Black Walnut In The United States

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ABSTRACT: -- The current situation of black walnut (Juglans nigra L.) in the United States related to area, volume, growth, mortality, and removals is presented. As of the most recent inventories, there were more than 15 million acres of timberland with black walnut present, 95 percent of which is privately owned. The majority of the black walnut timberland was classed as sawtimber. Growing-stock and sawtimber volume almost doubled between 1963 and 1989. The long-term future for black walnut appears bright due to favorable growth to removal ratios. Aspects of black walnut nut production in relation to the resource are presented.

GROWER RECOMMENDATIONS

Currently, nut production is a secondary consideration of most timberlands with black walnut (Juglans nigra L.) present. Plantations represent only one percent of the total black walnut resource throughout the Nation. Black walnut plantations specifically designed for nut production represent only a fraction of the total black walnut plantations. While the black walnut resource is growing, there has not been a focus on managing this resource for nut production. Demand for black walnut nuts has consistently met or exceeded supply due to the consistently growing demand and inconsistent availability of the nuts produced.

The supply of black walnut nuts and timber would be enhanced if establishment and management were focused on sites with high potential productivity. With the majority of black walnut timberlands owned by non-industrial private landowners, the future supply is dependent on land management goals that include nut and timber production. Private landowners own land for many purposes, if improving the quantity of both black walnut nuts and wood fiber is of high priority, public agencies could target these landowners for increased management, technical assistance, and cost-share programs.

Tree distribution records of state forestry agencies show that more than 3 million black walnut seedlings have been annually distributed throughout the eastern United States in 1990's (Johnson 1995). In addition, there are many private nurseries that distribute black walnut seedlings. To date, plantations have not made a significant impact on the supply of black walnut nuts or timber. However, if this level of planting continues, if the plantations are adequately managed, and if they are planted on productive sites, plantations have the potential to improve the future supply of black walnut nuts and wood fiber. The number of black walnut trees has consistently increased, growing-stock volume has consistently risen, the number of plantations has increased, and demand for nuts and fiber has consistently risen. If this growing resource is adequately managed, questions about the long-term supply of black walnut for both nuts and timber will be answered.

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INTRODUCTION

Black walnut, one of the most highly valued hardwood species, is found throughout most of the eastern half of the United States (Harlow and Harrar 1969). The species is not dominant in most forests, but rather is generally found as scattered single trees or as small isolated groups within hardwood stands (Fischer 1982). Black walnut has a large geographical range but a narrow range of suitable sites where it can grow at an adequate rate.

Since the late 1800's, the supply of black walnut has been a topic of concern. The concern for black walnut has been centered on high quality, large diameter trees but the supply of black walnut nuts has also received attention. In 1880, a Purdue University professor reported that about 85 percent of the black walnut resource in Indiana had been disposed of (Frye 1982). Foresters concerned about the supply of black walnut have historically urged an increase in the management and planting of black walnut (Quigley and Lindmark 1966, Adams 1981). In an address to the Third Black Walnut Symposium, R. Max Petersen recognized that while, for most hardwoods, growth significantly exceeded demand, the situation was quite the opposite for black walnut (Petersen 1982). He estimated that demand for black walnut had been greater than supply for many years and that the gap between demand and supply was projected to widen at an ever increasing rate. From a nut production perspective, demand has consistently met or exceeded supply.

Inventory results from the 1970's seemed to confirm the concerns expressed by forest industries, foresters, and landowners. For example, in Missouri black walnut growing stock decreased from 100 million cubic feet in 1959 to 97 million cubic feet in 1972, and sawtimber decreased from 238 million board feet to 217 million board feet in the same time period (Spencer and Essex 1976). In Iowa, black walnut growing-stock volume decreased by more than a third from 1954 to 1974, going from about 52 million cubic feet to about 32 million cubic feet (Spencer and Jakes 1980). Similar examples of decreasing black walnut volumes in the 1960's and 1970's could be provided for many other states.

Plantations have been viewed as a means to increase the supply of black walnut. While black walnut plantations have not met the expectations of either the producing landowners or the utilizing industries from a timber production standpoint (Schmidt and Kingsley 1997), they do hold great promise for increasing nut production. In light of the many concerns about black walnut, it is important to understand and evaluate black walnut's current status.

