

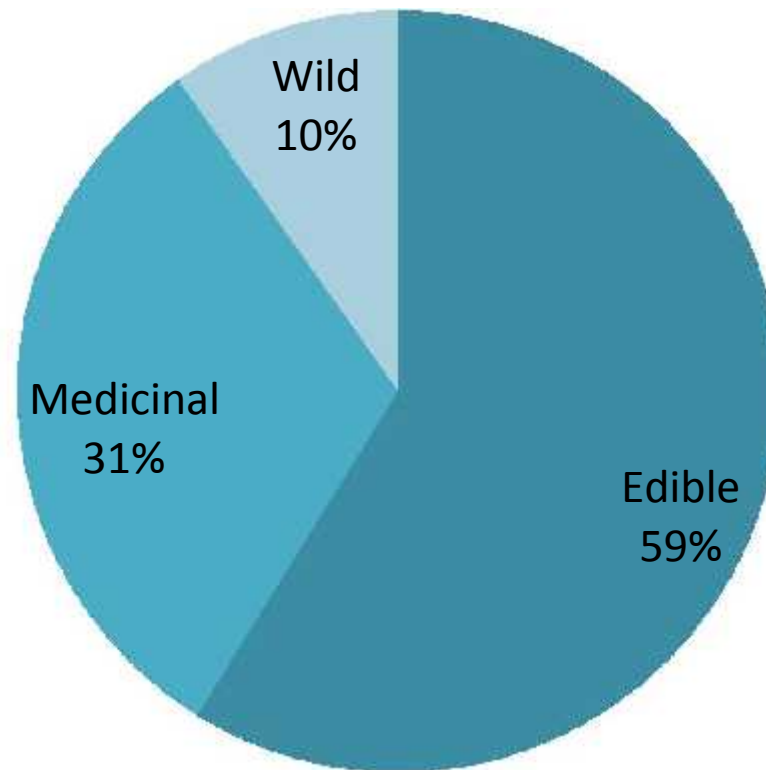
A Global Perspective of the High
Five: *Agaricus*, *Pleurotus*, *Lenz*,
Auricularia, & *Flammulina*

Daniel J. Royse

The Pennsylvania State University



World Mushroom Industry \$51 Billion (USD)



