceptible to grazing pressure following outplanting.

Innovations

Most nurseries demonstrated some level of innovation to improve seedling production (Figure 6). For example, nurseries with limited water supplies used sunken beds with furrow irrigation. Almost all used a 2-tree row per furrow production strategy that increased overall production efficiency. Another innovation was the use of nursery plants for sources of cutting materials for vegetatively-produced plants. For instance, one nursery in Jalalabad used pruning residues from harvested *Punica granatum* seedlings as cutting material for the next production cycle. Other nurseries either had stooling blocks or adjacent landscape trees as a source of cutting material. Given the limited resources at nurseries, fertilizer use was limited. Several facilities did have composting programs to ameliorate the situation. Unfortunately, the volume of compost required is far greater than the capacity of the nurseries' composting infrastructure.

The nurseries also demonstrated considerable innovation in their propagation strategies. The use of seedbeds and transplant beds is an effective use of limited nursery space. Seeds are sown in a seedbed and seedlings are transplanted (pricked out) to transplant beds after as much as one growing season. Transplants are grown for 1 to 3 seasons before being sold. Nurseries used the transplant process as an opportunity to sort or grade seedlings, ultimately improving crop uniformity, decreasing production costs, and improving stock quality. One nursery started conifer stock in containers and then transplanted them into the transplant beds (similar to Plug + 1). This method might shorten the production cycle by 1 year. Seedlings grown in native soil are sold as bareroot or BB stock.

The use of polyethylene-covered high tunnels (poly tunnels) over seed beds was observed at several nurseries (Figure 6D). This low-cost technique extends the growing season during the first year, ultimately resulting in shorter production times. Greenhouses lack electricity, and therefore have only a limited ability to control environmental (temperature) conditions. These greenhouses would be analogous to cold frames or hoop houses in the United States. The primary use of these limited greenhouses appears to be to start seedlings in containers for the first growing season. Some polybag and container (clay pot) plant materials are grown in unheated greenhouses to extend the growing

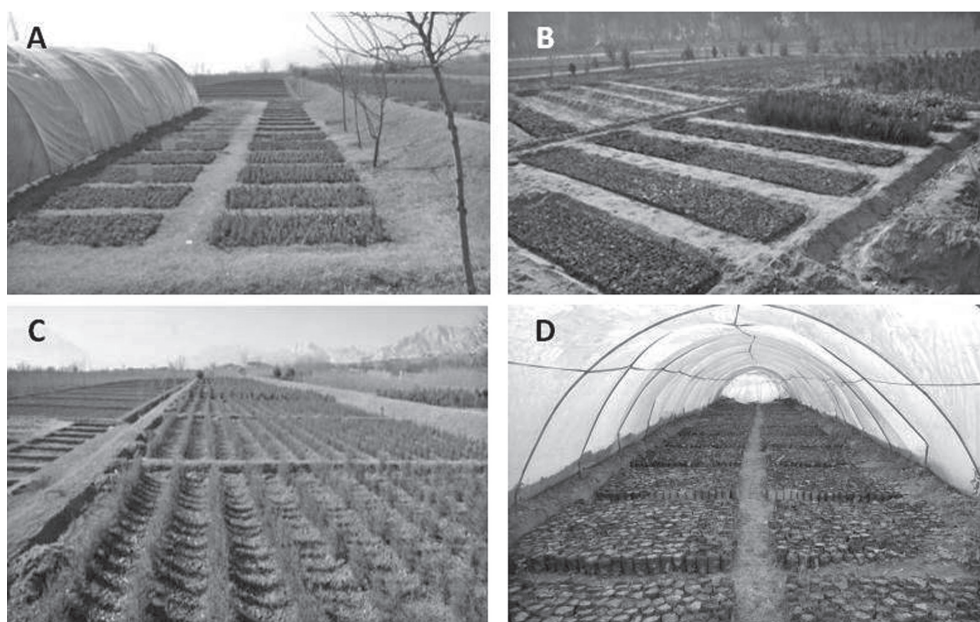


Figure 6. Nursery practices in Afghanistan: A) in-ground seedbed nursery production; B) in-ground polybag production system; C) transplant seedling bed for bareroot or BB production; and D) high tunnel polybag production.

season. Innovative growers excavated the growing area to a depth of 1 m (3.3 ft) or more. This effectively insulates the crop and raises the temperature inside the greenhouse in winter.