METHODS

Data for this paper are from the USDA Forest Service, Forest Inventory and Analysis' (FIA) Eastwide Data Base (EWDB) which contains the most recent statewide forest inventory for each state (Hansen et al. 1992). Data presented pertain only to timberland, however, more than 95 percent of the forest land in the United States is classified as timberland (Powell et al. 1993). Timberland is forest land capable of producing more than 20 cubic feet per acre per year of industrial wood crops under natural conditions and not withdrawn from timber utilization. There are other classifications of forest land that contain black walnut, including reserved forest land, narrow planted and natural wooded strips, and pasture land with trees that do not meet the timberland definition. Significant amounts of black walnut occur on these non-timberlands and they make important contributions to not only the nut and timber supply of black walnut, but also to other forest related benefits. It has been estimated that the majority of the harvested black walnut

nuts come from either open-grown forests, pastures with black walnut present, or plantations. The amount of black walnut on non-timberland has been estimated to range from 5 to 25 percent of that found on timberlands. Until recently, FIA did not install field plots on these other lands and, as a result, data are very limited for forestland classifications other than timberlands.

Black walnut is not a recognized forest type but is included within several forest types. Black walnut is a common associate of five forest cover types and is also found as an occasional associated species in four other forest cover types recognized by the Society of American Foresters (Williams 1990). Area data are generated from FIA tree-level records and are based on the existence of at least one 5 inch d.b.h. (diameter at breast height) or larger black walnut within an established FIA field plot. Area data for each state in the black walnut range are generated by this method for ownership, stand-size class, and site productivity class. For stand-size class determinations, sawtimber sized stands are stands with half or more of the total live tree stocking in trees that are at least 11 inches d.b.h. Growing-stock volume is the net volume in cubic feet of growing-stock trees 5.0 inches d.b.h. and over, from 1 foot above the ground to a minimum 4 inch top diameter outside bark (d.o.b.) or to the point where the central stem breaks into limbs. Sawtimber volume, a subset of growing-stock volume, is the net volume in board feet (International 1/4 inch rule) of the saw-log portion of live sawtimber sized trees from 1 foot above ground to a minimum 9 inches top d.o.b.

Dates of the most recent statewide inventories range from 1981 in Kansas to 1993 in Michigan. To determine the average most recent FIA inventory date for black walnut, the inventory year for each state was multiplied by the percent of the total national growing-stock volume represented by each state. This resulted in an average inventory date of 1989. By comparison, Quigley and Lindmark referenced the 1962 appraisal of the timber resources of the United States. Thus, comparisons over time are based on average inventory dates of 1962 and 1989, a 27-year time span.

To estimate the volume of timber produced from timberland, FIA units conduct direct mail canvasses of the mills that process the timber. There are two sources of black walnut timber products: those from timberland and those from lands not considered timberland such as nonforest area with trees, fence rows, and other lands. Thus, it is conceivable that the total volume of products removed can exceed the total volume of growing stock removed. If the total volume harvested was significantly greater than the growing-stock volume removed, it can be assumed that a significant volume was produced from non-growing stock sources (as is often the case).

RESULTS

Area

The most recent inventories indicate more than 15.4 million acres of timberland with black walnut present (Table 1). Of these acres, 99 percent occurred in natural stands and 1 percent was in plantations. Black walnut plantations generally are small, scattered acreages. While the majority of the black walnut plantations were located in Ohio, Kentucky, and Illinois, several additional states have plantations specifically designed for nut production.

Table 1.--Area of timberland with black walnut by ownership class.

Most Recent	Ownership class					
	National	Misc.	Other	Forest	Private	Private

State	Inventory	Total	forest	federal	Public	Industry	individual	corporation
					(Thousand acres)			
Missouri	1989	2,569.7	101.1	76.0	50.9	8.3	2,124.3	209.1
Kentucky	1988	1,971.2	46.1	-	15.5	10.3	1,770.3	129.0
Ohio	1991	1,759.8	26.8	-	46.6	19.0	1,532.3	135.1
West Virginia	1989	1,357.8	4.6	7.2	22.1	54.9	1,103.7	165.3
Tennessee	1989	1,234.6	7.7	36.2	11.5	59.7	1,088.3	31.2
Indiana	1986	1,064.2	12.9	31.4	27.5	1.9	907.6	82.9
Illinois	1985	941.5	20.1	-	15.8	4.0	853.1	48.5
Pennsylvania	1989	708.7	-	5.3	5.8	5.5	636.0	56.1
Virginia	1991	577.5	15.8	13.5	10.8	15.2	461.4	60.8
Iowa	1990	536.0	-	6.1	17.9	-	484.5	27.5
Kansas	1981	472.7	-	15.3	1.0	3.4	427.3	25.7
Arkansas	1988	451.4	52.0	6.3	6.2	9.7	343.8	33.4
18 other states		1,769.7	6.6	38.1	82.2	69.3	1,468.3	105.2
Total all states		15,414.8	293.7	235.4	313.8	261.2	13,200.9	1,109.8

There are 30 states with naturally occurring black walnut, however, the walnut resource is not evenly distributed across the Nation. For example, 50 percent of the total timberland area in the United States with black walnut occurred in only 4 states--Missouri, Kentucky, Ohio, and West Virginia (Fig. 1). Twelve states, mostly in the Central Hardwood Region, accounted for almost 90 percent of the total area of timberland with black walnut present.