Chang 1996 & 2013, Li 2012



Cultivated edible mushrooms

\$30 B

Wild mushrooms

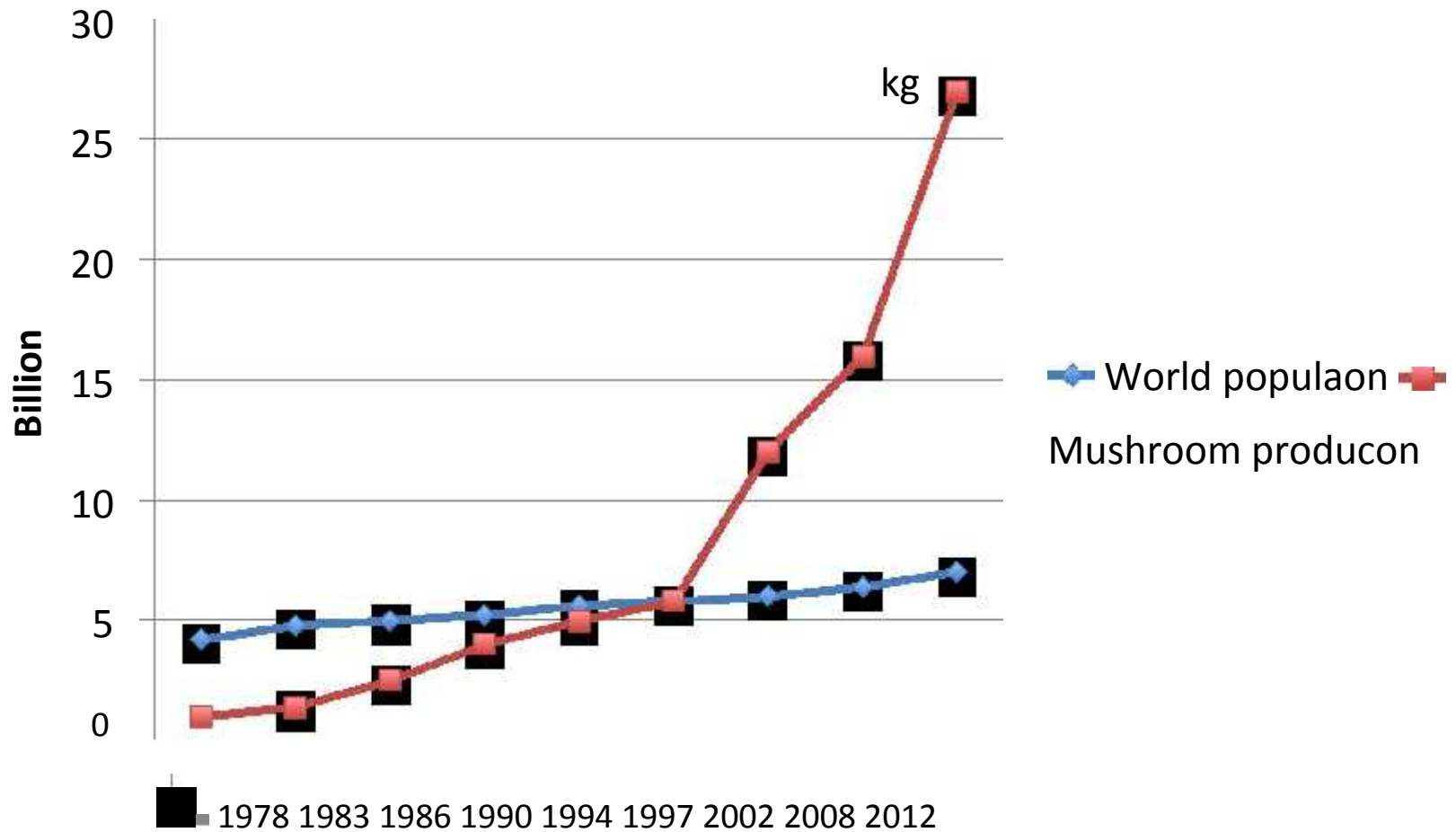
\$5 B

Medicinal mushrooms

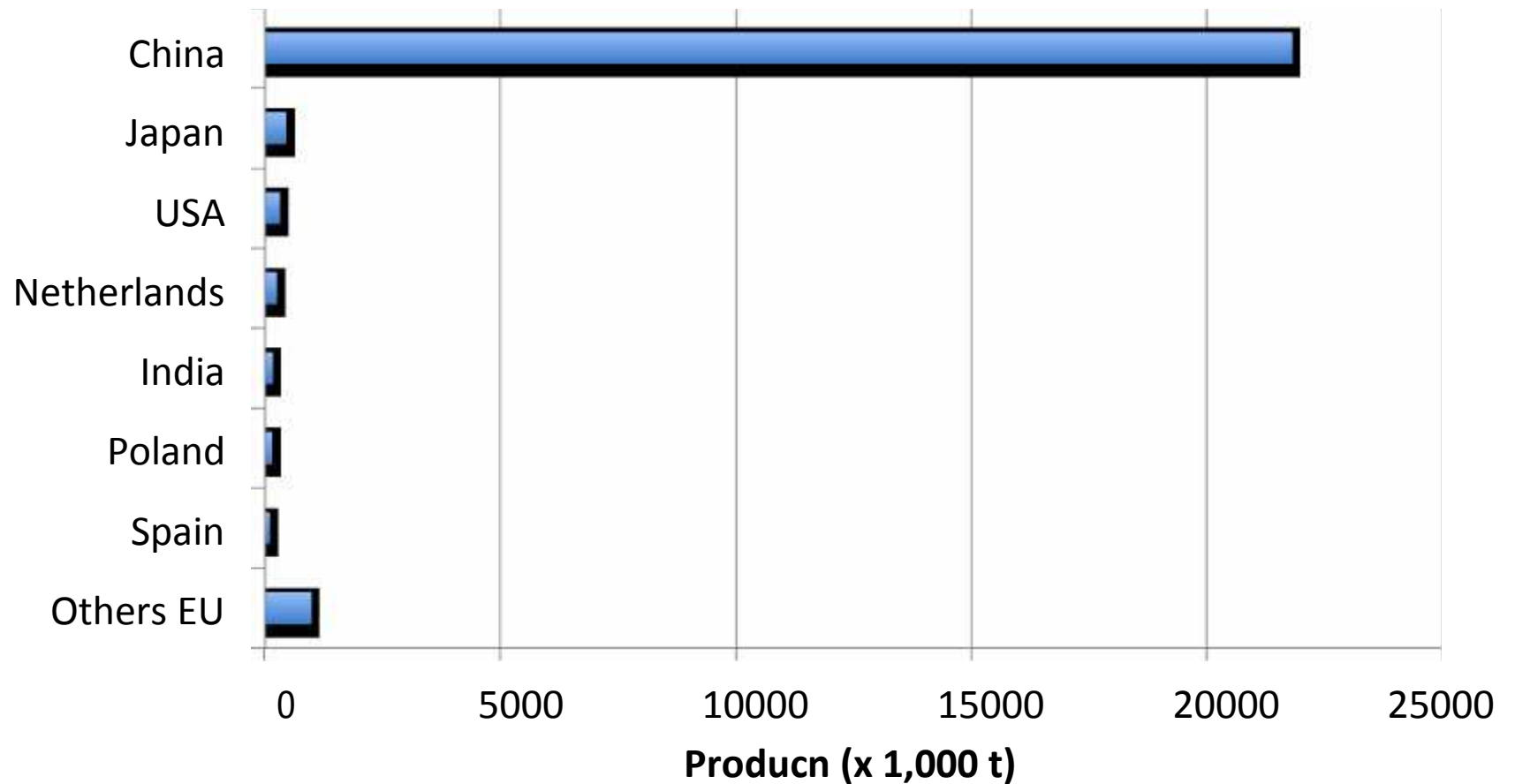
\$16 B



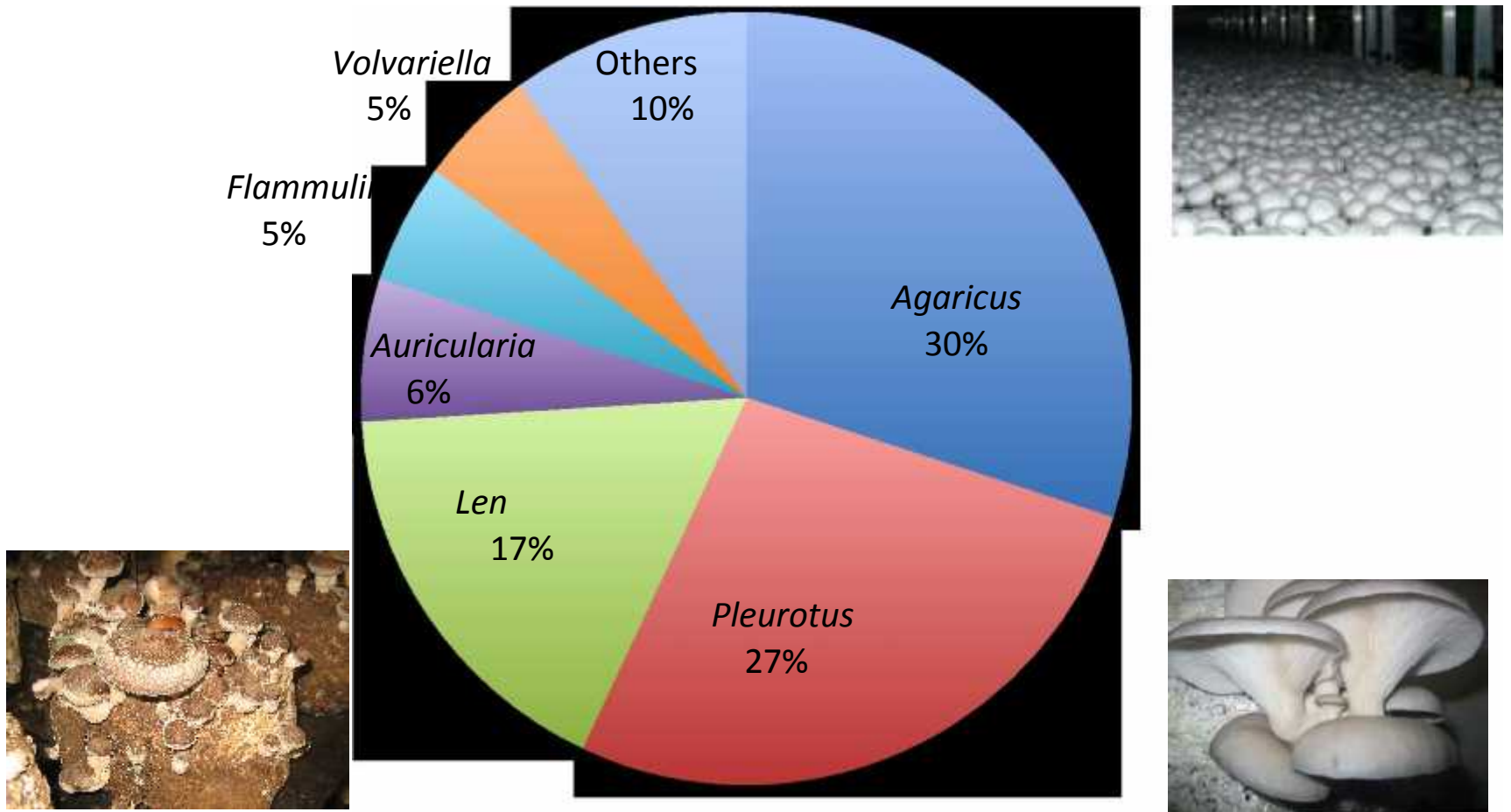
World Populaon vs. Mushroom Producon



Mushroom Production in Selected Countries (2010)

