Supplemental Table 1. Plant Transformation Infrastructure: Public Transformation Facilities in the USA.
The values shown represent full time equivalent (FTE) staff hours and the estimated # of independent events (in parenthesis) produced annually.
Horizontal shading represents the species that require approximately 75% of FTE effort for transformation.

Species (common name)	Institution/Facility Director: Boyce Thompson Institute	Iowa State University	Michigan State University	University of California (Davis)	University of California (Riverside)	University of Florida	University of Missouri (Columbia)	FTE /species
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Apium graveolens (celery)			0.3*					*
Arabidopsis thaliana (arabidopsis)					0.1 (300)		0.075 (80)	**0.18**
Atropa belladonna (deadly nightshade)			0.1 (360)					**0.10**
Brachypodium distachyon (stiff brome)	0.1 (50)							**0.10**
Brassica napus (canola)			0.8*	0.05 (30)	0.2 (600)			**0.25**
Brassica napus (rutabaga)			0.4*					*
Citrus spp. (citrus)				0.1 (40)	0.3 (20)	3.75 (400)		**4.15**
Glycine max (soybean)		1.65 (350)					1.5 (300)	**3.15**
Hordeum vulgare (barley)				0.2 (60)				**0.20**
Jatropha curcus (jatropha)					0.1 (10)			**0.10**
Lactuca sativa (lettuce)				0.2 (150)				**0.20**
Lycopersicum esculentum (tomato)	1.55 (750)		0.1 (100)	0.6 (600)	0.4 (500)			**2.65**
Malus × domestica (apple)			1*					*
Medicago sativa(alfalfa)				0.3 (160)	0.5 (10)			**0.80**
Medicago truncatula (barrelclover)				0.05 (25)	0.5 (10)		0.015 (20)	**0.57**
Nicotiana benthamiana			0.05 (360)	0.1 (75)	0.2 (30)		0.015 (20)	**0.37**
Nicotiana tabacum (tobacco)			0.05 (360)	0.2 (150)	0.1 (300)		0.015 (20)	**0.37**
Oryza sativa (rice)		0.6 (750)	0.1 (80)	0.4 (275)	0.3 (120)		0.015 (20)	**1.42**
Panicum virgatum (switchgrass)			0.5*				0.1 (200)	**0.10**
Petunia x *hybrida* (petunia)			0.1 (360)	0.05 (70)				**0.15**
Populus tremula (poplar)					0.1 (40)			**0.10**
Prunus cerasus (cherry)			1.5*					*
Setaria viridis (foxtail millet)	0.55 (275)						0.03 (30)	**0.58**
Solanum tuberosum (potato)	0.1 (50)			0.05 (30)	0.3 (600)			**0.45**
Sorghum bicolor(sorghum)							0.25 (150)	**0.25**
Triticum aestivum (wheat)				0.2 (150)			0.075 (80)	**0.28**
Vaccinium corymbosum (blueberry)			1.0*					*
Vitis vinifera (grapevine)				0.5 (90)				**0.50**
Zea mays (maize)		2.75 (1500)					1.15 (400)	**3.90**
FTE/facility	**2.30**	**5.00**	**0.50**	**3.00**	**3.10**	**3.75**	**3.28**	**20.93**

* Customized service. FTE estimation and requirement when starting the project, and thus not included in totals.

1 http://bti.cornell.edu/research/research-resources/facilities-services/biotechnology-center/service-fees/
2 http://agron-www.agron.iastate.edu/ptf/
3 http://www.ptc.msu.edu/index.html
4 http://ucdptf.ucdavis.edu/
5 http://ptrc.ucr.edu/
6 http://www.crec.ifas.ufl.edu/facilities/transformation/
7 http://plantsci.missouri.edu/muptcf/

In the U. S., seven public plant transformation facilities (PTFs) were founded in the early 2000s to provide genetic transformation services for 29 plant species on a fee-for-service basis. Each of these facilities was founded in the pre-genome-editing era, and faces challenges in transformation capacity and financial sustainability. These facilities transform both facile model plant species such as Arabidopsis and tobacco, and recalcitrant crop species such as soybean and wheat. Approximately 21 technical staff members are involved in these services, ranging from 0.5 to five full-time equivalent staff members per facility. Five crops - citrus, maize, rice, soybean and tomato - account for the majority (75%) of the transformation service efforts in terms of the number of FTEs involved in the process (shaded rows in the Table). In addition to the seven fee-for-service public PTFs, there are many individual academic laboratories that have “collaboration-only” arrangements for transformation activities that are performed by personnel supported by a grant or collaborative project for specific species.

Two major factors, personnel and infrastructure, are recognized by all PTFs as key constraints in increasing transformation capacity for the public sector. Transformation technologies as practiced today are labor intensive, skill demanding (especially for recalcitrant species), and cannot be readily automated. Transformation therefore requires significant investment in personnel who are drawn from a dwindling pool of individuals trained in applied plant cell biology. The skills and quality of the technical staff determine the consistency of the services and the ability to develop more efficient, high-throughput methods. The second major constraint is physical infrastructure, such as the availability of high quality plant growth facilities. Transformation protocols for some recalcitrant plant species (such as maize and sorghum) require immature embryos, making it necessary to grow plants year round as source material. While not all plant species are equally demanding for growth conditions, a high quality growth facility with adequate lighting, temperature, and humidity control are recognized as critical factors that determine the quality of tissue culture response and transformation efficiency for many recalcitrant species. As a result of limited growth facility space, the PTFs do not have a large quantity of explant material available for research activities, such as investigations to increase transformation efficiency, especially during a heavy service workload period. Until transformation breakthrough technologies emerge, the U.S. and other countries should examine their infrastructure for public crop genomics research. Without significant investment by governments and institutions, infrastructure could become the rate-limiting step for crop genomics research unless there are breakthroughs in methodology.