Polybag production was variable. Use of polybags in nursery production can be considered as a positive innovation given the ability of intact rootballs to mitigate stresses associated with plant harvesting, transportation, and planting. The predominant polybag used was 12.5 cm (5 in) wide by 15 to 20 cm (6 to 8 in) deep. Polybags were used in two production strategies: 1) faster growing deciduous stock, such as *Eucalyptus* spp.; and 2) conifers produced in outdoor nursery beds for 1 to 3 years until they reached marketable size. Polybag seedlings, primarily conifers, were also grown in poly tunnels for 1 year then transplanted to the field nursery for the remainder of the production cycle, typically 2 to 3 more years. The growing media for polybag production typically consisted of native sand, soil, and compost (2:1:1).

Limitations

Nursery limitations can be separated into infrastructure (capital) issues, and operational issues, including administration and personnel. The most significant and overarching capital limitation is the lack of reliable utilities, including water, electricity, and gas. Almost every process is done by hand, from bed preparation to seedling lifting. While mechanization has its advantages, the large potential work force in Afghanistan can be effectively used to offset the limitations associated with the lack of mechanization. Most nurseries also lacked greenhouses, and those with greenhouses lacked the ability to regulate temperature. While some nurseries did have a reliable water supply, most nurseries have had to take innovative steps, such as changing bed design or size, to make good use of their limited water supply.

The public nurseries appear to rely on public sales to sustain operations. The level of funding these nurseries receive from the government was unclear. The request from one such nursery for money to pay for laborers, fertilizer, and hand tools is indicative of the shortfall in operational funding. In contrast, the 3 NGO nurseries do not rely on public sales, and were appropriately staffed and had active annual fertilization programs. The impact of consistent

funding on the final product is evident in the overall uniformity of the plants being produced at the NGO nurseries.

Nursery personnel lacked access to currently accepted propagation practices and other advances in horticultural and conservation nursery operations. An example of this knowledge gap is the lack of seed refinement and seed pre-treatments. A better understanding of these aspects of propagation could improve seedbed space utilization and overall seed use efficiency. A second example is in the area of crop uniformity; at several nurseries there was considerable variability in crop size. Such variation resulted in partial bed harvesting and remnant trees being left in production beds until they reached a salable size, as much as one year later. Such practices decrease the overall production efficiency while increasing operational costs.

The size of conservation or reforestation planting stock produced in Afghanistan nurseries is much larger than conventional reforestation planting stock, that is, more similar to horticultural plant material. Poor handling of these large seedlings as they are lifted from the nursery beds and transported to outplanting sites tends to reduce stock quality.

Opportunities for Improvement

There are two primary areas, irrigation and greenhouses, in which existing infrastructure can be modified to improve production efficiency with modest investment. Conversion to sprinkler or drip irrigation systems will require investment into pressurizing systems and expensive, high-maintenance filtration systems. Improving the existing flood and furrow/sunken bed irrigation system, however, will suffice to overcome current limitations without costly investment. For example, concrete lining of distribution ditches and installation of turnouts and individual bed gates would reduce the amount of water lost to seepage.

Limited-technology hoop houses or cold frames could also enhance efficiency. There are currently several nurseries that use these structures, referred to as greenhouses. With training and appropriate use of the structures, other nurseries could improve production efficiency. Using these limited-technology structures can also serve as an effective tool to increase the use of polybags in the production of reforestation planting stock.

Nursery Protocols

Conifers are propagated from seeds that are sown in the fall or winter (Figure 7A). Typically, the seeds are sown in a seedbed and grown for 1 year, transplanted, and grown for an additional 2 to 4 years until they reach marketable size (1+2 or 1+4). The final product is typically sold as BB stock. There were some variants to this practice, including sowing seeds in polybags for 1 year and then transplanting into transplant beds (Plug+1), or starting the plants in seedbeds inside a high tunnel and then transplanting them after 1 growing season to the transplant beds. The underlying benefit of transplanting polybag-grown seedlings is the harvesting (lifting) process is less stressful to the plant, less expensive in terms of manpower, and results in greater production efficiency than digging and transplanting bareroot seedlings.

Bareroot deciduous seedlings are propagated from either cuttings or seeds (Figure 7B). When propagated from cuttings, the cuttings (whips) are collected while dormant, typically in late winter or early spring, and then planted (stuck) into the nursery beds. Depending on growth rates, the cuttings are raised to marketable size in 2 to 3 growing seasons. When propagated from seeds, sowing takes place in the fall or early winter for those species requiring stratification, or in early spring or shortly after seed dispersal for those with no stratification requirement. Seedlings are typically produced over 2 growing seasons (2+0).

Polybag production of deciduous species is limited to seed propagation of fast-growing species, such as *Eucalyptus* spp. Polybags are typically sold after 1 year; there were several nurseries in Nangarhar Province, however, where the seedlings were held for 2 years and were clearly oversized for the size of the polybag.