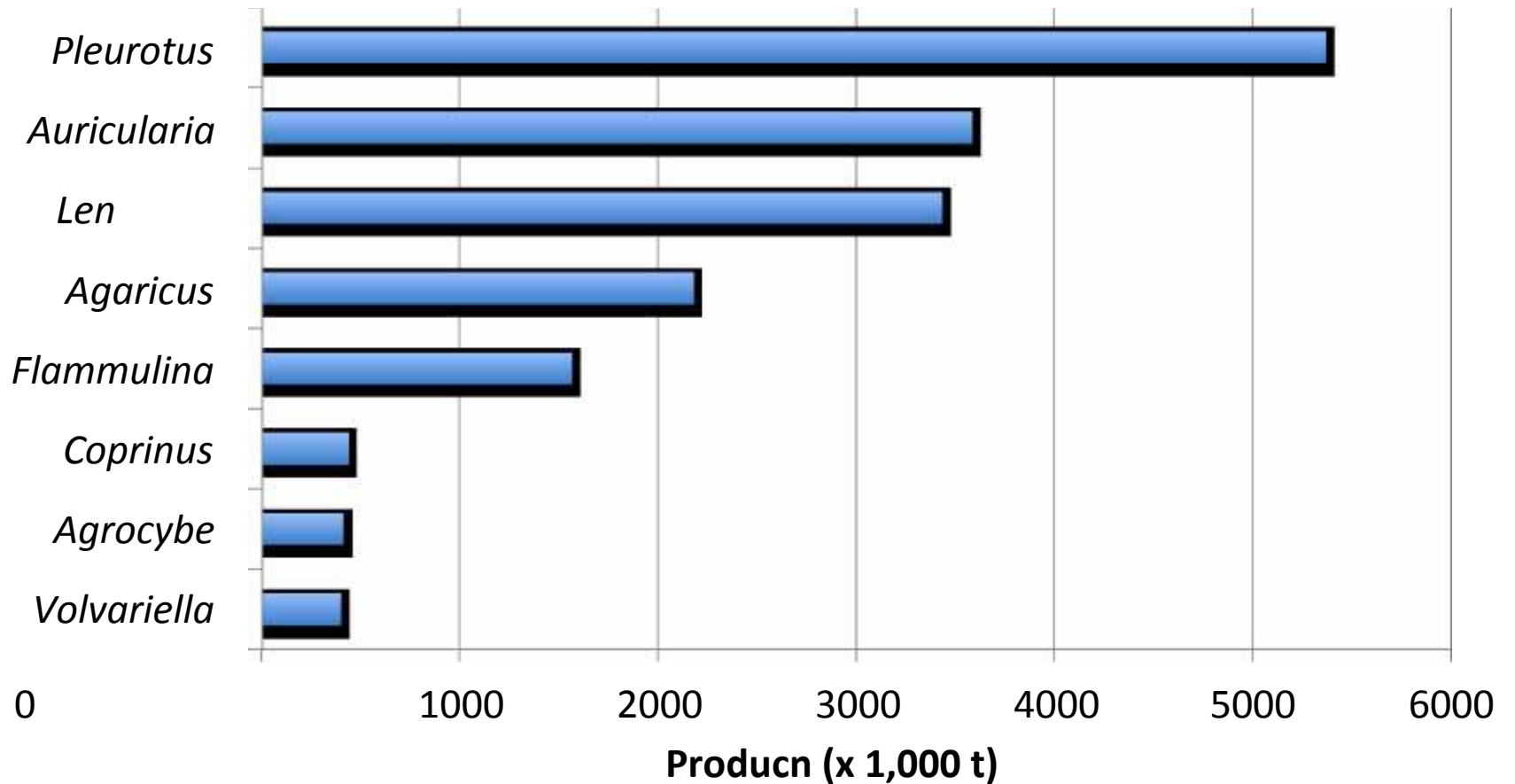


Cultivated Edible Mushrooms



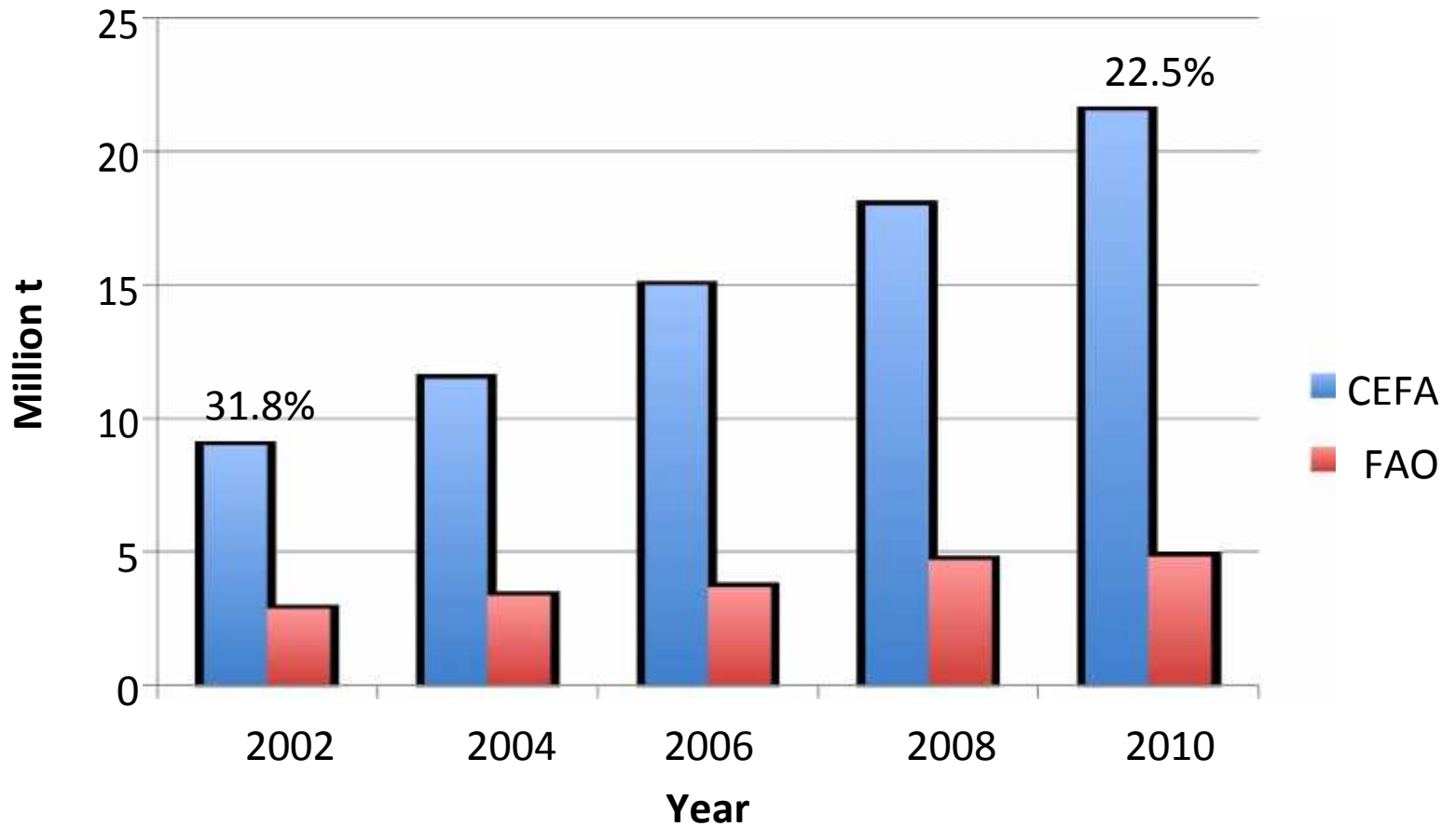
Chang 2006, ISMS 2007, Li 2012

Mushroom Production in China by Genus (2010, CEFA)



