POPLAR IS POPULAR: A SUCCESS STORY OF TREE INTRODUCTION IN CHINA

Ming Xiu Wang and Fan H. Kung[1]

ABSTRACT.--Populus deltoides clones were introduced in China in 1972. Clonal tests from six plantations indicated that two American cultivars "Harvard" and "Lux" and a hybrid "San Martino" were superior to other introduced clones in growth and survival. Large scale aforestation with these selected clones started in 1980 among the flood plains of the Yellow River and Yangtze River. More than 135,000 hectares of cottonwood were planted as clonal forestry and no less than 100 million trees were planted along river-sides, road-sides and country-sides as windbreaks and shade trees. Most trees grow 2.5 to 4 meters in height and 3 to 5 cm in diameter per year. Survival rate within the recipient region are 60 to 100 percent. Based on a 10-year rotation, the profit ratio is 11.6 for the poplar plantation. A present value of $6,689 per hectare is attainable when soybean is interplanted with cottonwood. Further introduction of American clones and hybridization between P. deltoides and P simonii are being investigated.

Additional keywords: Populas deltoides, Agroforestry, Clonal forestry.

INTRODUCTION

The region of east central China has a warm temperate climate and abundant precipitation. Although ecologically the region is classified as deciduous and evergreen hardwood forest, no fast growing native timber species are suitable for planting. In order to meet the need of forest products in the populated region, poplar clones were introduced.

Poplar introduction was initiated in the 50's. More than 200 clones have been tried. Rigorous clonal tests started at the Nanjing Forestry University in 1972. Based on the growth rate, pest resistance and field adaptability in the nursery, 10 clones were initially screened out for clonal test in six locations.

Among the top 10 tested here were two clones from the United States: the 1-63 and 1-69. Clone 1-63 was originated from Stoneville, MS and the clone 1-69 was from Massac County in southern Illinois. These two American clones were also included in the final five selections:

1-63 (Populus deltoides Bartr. var. deltoides cv. "Harvard", ex. 1-63/51)
1-69 (P. deltoides Bartr. var. deltoides cv. "Lux", ex. 1-69/55)
1-72 (P. X euramericana (Dude) Guinier cv. "San Martino", ex. 1-72/58)
1-214 (P. X euramericana, 1-214)
1-45 (P. X euramericana 1-45).

[1] President, Nanjing Forestry University, Nanjing, China and Professor, Department of Forestry, Southern Illinois University, Carbondale, IL USA 62901.

In this paper we will report the distribution range of the imported clones, the climate and the planting techniques that lead to the successful large scale aforestation, and finally the superior survival and growth rate which make possible a great improvement of the rural economics for east central China.

DISTRIBUTION

The present poplar planting area marks its north extreme at 38 degrees north latitude along the northern bank of the lower reaches of Yellow River in the Shandong province and cuts it south boundary at 25 degrees north latitude at Chen County in the Hunan province. The limiting factors probably are low temperature in the north and rugged topography in the south.

Areas where the planting is relatively concentrated are the south-eastern part of Shandong, the eastern part of Henan, the northern part of Jiangsu, the south-eastern part of Hubei, and the northern part of Hunan (Figure 1).

Cultivation of the American clones 1-63 and 1-69 has been centered mainly in two general zones; the alluvial areas flooded by the ancient Yellow River, and the alluvial plains along the middle and lower reaches of Yangtze River. In the delta areas, poplar plantations are almost exclusively of Euro-american hybrids.

From 1980 to 1983, more than 68,000 hectares were planted in Jiangsu, Hunan and Hubei and another 67,000 hectares in other provinces.

AGROFORESTRY

The east-central region is one of the most populated regions in China. Economics of land use is of great importance. All arable lands are devoted to crop production and the role of forestry is to support the farming system. Poplar trees are planted as farmland shelterbelts, windbreaks, and sandbreaks. They are compatible with the rice cultivation as well as peanut, sweet potato and wheat farmings.

Cottonwood is also planted along country roads. It stabilizes the shoulders of the road and is good practice for soil and water conservation. Soil compaction on the road bed seems to have no adverse effect on the survival and growth of these trees as compared to those grown in the forest condition. It may be that better soil fertility and wider spacings have made up for the loss in growth due to soil compaction.