Several potential changes to the production regimes of bareroot seedlings could improve production efficiency or product quality. These changes incorporate greater use of polybag containers into various aspects of the production regime (Figure 7C). Ultimately, converting the final product to polybags should improve transplant performance due to: 1) increased protection of roots by the contained rootball; and 2) container-grown plants can have better transplant performance in arid and semi-arid planting sites.

Seed handling, specifically seed treatment, can also be addressed to improve plant production. All nurseries used natural environmental conditions (fall or winter sowing) to meet stratification requirements. None of the nurseries were using scarification techniques for species that require it, for example, black locust (*Robinia pseudoacacia*) and

Afghan redbud (*Cercis griffithii*). Relying only on natural stratification requires the seeds of many species to be sown shortly after collection. Artificial stratification and scarification treatments allow nurseries to spend more time to refine seeds, thus increasing the amount of viable seeds being sown. Artificial stratification can also be used to re-sow seeding beds with poor initial germination, a condition observed in several of the nurseries. Finally, species could be sown in the spring if scarified properly. Implementing scarification treatments is typically a cost-effective means to improve germination and production efficiencies.

Nurseries are producing healthy, quality planting stock (Figure 8 A, B, C). The lifting and handling processes, however, are likely degrading this quality quite dramatically. Nursery and transport personnel, as well as the end users, should be trained in the importance of careful handling. Training would need to focus on four principal areas: keeping roots moist and protected throughout the process; keeping plants cool throughout the process; using covers to protect the plants during transport; and ensuring that container or bagged plants have moist soil.

Outplanting

Contour terracing, the dominant site preparation practice, seems to be the most effective means of combining site preparation and erosion control (Figure 8D). Many of the sites needing reforestation are so degraded that surface erosion rates have increased significantly. The loss of the nutrient-rich surface soil layer creates challenges to successful reforestation, as well as numerous other detrimental impacts throughout the associated watershed. The practice of contour terracing, while labor intensive, is effective at reducing surface erosion and runoff and improving infiltration at the planting sites. Several contacts reported survival was routinely high ($\geq 90\%$). Site visits by the senior author, however, indicate a much lower success rate (Figure 8E). Some sites, such as those in Paktika Province, are so large and degraded that the potential for terracing may be limited. Other soil stabilization practices, such as direct seeding of grasses and shrubs, will need to be employed before trees can be successfully established. The sites will also need to be protected from grazing pressure until the trees are established.

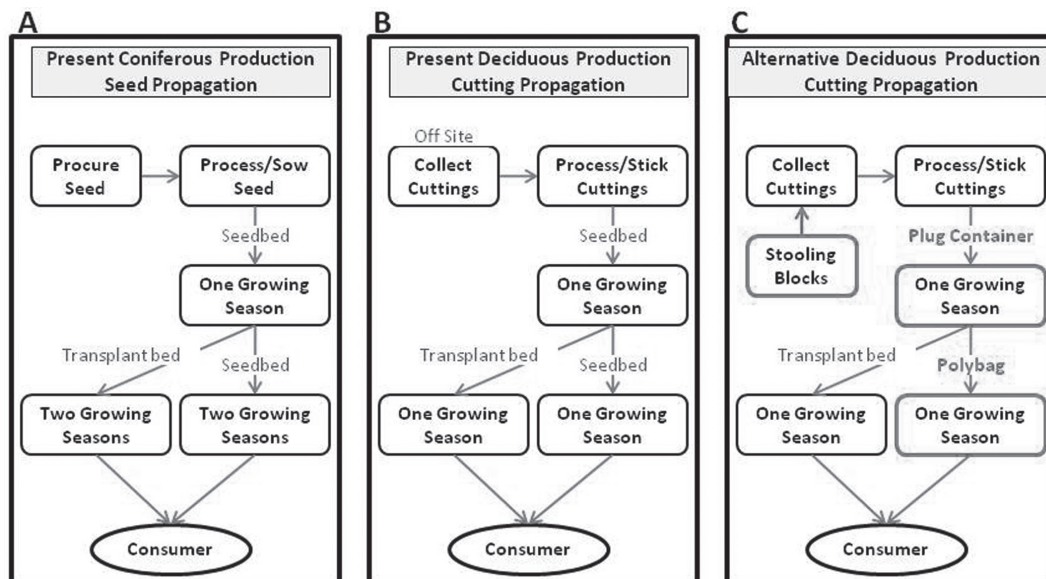


Figure 7. Schematic of current conifer and deciduous seedling production protocols and proposed alternative.