Mushroom Production In China

Chinese Edible Fungi Association vs. FAOSTAT

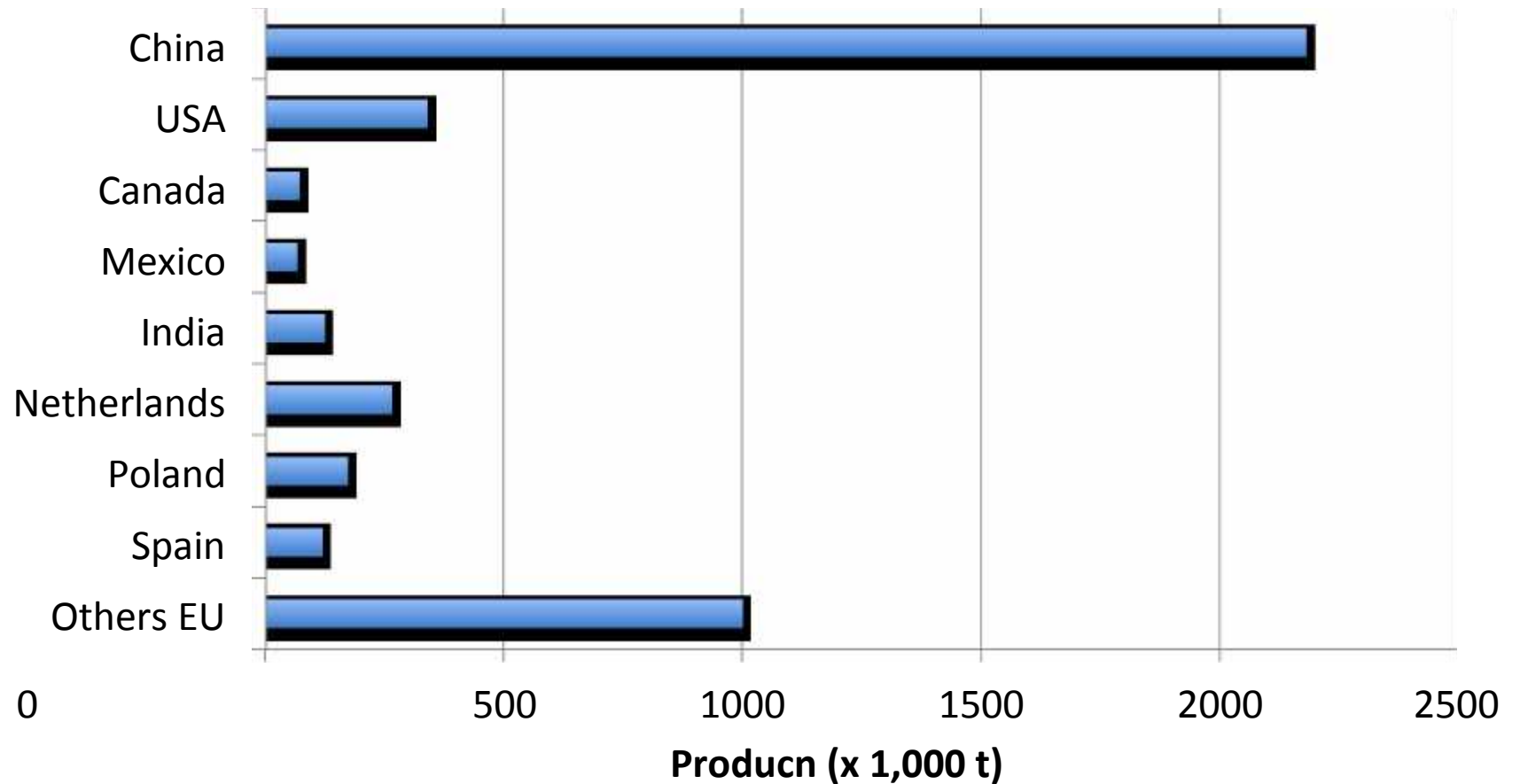


Agaricus



- 30% of world produc
- Primarily *A. bisporus* (some *A. brasilensis*)
- White (90%)
- Brown (10%)
 - Crimini
 - Portabella

Agaricus Production in Selected Countries (2010)



Agaricus producon - China

- Began in 1925 –
introduced from Europe
- 1966, Fujian province -
large scale producon
- 1996, 75% of
producon in China
- A1996, producon
began to spread north
to Shandong, Henan
and Xinjiang



Agaricus spawn - China

- Spawn industry yet to fully develop
 - Few suppliers
 - Many farmers produce own spawn
- Demand for commercial spawn increasing
- 100 million kg/year
- \$200-\$300 million/year

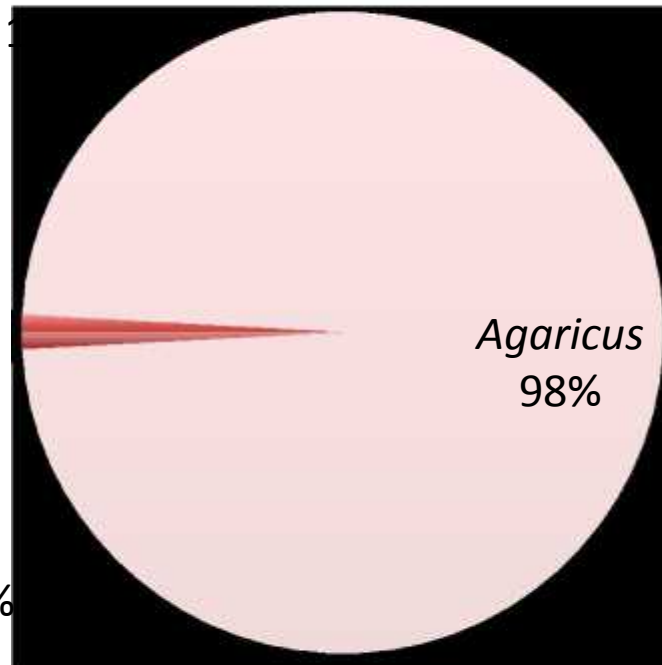


Agaricus - United States

Product

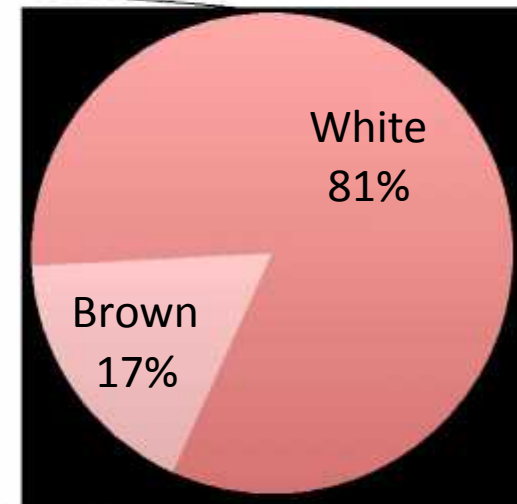


Pleurotus spp.