In order to protect the waterfronts, cottonwood is planted along river-sides and lakesides. The economic return of the cottonwood is far greater than that of willows.

Around the villages and houses, cottonwood is a favorable shade tree. Thus, cottonwood is used for the so-called "4-sides planting" in the agricultural areas: river-sides, road-sides, country-sides and house-sides. In the Jiangsu province alone, more than 95 million cottonwoods were used for the "4-sides planting."

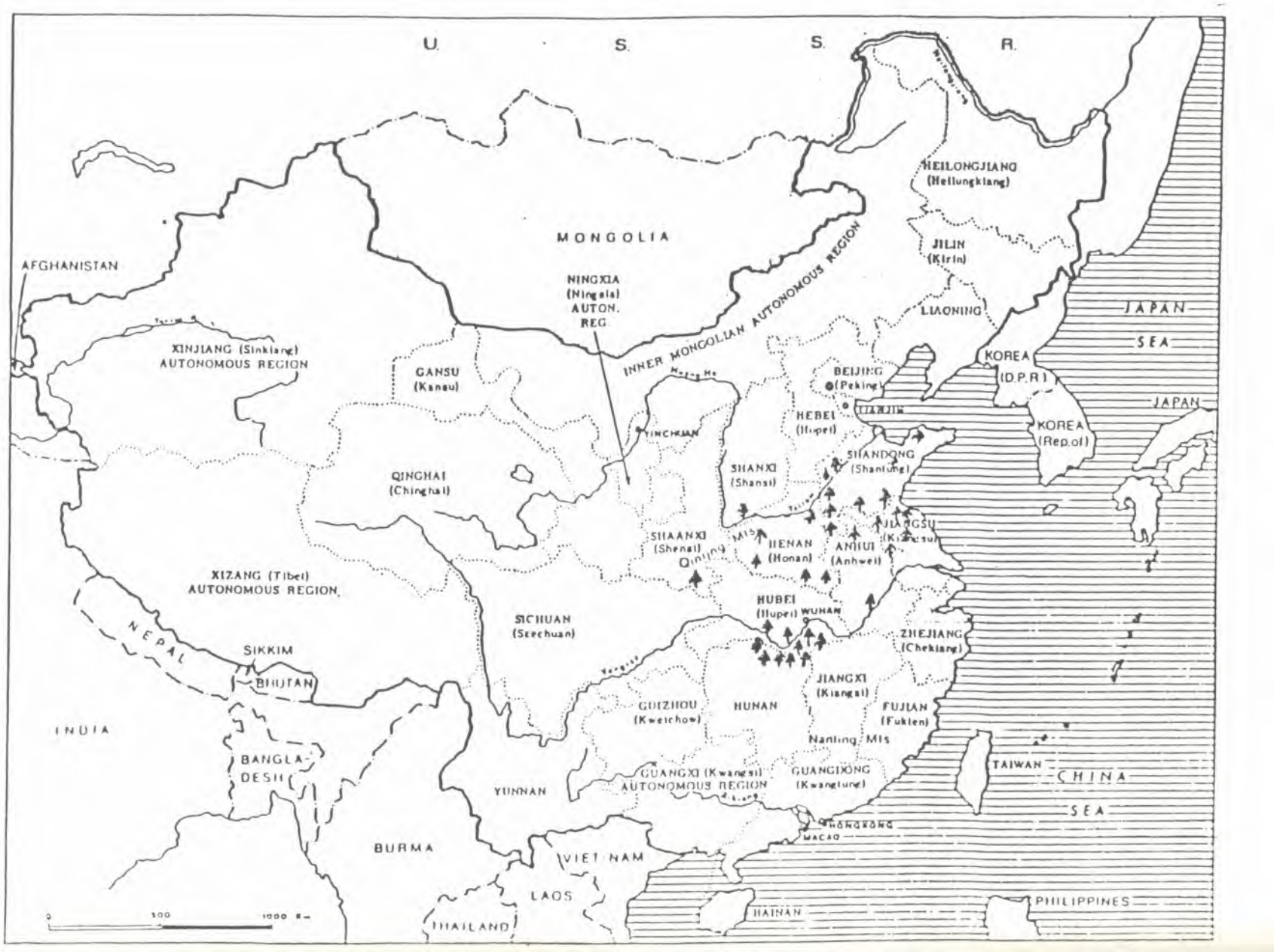

Figure 1. Poplus introduction in China. 4 = planting areas.