Comparing the area of timberland with black walnut present to the total area of timberland, Kansas ranks first with almost 40 percent of its timberland having black walnut present. Other states with high percentages of timberlands with black walnut present include Iowa, Indiana, Illinois, Ohio, Missouri, Kentucky, West Virginia, and Nebraska. In these states, at least 10 percent of the total timberland area contain black walnut. By comparison, Pennsylvania was 8th in total area of timberland with black walnut (709 thousand acres) but this was less than 5 percent of their total timberland area (15.9 million acres).

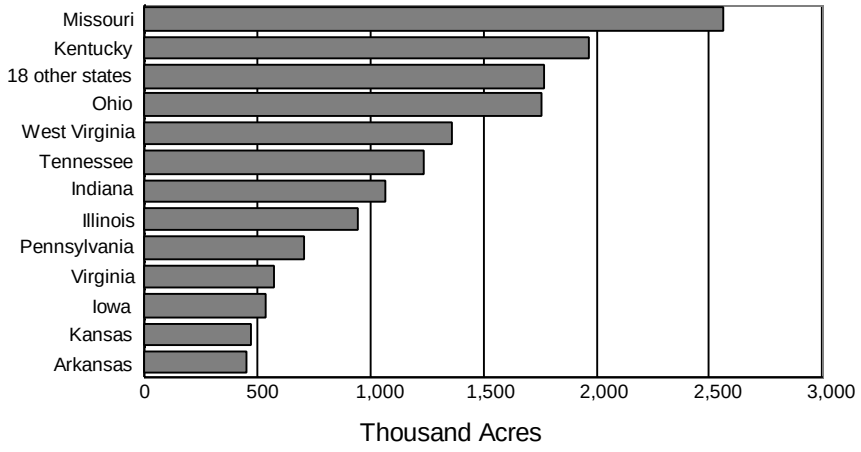

Figure 1. Area of timberland with black walnut present from most recent inventories, by state.

In the most recent inventories, 58 percent of the timberland with black walnut was in sawtimber-sized stands, 28 percent was in poletimber-sized stands, and 14 percent was in sapling-seedling sized stands (Fig. 2). All thirty of the states had the most timberland area with black walnut present in the sawtimber-size class (Table 2). These data represent the average stand size determined from the dominant trees in the stand, black walnut might or might not have been the dominant trees. However, since black walnut seedlings are intolerant of shade and are seldom found under dense tree canopies (Williams 1990), the black walnut size class should be similar to that of the overall stand.

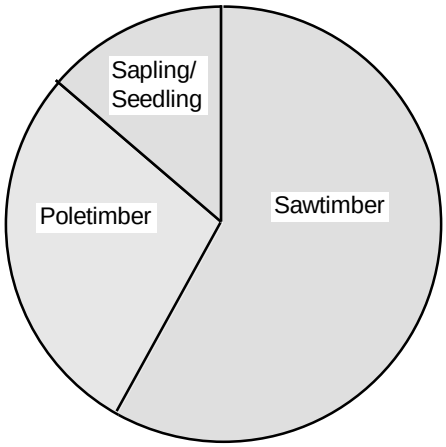

Figure 2. Size class distribution of timberland area with black walnut present.

Table 2.— Area of timberland with black walnut by stand-size class.

		Stand-size class		
State	Total	Sawtimber	Poletimber	Sapling-seedling
		(Thousand acres)		
Missouri	2,569.7	1,293.8	875.4	400.5
Kentucky	1,971.2	1,041.4	648.6	281.2
Ohio	1,759.8	1,012.3	420.1	327.4
West Virginia	1,357.8	774.1	442.8	140.9
Tennessee	1,234.6	659.8	401.3	173.5
Indiana	1,064.2	749.7	176.2	138.3
Illinois	941.5	668.0	173.1	100.4
Pennsylvania	708.7	400.1	236.4	72.2
Virginia	577.5	389.5	143.0	45.0
Iowa	536.0	390.1	107.7	38.2
Kansas	472.7	234.2	113.4	125.1
Arkansas	451.4	196.5	186.6	68.3
18 other states	1,769.7	1,130.9	437.7	201.1
Total all states	15,414.8	8,940.4	4,362.3	2,112.1

Almost 70 percent of the black walnut timberland acreage were located on the two lowest productivity classes (Table 3). Less than 10 percent of the black walnut timberland was classified as being on sites with very high to excellent productivity potential (120 + cubic feet of growth per acre

per year). However, there were a few states with significant acreages of black walnut timberland on the higher productivity sites. For example, more than 60 percent of the black walnut timberland in Indiana was located on sites with a potential productivity of at least 85 cubic feet per acre per year. From a nut production perspective, it is critical that plantations be located on the highest productivity sites possible.