Len

1%



Brown value = 22%
Specialty value = 6%

USDA 2014

Agaricus - United States

- Value \$1.05 billion (2013)
- 2nd largest producer in world – 400,820 T
– 0% increase from 2011
- *Agaricus* – New Dutch style farms



Agaricus - United States

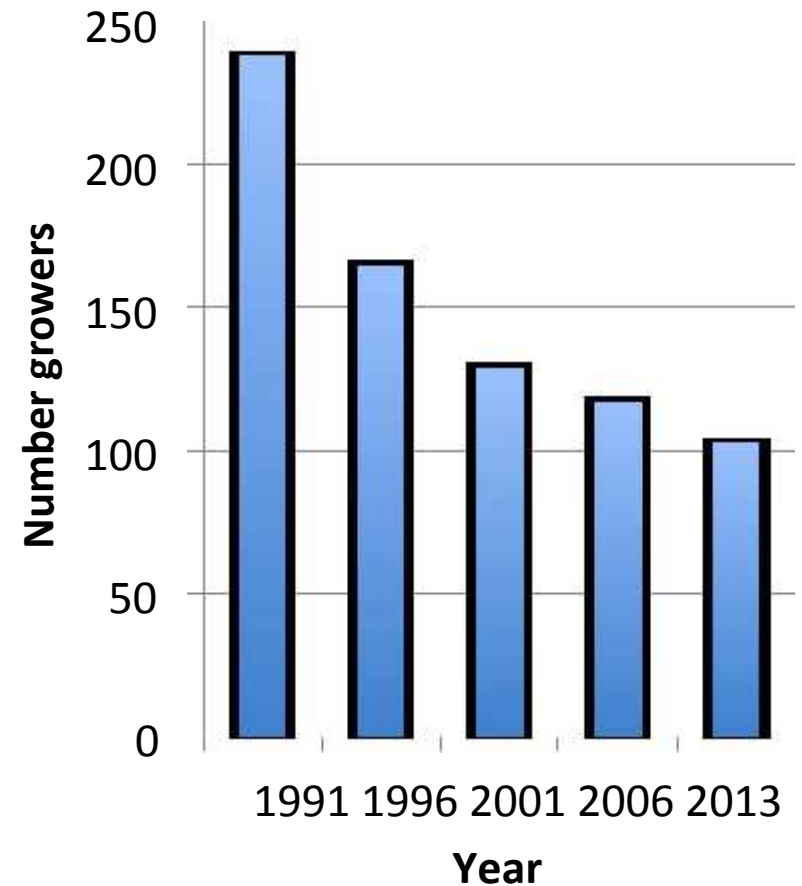
- 65% in Pennsylvania
- 12% California
- 3% organic sales
- 87% sold fresh
- 13% processed
- 19% of growers certified organic



Source: Phillips Mushroom Farms

Agaricus - United States

- Number growers decreasing
 - -57% in 22 y
- 31 growers produced 77% of total (> 4.50 million kg each)
- Price per kg
 - 2004 = \$2.51
 - 2013 = \$2.77



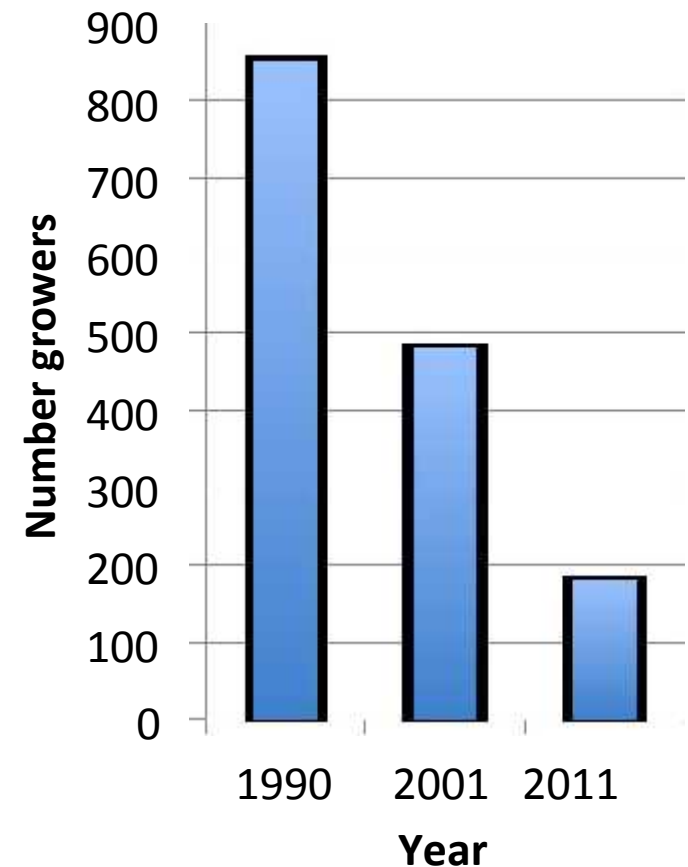
Agaricus - Netherlands



- 95% *Agaricus bisporus*
- World's 3rd largest producer (260 M kg)
- 140 M kg into canned and frozen mushrooms
 - Germany, France, Greece
- Most fresh exported to UK, Germany, France
- Three main compost producers
- Mostly fully colonized (phase III compost)

Agaricus - Netherlands

- Three companies supply casing soil
- Number of growers decreasing
- 75% of growers hand harvest; 25% mechanical
- Overall industry is highly mechanized



Agaricus - Poland, Ukraine and Russia

- Production continues to move eastward
- Poland now equals output of Netherlands
- 80% Poland's production for fresh market
- Poland exports to Russia and Ukraine
- 90% of Russian market supplied by Poland



Agaricus - Poland, Ukraine and Russia

- Ukraine well positioned to increase share of Russian market
- Ukraine wages lower (1/2) than Poland
- Raw materials less expensive in Ukraine
- Ukraine mushrooms likely to replace Polish mushrooms to Russia



Agaricus - Biotechnology

- 50 years of genetic research
- First hybrids – 1980s
- Breeding difficult
- Brown mushrooms increasingly popular
- Brown hybrid developed at Amycel
- 20% increase in yield

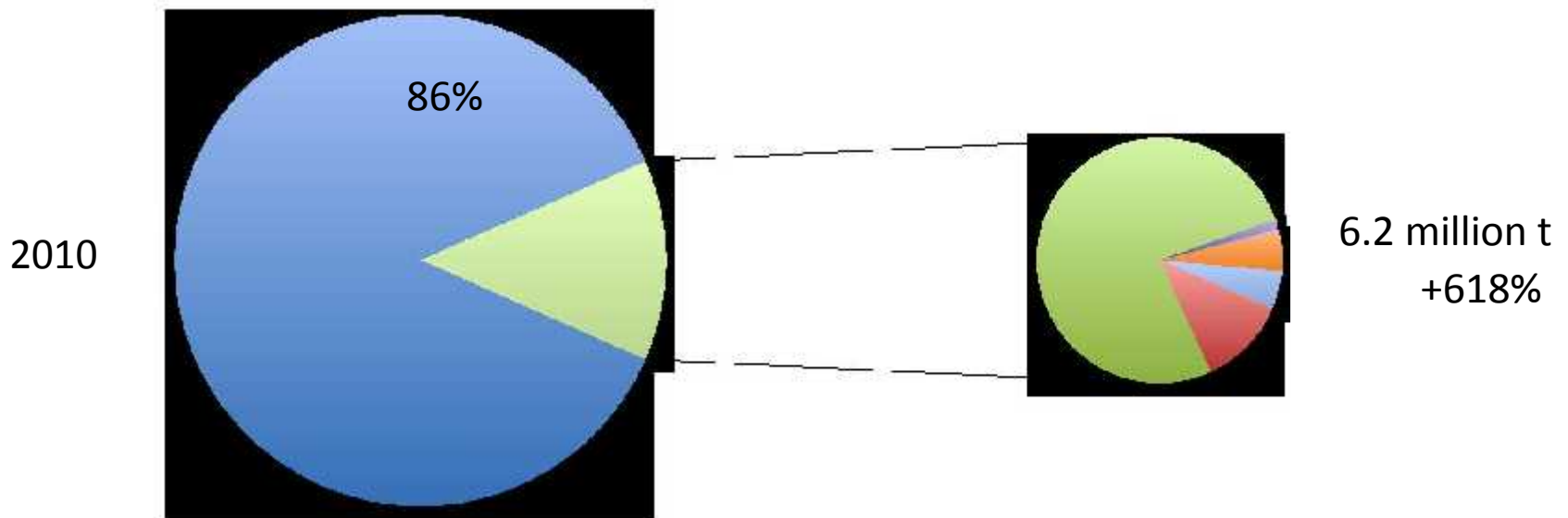


Agaricus - Speed Spawn

- Alternative to grain spawn
- Less susceptible to green mold disease
 - Like starch, more protein
- Greater particles per unit weight
 - Faster colonization of compost