SURVIVAL

Survival rates for poplar cones were 90-100 percent in Jiangxi, Hunan and Hubei and 60-85 percent in Jiangsu and other northern provinces (Lu and Xu 1980). Severe cold damages were found in areas north of 37 degrees of latitude. The American clones could not stand the sub-zero temperature of -20 C, but the hybrid 1-214 seemed to be winter hardy.

The American clones 1-63, 1-69 and the hybrid 1-72 were resistant to flood. In the summer of 83 when the water levels of Yangtse River and Dongting Lake broke the 100-year record many plantations were flooded. In one extreme case, there were 5,000 hectares of 2 year old young poplar trees immersed in 6 meters of flood water for 75 days. No adverse effects of flooding were found on the poplar trees. On the contrary, they even obtained a certain among of growth.

No severe insect and disease damages were observed among the introduced poplar trees.

GROWTH AND YIELD

Field planting in Jiangsu, Zhejiang, Shandong, Henan, Jiangxi, and Hubei provinces indicated that the selected clones were far superior to the existing commercial forest species in the region. At age 10, the height growth of the poplar clones was 1.7 to 7.6 times the height of the native trees, while in diameter, 4.1 to 12.1 of the local species (Table 1).

Table 1.--Comparison of growth between the selected clones and the existing species.

Species	Height at age		Diameter at age	
	5	10	5	10
	- - -m - - -		- - - cm - - -	
Populus deltoides	16.5	25.0	24.4	43.6
Pinus massoniana	1.3	3.6	-	3.6
Cunninghamia lanceolata	2.3	6.6	1.7	8.3
Robinia pseudoacadia	-	14.6	-	10.6
Eucalyptus citriodora	9.3	12.1	3.8	9.3

The American clones compared favorably to other poplar introductions. The 1-63 and 1-69 were taller but the 1-72 was larger in diameter. In terms of volume, clone 1-72 was the top in 3 out of 4 testing plantations, whole clone 1-63 was the best in Huailin, Jiangsu (Table 2).

At the spacing of 8m x 8m or density of 156 trees per hectare, the American clones reached an average height of 30 m a diameter of 43 cm and a

single tree volume of 1.66 cubic meters at age 10. The mean annual volume increment for the two American clones was 26 cubic meters per hectare per year but the hybrid 1-72 was 5 cubic meters more.

Table 2.--Growth and yield of poplar clones in central China.

Plantation	Degrees of Lat.	Degrees of Long.	Age	Clone	Total growth Ht.	Total growth Dia.	Total growth Vol.	Mean Annual Increment
	N	E	Yr	No.	m	cm	m^3	m^3/ha Yr
Siyang, Jiangsu	33.7	118.7	10	I-63	29.0	43.8	1.64	25.6
				I-69	31.0	42.9	1.68	26.1
				I-72	28.9	48.2	1.98	30.9
				I-214	26.5	41.5	1.36	21.2
Huailin, Jiangsu	33.4	119.4	8	I-63	27.5	44.5	1.61	31.5
				I-69	26.4	38.3	1.15	22.5
				I-72	26.3	44.9	1.58	30.8
				I-214	23.0	39.8	1.10	21.4
Hanshou, Hunan	28.8	112.0	7	I-63	25.5	36.2	1.00	22.3
				I-69	24.9	35.8	.95	21.3
				I-72	24.1	37.9	1.04	23.1
				I-214	17.9	28.5	.45	10.1
Quangiang, Jiangxi	30.2	112.7	4	I-63	18.2	23.8	.32	16.3
				I-69	18.2	23.9	.33	16.5
				I-72	17.6	25.8	.37	18.7

The rotation age for clones I-63 and I-72 can be set as early as 8 years and for clone I-69, 10 years.

ECONOMICS

The ancient courses of Yellow River in the northern part of Jiangsu, Anhui and Henan were once the "dust bowl" of China. Now, the annual fearsome dust storms in March-April may soon become a passing event in history. Since 1980, more than 95 million cuttings of poplar were planted in the region as windbreak and more than 50,000 hectares as commercial forest in the region. As the result of aforestation, conservation of soil and water was greatly improved and damage reduced. It is possible to double the crop yield, triple the cotton yield, and quadruple the personal income for the farmers.