Table 3.--Area of timberland with black walnut by site productivity class.

		Productivity class (cubic feet of growth per acre per year)				
State	Total	165+	120 -164	85 -119	50 -84	20 -49
			(Thousand acres)			
Missouri	2,569.7	15.4	28.9	207.9	1,289.0	1,028.5
Kentucky	1,971.2	-	149.9	353.6	605.8	861.9
Ohio	1,759.8	-	58.9	159.9	405.5	1,135.5
West Virginia	1,357.8	-	139.3	404.3	362.6	451.6
Tennessee	1,234.6	52.3	184.0	316.6	485.1	196.6
Indiana	1,064.2	-	206.1	449.6	298.4	110.1
Illinois	941.5	-	47.5	382.8	408.5	102.7
Pennsylvania	708.7	-	65.7	107.9	198.4	336.7
Virginia	577.5	4.6	15.1	158.4	356.3	43.1
Iowa	536.0	3.2	5.8	181.1	260.6	85.3
Kansas	472.7	-	2.1	67.4	220.5	182.7
Arkansas	451.4	4.8	0.0	40.0	280.3	126.3
18 other states	1,769.7	117.2	183.5	539.6	670.4	259.0
Total all states	15,414.8	197.5	1,086.8	3,369.1	5,841.4	4,920.0

Number of Trees

In the most recent inventories, there were almost 500 million black walnut growing-stock trees in the United States (Table 4). More than 90 percent of these trees were located in twelve states. Of the half billion black walnut growing-stock trees, two-thirds were less than 5 inches d.b.h. In the most recent inventories, only 8 percent of the total number of black walnut growing-stock trees were larger than 11 inches d.b.h., considered the minimum size necessary for being classified as sawtimber. Only one percent (5.4 million) of all of the black walnut growing-stock trees in the United States were larger than 17 inches d.b.h.

Table 4.– Number of black walnut growing-stock trees by diameter class.

Diameter class (inches d.b.h.)

State	Total	1.0 -4.9	5.0 - 8.9	9.0 - 12.9	13.0 - 16.9	17.0 - 20.9	21.0 +
				(Thousand trees)			
Kentucky	94,453	70,875	14,854	6,507	1,732	410	75
Ohio	76,552	58,244	9,770	5,386	2,408	669	76
West Virginia	63,123	50,553	7,020	3,541	1,544	394	71
Pennsylvania	57,385	46,210	7,051	2,528	1,221	297	77
Missouri	50,936	33,580	9,860	5,417	1,668	376	36
Illinois	26,397	14,548	7,339	2,904	1,240	270	97
Indiana	22,715	11,900	5,686	3,208	1,489	375	56
Kansas	20,969	13,163	4,430	2,406	756	173	41
Iowa	13,677	8,238	2,351	1,920	867	272	29
Virginia	11,413	3,254	3,501	3,000	1,233	335	90
Tennessee	10,732	1,669	4,532	3,242	1,065	194	30
Michigan	7,968	3,470	2,494	1,343	468	160	34
18 other states	43,306	22,064	11,769	6,670	2,083	566	154
Total all states	499,625	337,768	90,657	48,071	17,773	4,491	865

In addition to the half billion black walnut growing-stock trees, there were 91 million non growing-stock black walnut trees (typically rough or rotten trees classified as cull) on timberland in the most recent inventories. Estimates of the number of black walnut trees on non-timberland run as high as an additional 125 million trees. These trees represent an important source of nuts. Black walnut trees in these more "open-grown" conditions tend to have a higher nut production level when compared to trees growing in the more heavily stocked timberland situations. Kentucky, with almost 95 million trees, had the greatest number of black walnut growing-stock trees, almost 20 percent of the total number of black walnut growing-stock trees in the Nation. Ohio, West Virginia, Missouri, and Pennsylvania all had more than 50 million black walnut growing-stock trees.

The number of black walnut trees has been increasing. In Missouri, the number of black walnut trees increased from about 21 million in 1972 to more than 50 million in 1989. In Iowa, the number of black walnut trees doubled from 1974 to 1990, increasing from 7 million to almost 14 million. Similar increases occurred in most of the other states. Although increases occurred in all diameter classes, the majority of the increase in number of black walnut trees was in the smaller diameter classes.