Pleurotus Production in Selected Countries and Regions



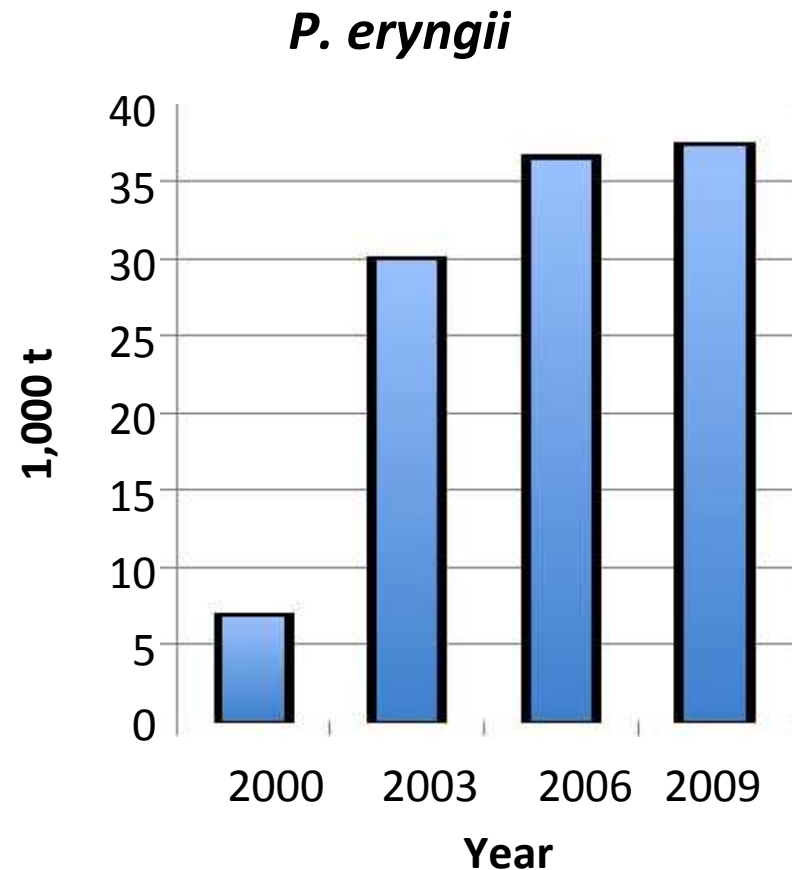
China – *Pleurotus* spp.

- Primarily from 2 species:
 - *P. ostreatus*, *P. cornucopiae*
- Administrative agencies guide farmers:
 - Regions, and resources
- Northeast of China (cool climate & sawdust avail):
 - *P. ostreatus*, *P. eryngii*,
P. nebrodensis

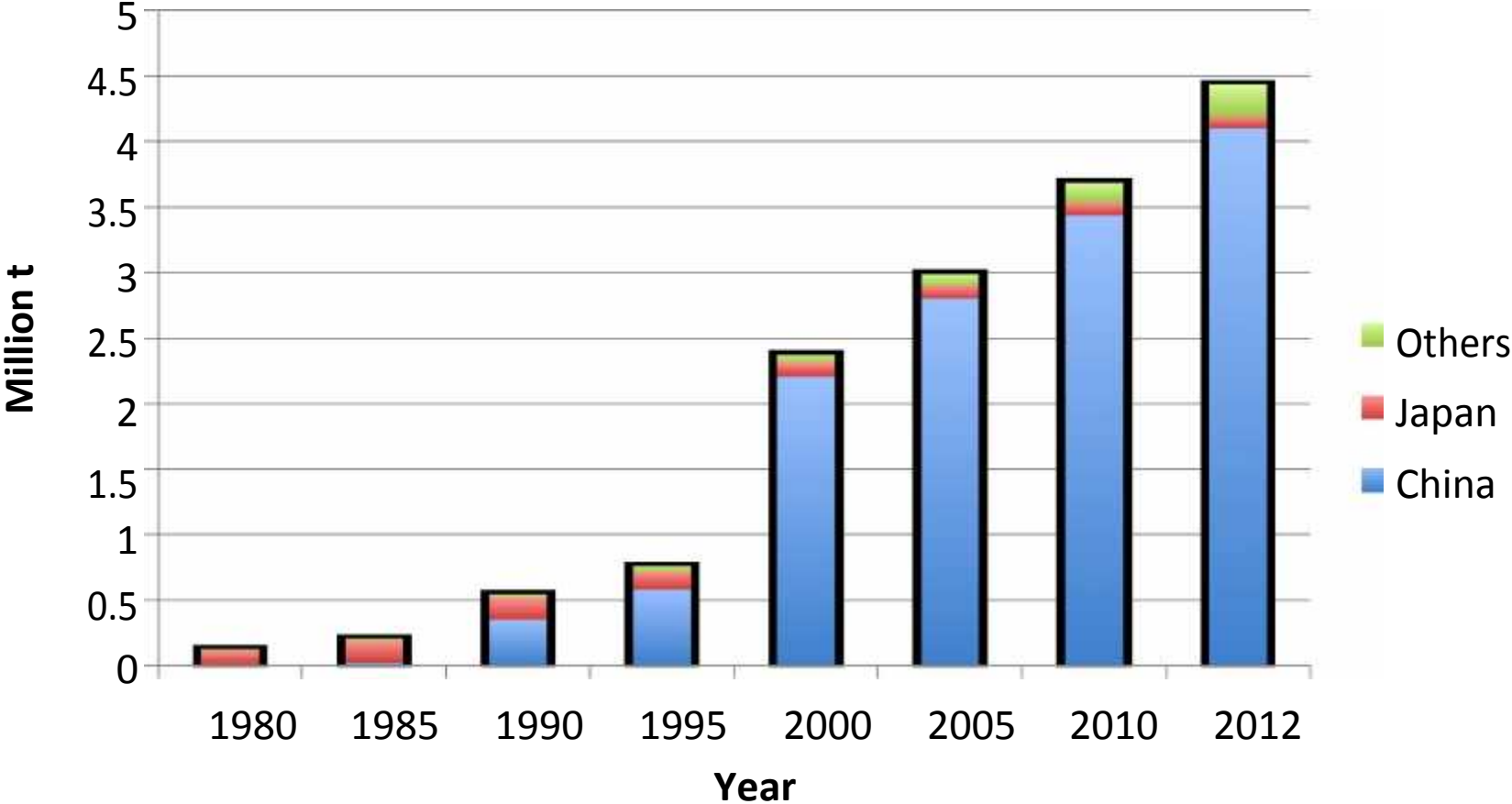


Japan – *Pleurotus* spp.