The balance sheet for commercial cottonwood forest can be described as follows. The initial investment is about $500 per hectare, excluding land cost. Based on a farm loan interest rate of 4.8 percent and a 10-year rotation, the final value for investment comes up to $760. A conservative

estimate of stumpage price of $53 per cubic meter and a harvest cut of 180 cubic meter gives a gross income of $9,540, or a net income of $8,780 per hectare at the end of the rotation. The operating ratio therefore is $760/$9,540 = 1/12.6 and the profit ratio is $8,780/$760 = 11.6. The profit ratio is considerably higher than that for soybean (0.75). From the final value ($9,540), we can compute the gross annual revenue from the cottonwood plantation as $872 per hectare.

Interplanting between cottonwood and soybean created a new ecosystem on the once barren sandy plains and a rewarding operation for the farmers. The trees are planted at a spacing of 8 meters or 156 trees per hectare. With such wide spacing the farmer can economically plant soybean in between trees for four to five years. With the price of soybean at $0.48/kg in China, the gross income per hectare can reach $691 at the first year and decrease to $432 in the fourth year (Table 3). The profit margin for soybean farming is about $0.20/kg. The total profit for interplanting at the end of 10 years is calculated at $10,200 per hectares with $1,420 coming from soybean and $8,780 from cottonwood. Given a 4.8 percent farm loan interest rate, the net annual payment to the farmer is $932/hectare with $130 from soybean and $802 from trees (Table 3). The present value for the interplanting is $6,689 per hectare which is equivalent to $2,675 per acre.

Table 3.--Yield and income per hectare from interplanting soybean and poplar.

	Yield		Gross Income		Profit	
	Soybean	Poplar	Soybean	Poplar	Soybean	Poplar
Age	kg	m^3	$	$	$	$
1	1440	-	691	-	288	-
2	1350	-	648	-	270	-
3	1260	-	605	-	252	-
4	900	-	432	-	180	-
10	-	180	-	9540	-	8780
Final value at age 10*			3409	9540	1420	8780
Present value*			2236	6232	931	5758
Annual payment**			312	872	130	802

*Based on compound interest rate of 4.8 percent.
**in 10 installments.

DISCUSSION

The survival rates of the introduced poplar clones in east-central China were similar to those in southeastern U.S. Baker (1973) found that the survival rate of the eastern cottonwood on an abandoned field in the Mississippi Delta ranged from 67 to 85 percent. Higher survival was due to summer fallowing. Within the recipient region in China, the southern plantations usually had a survival rate of 90-100 percent, and, the northern plantation, 60-85 percent.

The growth rates of the American clones 1-63, 1-69 and the hybrid 1-72 planted in China were greater than the growth rates of the best selections planted in the U.S. The annual increment in diameter for the best clones in the Mississippi Valley was about 2.5 cm (White and Carter, 1970; Randall, 1973). In China, it is usually from 4.5 to 5.3 cm. The reason for the faster growth in China probably is the result of the more abundant rainfall during the growing season (700-900 mm from April to September) and the greater depth of top soil (50 to 100 cm).

Looking into the future, we should keep on introducing the new selections which may outperform clones 1-63, 1-69 and 1-72 in east-central China. One of the possibility is the Stoneville selections. Since the Stoneville selections outgrew the local poplar trees in Cairo, Illinois (Randall, 1973), we would expect that clone 1-69, which came from southern Illinois, could be replaced by the Stoneville selections. According to Cooper and Ferguson (1979) the four best clones,ST-66, ST-69, ST-70 and ST-72, had a volume at age 14 averaged 74 percent better than the random population on silt loam soil and 65 percent better on clay soil. These four Stoneville should have great potential to enrich the poplar introduction program in China.

We are also interested in poplar trees which may be useful for planting in the northwestern part of China. The tree to be introduced should grow well in the following climate: annual rainfall = 600-700 mm, average temperature = 12-13 C, and minimum temperature = -22 C. Possible candidates from the NC-51 Regional Cooperative cottonwood provenance and progeny test (Houston 1979) are being considered.

Hybridization between P. deltoides and P. simonii has been carried out in the Nanjing Forestry University for the last five years. The goal is to obtain more vigorous hybrids resistant to drought and cold weather for planting in poorer sites of the remote regions.

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