Volume

In 1962, there were more than 1 billion cubic feet of black walnut growing-stock volume on timberland in the United States, 41 percent of which was sawtimber volume (Quigley and Lindmark 1966). In the most recent inventories, there were almost 1.6 billion cubic feet of black walnut growing-stock volume, 41 percent of which was sawtimber (Table 5). This was a 60 percent increase in total volume from 1962 to 1989, representing an average increase of about 22 million cubic feet per year. Interestingly, the ratio of sawtimber volume to growing-stock volume remained about the same between the two time periods.

In addition to the black walnut volume found on timberlands, there are large quantities growing in pastures, narrow wooded strips, and other areas not classified as timberland. As previously

mentioned, these areas are not included in the volume estimates but they do contribute to the overall supply of black walnut nuts and wood fiber in the United States.

Table 5.--Volume of black walnut growing stock by diameter class.

		Diameter class (inches d.b.h.)								
State	Total	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21+
		(Million cubic feet)								
Ohio	183.6	13.5	21.2	29.1	36.0	36.4	18.0	15.4	10.0	4.2
Kentucky	183.3	19.6	33.2	42.7	27.4	22.8	17.5	11.7	3.6	5.0
Missouri	147.5	11.9	22.4	29.6	26.6	24.5	14.4	11.1	4.8	2.3
Indiana	127.2	7.4	17.1	19.0	23.0	19.8	21.3	10.2	5.9	3.5
West Virginia	123.7	9.7	16.7	22.4	19.9	23.2	13.5	9.8	4.5	4.0
Illinois	119.1	11.5	18.5	16.7	22.7	20.7	11.7	7.9	3.7	5.7
Virginia	115.2	4.1	10.0	21.1	18.3	23.2	11.4	6.3	12.5	8.3
Pennsylvania	100.5	9.5	16.5	13.9	16.1	17.3	10.6	7.2	4.7	4.8
Tennessee	91.3	6.2	11.4	19.3	17.8	14.9	11.3	4.2	3.8	2.3
Iowa	63.8	2.9	4.6	9.4	12.0	13.0	7.7	6.2	5.9	2.2
Kansas	58.4	7.9	6.0	9.6	11.0	8.0	5.9	4.6	2.0	3.4
Michigan	54.4	4.4	6.4	9.4	9.5	8.4	5.7	5	2.9	2.9
18 other states	220.1	14.6	31.3	42.4	40.3	29.3	28.3	14.5	9.6	9.7
Total all states	1,588.1	123.2	215.3	284.6	280.6	261.4	177.2	114.0	73.7	58.1

Only 8 percent of the total growing-stock volume in the United States was in diameter classes larger than 19 inches d.b.h. The majority of the growing-stock volume was in diameter classes from 9 to 15 inches d.b.h., reflecting a resource that has the potential to greatly expand its volume, assuming these medium sized trees continue to mature (Fig. 3). If market pressures increase to where smaller sized sawtimber trees are harvested, the potential for greatly increasing the volume will be diminished.

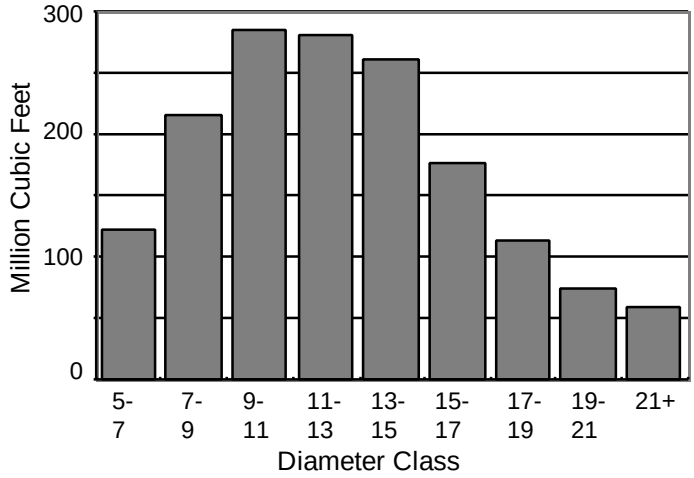

Figure 3. Black walnut growing-stock volume by diameter class.

Ohio and Kentucky had the most black walnut growing-stock volume, each with about 183 million cubic feet (Table 5). These two states accounted for almost one-fourth of the total black walnut growing-stock volume in the United States. While these two states had similar totals, they differed in diameter class distribution. Ohio tended to have more volume in trees 11 inches d.b.h. and greater while Kentucky had more volume in trees less than 11 inches d.b.h.

In 1962, there were an estimated 2.7 billion board feet of black walnut sawtimber (Quigley and Lindmark 1966). As of 1989, there were 4.3 billion board feet of black walnut sawtimber (Table 6). Over the 27-year period between the two estimates, black walnut sawtimber volume increased by almost 70 percent, averaging an increase of about 59 million board feet per year.