- *Pleurotus eryngii* fastest growth since 2000 +453%
- 8.1% of total production
- Considered “best taste”
- Hokuto & Yukiguni – 65% of production



Growth in World Shiitake Production



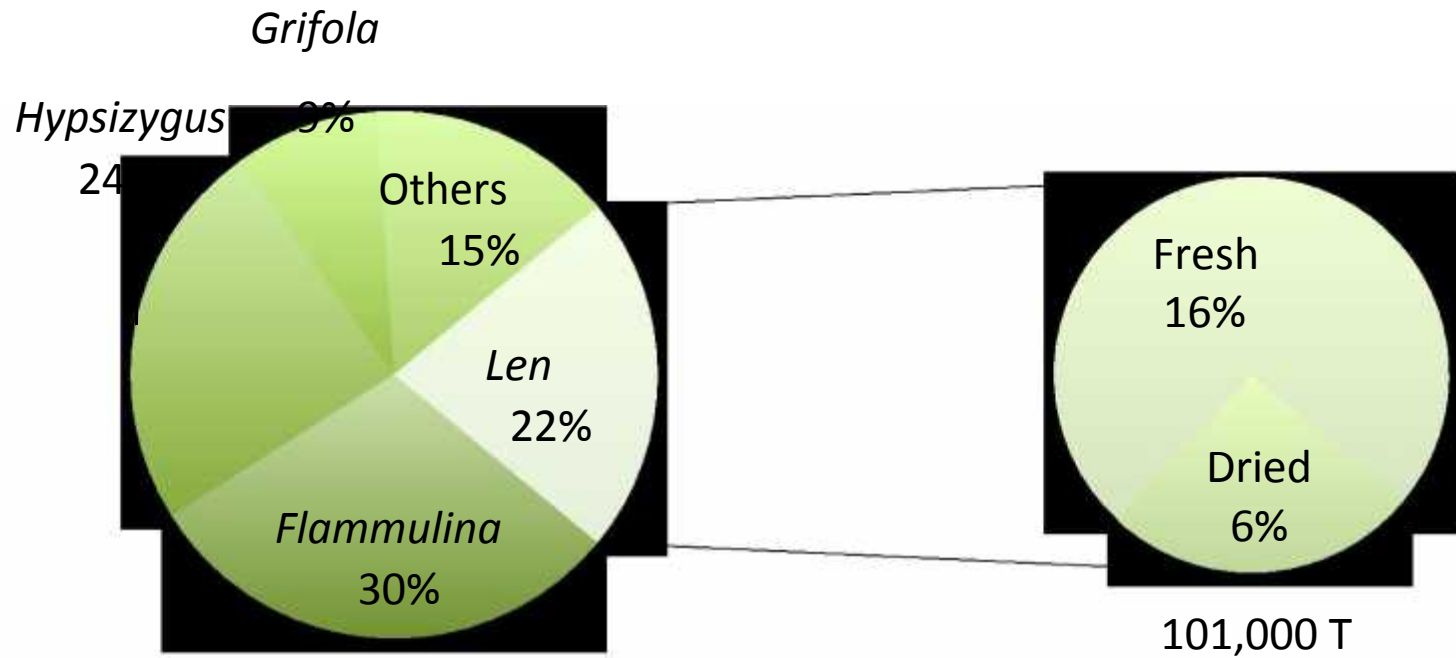
Shiitake - China



- 4 million tons
- 90% of total world produc
- Ene communis
lied from poverty
- Excellent quality
- Logs exported to USA
- Harvest one flush –
discard (550 g)

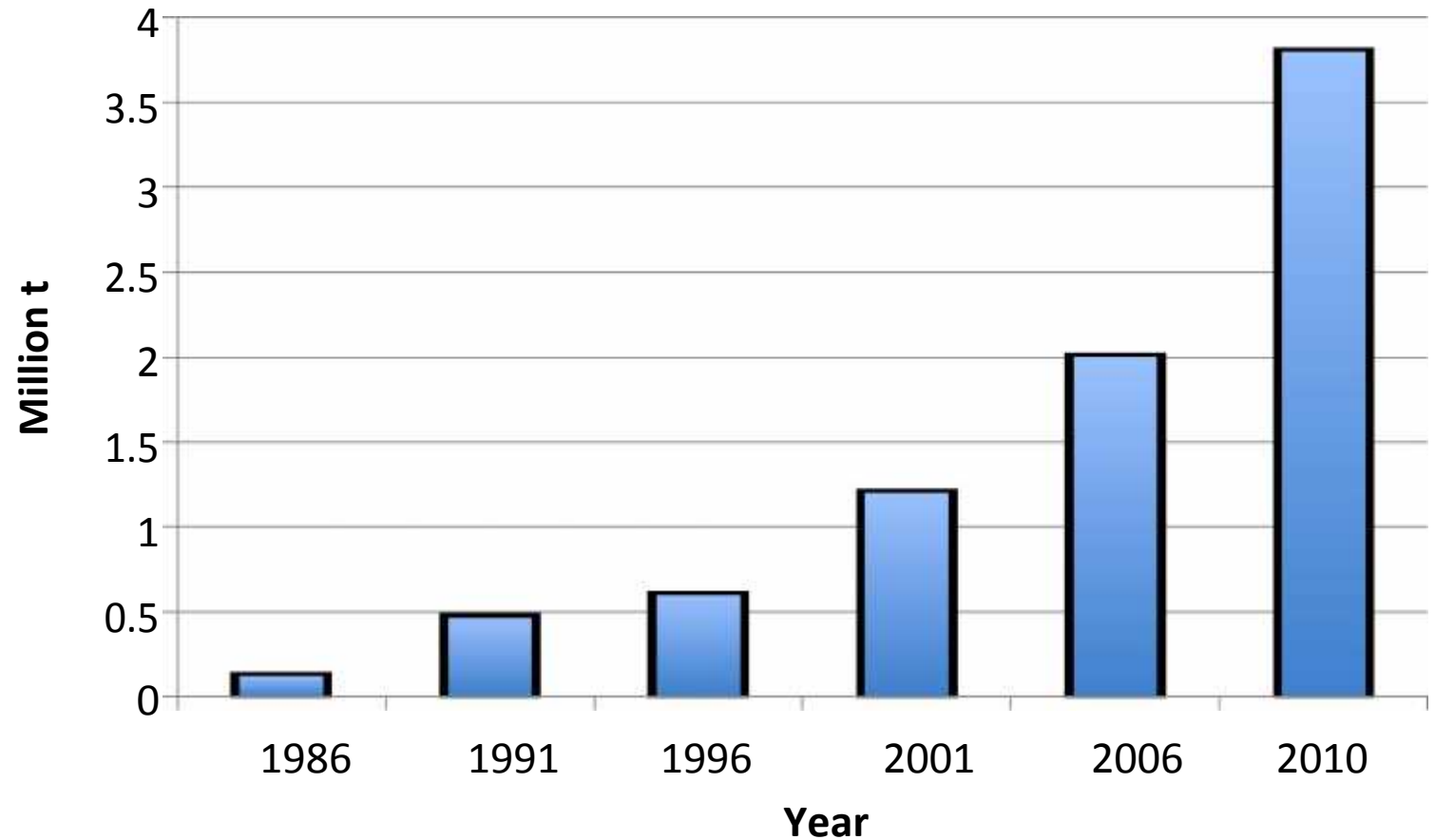
Shiitake - Japan

461,107 T



Yamanaka 2009

Growth in World *Auricularia* spp. Production (1986-2010)