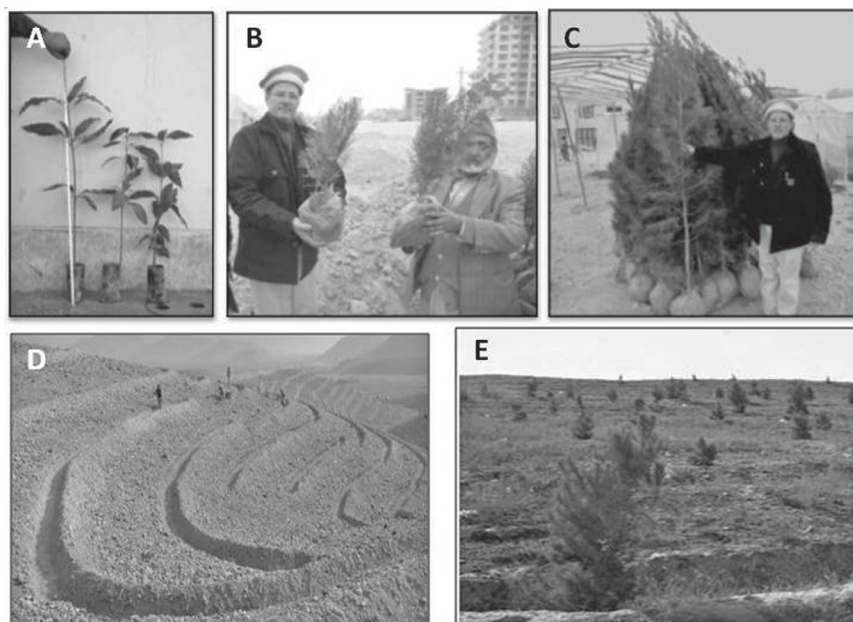


Figure 8. Representative seedlings produced in: A) polybag production; B, C) BB production; D) watershed restoration catchment trenches; and E) *Pinus halepensis* restoration.

Research and Development

A nationwide nursery research and development program should be administered by the Ministry of Agriculture, Irrigation and Livestock (MAIL), possibly in conjunction with major universities in Afghanistan. The partnership is a logical one; universities have greater research capabilities, and the nurseries have a need for applied research and development. A MAIL/university partnership would provide a platform to bolster or develop a forestry/horticulture curriculum in the universities, developing a capacity for Afghanistan to train future forestry/horticulture professionals. The larger NGO and private nurseries may want to support an effort similar to that of nursery cooperatives in the United States. They could develop their own programs, but that would likely be more expensive and perhaps redundant.

Evaluating alternative production regimes, predominantly polybag production, should be conducted simultaneously with work on developing reforestation planting stock that matches the planting site. Polybag containers will continue to be the best alternative, given the prohibitive cost of rigid containers and artificial growing media. One important aspect of polybag production research that would need to be addressed is size. Various manufacturers produce different sizes of these bags. Because plants produced in polybag containers are prone to root spiraling, it will be important to address correct sizing of the polybags and production systems that produce plant sizes that reduce the risk of root spiraling. Harvesting, handling, and planting are other areas where significant gains in transplant survival and performance could be realized with nominal research and development expenditure. As with the research in production strategies, the majority of the foundation research in these areas has already been done elsewhere in the world. It is necessary to refine this information to meet the specific needs of Afghanistan.

Additional Opportunities

The years of military conflicts have resulted in many widows with no source of income or support. One novel program is the “Foster Mum” program where families were provided with training and supplies to start small nurseries as a source of income (Figure 9). AWATT provided training to MAIL, the Directorate of Agriculture,

Irrigation, and Livestock (DAIL), Provincial Reconstruction Teams (PRTs), and Agribusiness Development Teams (ADTs). These programs then provided training to the families. This program will likely require ongoing support in the form of supplies (containers, seeds, fertilizer) and additional training.

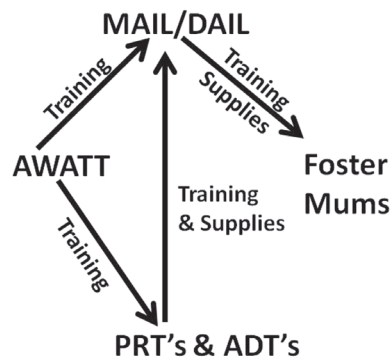


Figure 9. Diagram of the organizational structure of the “Foster Mums” program in Afghanistan. AWATT is the Afghanistan Water, Agriculture, and Technology Training Program; MAIL is the Ministry of Agriculture, Irrigation, and Livestock; DAIL is the Directorate of Agriculture, Irrigation, and Livestock; PRTs are the Provincial Reconstruction Teams; and ADTs are the Agribusiness Development Teams.

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The content of this paper reflects the views of the authors, who are responsible for the facts and accuracy of the information presented within.