Table 6.— Volume of black walnut sawtimber by diameter class.

		Diameter class (inches d.b.h.)					
State	Total	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21+
		(Thousand board feet [1])					
Ohio	510,820	143,700	155,297	82,845	65,743	43,858	19,377
Indiana	427,500	113,062	101,737	111,392	53,600	30,390	17,320
Missouri	398,063	127,338	117,467	68,453	52,050	22,325	10,430
Illinois	368,033	111,592	106,211	61,051	41,740	19,171	28,269
Kentucky	363,548	98,539	90,715	76,189	54,308	18,874	24,924
West Virginia	306,088	71,492	92,027	58,740	40,756	21,305	21,769
Virginia	301,859	62,459	84,257	43,205	25,101	51,009	35,828
Pennsylvania	251,310	59,690	71,349	45,508	31,511	21,880	21,372
Tennessee	244,059	69,949	69,431	54,150	21,012	19,161	10,357
Iowa	223,198	57,822	62,394	36,931	29,077	27,230	9,745
Kansas	170,256	52,427	40,291	30,144	23,267	9,463	14,665
Michigan	160,997	41,073	39,127	27,372	24,518	14,321	14,586
18 other states	570,843	158,613	126,882	120,821	69,986	48,505	46,035
Total all states	4,296,573	1,167,755	1,157,184	816,799	532,668	347,492	274,675

[1] International 1/4 inch rule.

In addition to the sawtimber volume, there are many black walnut trees that are considered "short-log" trees and are not included in the sawtimber volume estimates. To be included in sawtimber volume estimates, a minimum of one 12-foot, or two non-contiguous 8-foot, sawlogs is required. In western portions of the black walnut range, trees often do not reach sufficient height to contain the minimum sawlog requirement. However, industry will use smaller length logs if they meet other quality and size standards. For example, in Nebraska short-log black walnut trees represent an additional 7 percent of the total black walnut sawtimber volume in the state. Many of these trees are of the highest quality and are marketed worldwide. In addition, log-length does not impact the potential nut production capability.

Considering only large trees (>21 inches d.b.h.), Virginia had the most volume followed by Illinois, Kentucky, West Virginia, and Pennsylvania. All five of these states had at least 20 million board feet of sawtimber in the largest diameter class. In Virginia, 29 percent of the total black walnut sawtimber volume in the state was in trees at least 19 inches d.b.h., compared to a national average

of 14 percent. Virginia alone accounts for 14 percent of the black walnut sawtimber volume larger than 19 inches d.b.h. in the Nation. As one compares the sawtimber volumes for smaller diameter classes, other states begin to dominate but Virginia is the current king of large diameter black walnut sawtimber.

Growth, Mortality, and Removals

Black walnut growing stock averaged 55 million cubic feet of gross growth and about 11 million cubic feet of mortality each year across the country in the most recent inventories (Table 7). The result was an average annual net growth rate of 44 million cubic feet, 2.7 percent of the Nation's total growing-stock volume. This annual net growth would provide enough wood to make almost a million desks completely out of black walnut or make a stack of black walnut wood four feet high and four feet wide that would stretch from Springfield, Missouri to Richmond, Virginia.

States with above average annual net growth rates when compared to total growing-stock volume include Kansas, Pennsylvania, Illinois, Iowa, Michigan, and Indiana. Kansas and Pennsylvania led all states, each averaging annual net growth rates that were 3.7 percent of their total growing-stock volume. Missouri and Virginia show the lowest percent of growing-stock growth to total volume ratio in the United States, both having a net growth rate of less than 2 percent. Missouri's lower net growth rate was in-part due to higher than average mortality rates.

Average annual mortality was estimated to be 0.7 percent of the Nation's total black walnut growing-stock volume. Of the known causes of black walnut mortality as identified by FIA field crews, weather related factors and diseases were most commonly reported. Tennessee and Missouri had the highest average annual mortality rates, both being about 1.2 percent of total volume. States with low mortality rates included Iowa, Michigan, Pennsylvania, West Virginia, and Kansas. Iowa's black walnut average annual mortality rate was a mere 0.2 percent of its total growing-stock volume.

Table 7.--Black walnut growing-stock volume and average annual growth, mortality, and removals.