Auricularia sp. – China

- Major producer
 - 3.6 million tons
- Earliest cultivated mushroom
- Two species
 - *A. auricula*, *A. polytricha*
- Domesticon of wild type strains selected for season, locaon



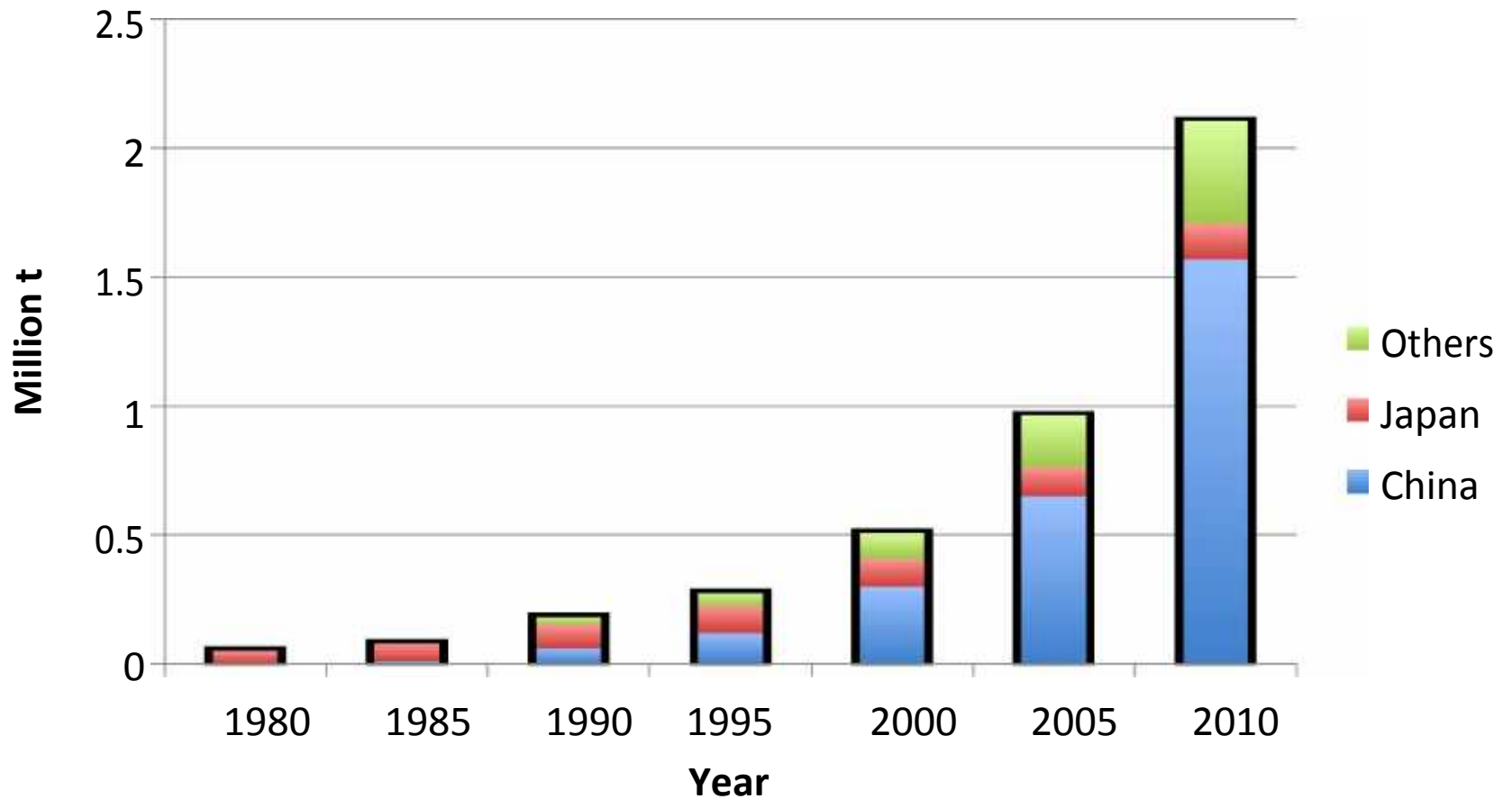
Auricularia sp. - China



Auricularia sp. - China

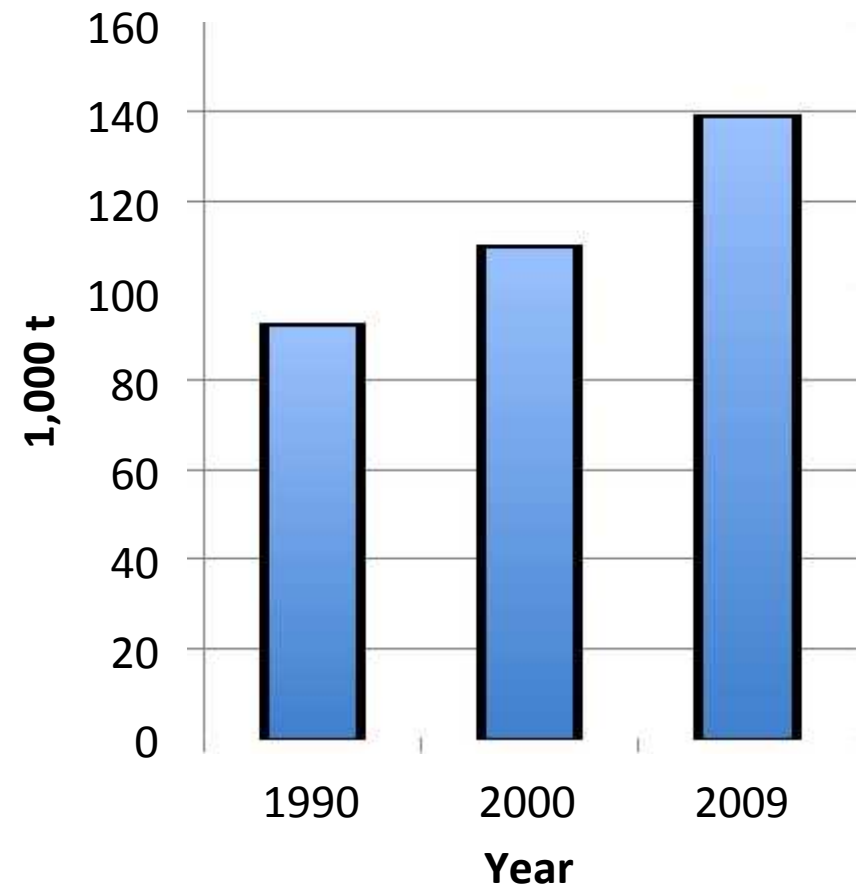


Growth in World Production of *Flammulina velu* (1980-2010)



Flammulina - Japan

- 50% increase 1990- 2009
- On sawdust or corncobs
- Boes



Flammulina - China

- 1995 to 2010
- +1,208%
- Many new farms in last 5 y
 - Bole technology
- One farm produces 60 t/d
 - Equivalent to 6% of Japan total producon
 - 80% for domesse
 - 20% export
 - Southeast Asia and Europe



Outlook

- Mushroom consumption/production increasing worldwide – industry continues to expand
- Increasing trend toward mechanization and bulk handling of materials
- Consumers look to mushrooms to help satisfy their need for a healthy diet – while enjoying the culinary characteristics