	Growing stock					
State	Volume	gross growth	Mortality	net growth	removals	net gain /loss
	(Thousand cubic feet)					
Ohio	183,618	5,751	1,049	4,702	2,635	2,067
Kentucky	183,349	5,521	1,454	4,067	2,279	1,788
Missouri	147,480	4,120	1,789	2,331	2,103	228
Indiana	127,223	5,309	1,335	3,974	1,978	1,996
West Virginia	123,743	4,063	604	3,459	1,086	2,373
Illinois	119,080	5,335	1,186	4,149	875	3,274
Virginia	115,219	2,723	636	2,087	2,746	-659
Pennsylvania	100,498	4,068	359	3,709	449	3,260
Tennessee	91,251	3,556	1,312	2,244	865	1,379
Iowa	63,757	2,372	159	2,213	699	1,514

Kansas	58,370	2,480	305	2,175	485	1,690
Michigan	54,447	1,939	181	1,758	474	1,284
18 other states	220,107	8,895	1,070	7,825	2,699	5,126
Total	1,588,142	55,182	11,534	43,648	19,373	24,275

Growing-stock average annual removals averaged 19 million cubic feet per year, about 1.2 percent of the total volume. Most states had statistically similar growing-stock removal rates, although Virginia reported a removal rate (2.4 percent of its total growing-stock volume) that was double the national average. Even though Virginia has only 63 percent of the growing-stock volume of Ohio, it has a higher removal rate. The high removal rates in Virginia probably could be attributed to harvesting and urban/suburban sprawl pressures. In the long-term, this high removal rate will impact the potential nut production.

If mortality and removals are subtracted from total gross growth, the net result is an increase of 24 million cubic feet of black walnut wood each year in the United States. This compares to the average annual increase of 22 million cubic feet of black walnut that was calculated based on comparing 1962 total growing stock with 1989 total growing stock (see discussion in volume section). Thus, the average annual increase in growing stock is probably between 22 and 24 million cubic feet. Comparing average net growing-stock growth to removals shows a ratio of 2.25/1.0, reflecting a growing resource with long-term sustainability.

The national average net annual gain in volume of black walnut of between 22 and 24 million cubic feet represents about 1.5 percent of the Nation's total black walnut growing-stock volume. The net annual increase in growing-stock volume as a percentage of the state's total growing-stock volume was largest in Pennsylvania, Kansas, and Illinois. Each of these states have a net annual increase of at least 2.5 percent of their total growing-stock volume. Missouri, with a net annual gain of 228 thousand cubic feet or 0.1 percent, is nearly static in terms of annual changes in total growing-stock volume. This is primarily due to above average mortality and removal rates. The current condition in Virginia is different than in any other state in the entire range of black walnut, primarily due to its large volume of sawtimber-sized trees. Virginia is experiencing an annual decrease of 659 thousand cubic feet. If current conditions continue in Virginia, the black walnut resource will dwindle, which will have adverse impacts on both the potential nut production and forest industry.

Sawtimber Quality

Black walnut sawtimber removals have a direct relationship to the quality of the trees available. Therefore, discussions concerning resource quality must precede discussions of the utilization of the resource. In 1965, approximately 45 percent of the volume in walnut sawtimber in Illinois, Kentucky, and Missouri was in grades 1 and 2 (Quigley and Lindmark 1965). As a comparison, 38 percent of the black walnut sawtimber in the most recent inventories were grade 1 or 2 (Table 8).

Many field foresters, log-buyers, and industry officials feel that the decrease in quality was partially the result of a decrease in the size of the timber available for harvest. However, a comparison of sawtimber volume by diameter classes between 1962 and 1989 show that, in fact, the average

diameter of sawtimber trees in the United States has been increasing. The percent of black walnut sawtimber in the largest diameter classes, above 19 inches d.b.h., actually increased from 10 percent in 1962 to 14 percent in 1989.

Table 8.— Percent of black walnut sawtimber by grade.

State	Grade 1	2	3	4
	(Percent)			
Ohio	9	22	63	7
Indiana	11	30	50	9
Missouri	5	19	45	31
Illinois	13	38	41	8
Kentucky	12	34	50	4
West Virginia	13	31	38	18
Virginia	4	30	55	11
Pennsylvania	3	25	46	26
Tennessee	5	18	63	14
Iowa	12	34	50	4
Kansas	24	37	39	0
Michigan	20	46	31	3
18 other states	10	27	53	10
Total	10	28	51	11

More than half of the black walnut sawtimber in the United States was graded as grade 3 in the most recent inventories. This grade is suitable for lumber and other miscellaneous products and can often have more "character" than higher grades. For example, furniture made from low grade black walnut lumber with knots and other sound defects adds to the charm and diversity of each piece (Chenoweth 1995).

From a nut production perspective, tree grade is not of major importance. In fact, the best nut producing trees are often those with lower grades because they have more limbs to produce nuts. Black walnut products come from a wide variety of sources beyond the typical forestlands. Because of the economic value associated with black walnut, the eastern United States are scoured for trees that are of the size and condition for producing nut and for the timber industry. Aside from black walnut, there are not many tree species where cull and nonforest trees are considered of economic value.

Current Annual Removals

Current annual removals are estimated for wood fiber products only, current annual nut production can be more accurately estimated by others. In the North Central Region, an estimated 7 million cubic feet of black walnut growing-stock and 5.3 million cubic feet of black walnut non-growing stock are currently harvested based on the most recent Timber Product Output surveys (Table 9). Of the harvested black walnut, about 82 percent (10.1 million cubic feet) was removed from the site, generally to a processing facility and 18 percent (2.2 million cubic feet) was left on the ground as logging residue/slash.

Missouri and Indiana were the leading states in the North Central Region in current annual total black walnut harvested volume. These two states had similar levels of growing-stock removals but different levels of non-growing stock removals. Missouri, in 1993, had more black walnut harvested from non-growing stock sources (2.5 million cubic feet) than from growing-stock (1.8 million cubic feet). Indiana's 1990 black walnut harvest from growing stock (1.8 million cubic feet) was five times the harvesting from non-growing stock (343 thousand cubic feet). States besides Missouri in the North Central Region with a large percentage of total black walnut harvest from non-growing stock include Iowa and Wisconsin.

Almost 20 percent of all of the black walnut harvest in the North Central Region was from cull (non-growing stock) trees. Cull trees are on timberlands but they do not meet the requirements for growing stock. Cull trees include short-log trees, trees with excessive sweep and/or crook, trees with excessive taper to where they do not meet the minimum top diameter, and rotten trees. While FIA classifies these as cull trees, they obviously constitute an important part of the supply of black walnut in the region. Missouri and Iowa both had significant volumes of cull black walnut trees that were harvested for sawlogs. In addition to the cull tree harvest, more than 1.3 million cubic feet of black walnut are harvested annually in the North Central Region from trees that are not on timberlands. These trees occur on pasture land, in narrow wooded strips, in windbreaks, and in other locations and generally provide a significant portion of the annual nut harvest.

CONCLUSIONS

Several state inventory results from the 1940's through the 1970's seemed to confirm the concerns expressed about the perceived dwindling supply of black walnut. Other states, however, were showing significant gains in volume. Ohio, the number one black walnut State in terms of growing-stock volume, posted a 22 percent increase in growing-stock volume from 1968 to 1979. Kentucky dramatically increased its black walnut growing-stock volume from 1963 to 1975. Thus, the changing black walnut picture was different depending where one looked. Overall, national compilations show a significant increase in black walnut volume. Inventories in the 1980's and early 1990's show significant gains in black walnut growing-stock volume in all of the primary walnut states. Illinois and Indiana showed the most impressive gain, rising from 44.9 million cubic feet in 1962 to 119.1 million by 1985 and from 64.5 million cubic feet in 1967 to 127.2 million in 1986, respectively.

Why this sudden increase? During this same period, the volume of all hardwoods increased dramatically as hardwood forests matured. However, the rate of increase of black walnut was significantly greater than for other hardwoods. This perhaps may be explained by two factors. First, because black walnut is pest resistant and alleopathic, growth is seldom impeded. Secondly, many black walnut trees were already well established in pasture land that reverted to forest land in the 1970's and 1980's. These trees, with their significant volumes, would have been new additions to the total growing-stock volume.

More than half of the existing black walnut timberlands are in sawtimber-sized stands. These stands have limited potential for redirecting management toward improved quality and stocking rate. Additionally, many of these older stands have been subjected to practices such as grazing that limit their long-term productivity. Returns on investments are limited in older stands when compared to similar investments on younger stands. However, more than two-thirds of the black walnut trees in the United States are currently less than 5 inches d.b.h., which is an excellent size to actively manage for both nut and timber production. In this size class, pruning, releasing, thinning, and other management activities have the potential to greatly improve the quality as well as the quantity of black walnut in the stand, especially if they are on highly productive sites.

The supply of black walnut nuts and timber would be enhanced if establishment and management were focused on sites with high productivity potential. With the majority of black walnut timberlands owned by non-industrial private landowners, the future supply is dependent on land management goals that include nut and timber production. Private landowners own land for many purposes, if improving the quantity of black walnut is of high priority, public agencies could target these landowners for increased management, technical assistance, and cost-share programs. To date, plantations have not made a significant impact on the supply of black walnut. However, if the current level of planting continues, if they are adequately managed, and if they are planted on productive sites, plantations have the potential to improve the future supply of black walnut.

The overall future for black walnut appears bright, the number of black walnut trees has been consistently increasing, growing-stock volume has consistently been on the rise, and the number of plantations has been constantly increasing. If this growing resource is adequately managed, questions about the long-term supply of high quality of black walnut for both nuts and timber will be answered.

APPENDIX

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