9. It has been suggested that quail food shortages may exist in late summer and fall in some sections of the Southeast. Factors limiting the carrying of a maximum number of birds to the hunting season need to be determined.

10. There is a definite lack of communications between states in the Region, particularly between men engaged in research. The creation of a Research Newsletter to keep field workers up to date with progress and results of studies is needed.

11. There is need for surveys to provide information as to the relative availability of land to public shooting. Such surveys should be executed by technical personnel attired in hunting clothes operating in areas where they are unknown to landowners. Pertinent facts as to why access is denied or granted should be recorded and evaluated. Surveyors connection with game departments should not be disclosed. Statistical assistance should be engaged in planning survey routes in relation to hunter concentrations, metropolitan areas, and the distance the average hunter is willing to travel for sport.

AN EXOTIC OAK, QUERCUS ACUTISSIMA, FOR WILDLIFE FOOD PLANTING

EDWARD G. SULLIVAN [1] AND W. C. YOUNG [2]

For the past 25 years the forestry profession has done a commendable job in research, education, and management of our woodlands for higher yields of timber and pulpwood. The wildlife manager has been hard-pressed to keep abreast of the rapid advance in forest technology and keep these improved woodlands productive of wildlife.

Modern forestry has, no doubt, increased the carrying capacity for deer over much of our area. The increase in wild turkeys in several areas of the South can be tied back to better forest management and protection. Over much of our woodland, squirrels have not fared quite so well.

Many studies have been made to "save" or improve wildlife habitat in woodland. Most of these studies have dealt with the maintenance of adequate native hardwood species for wildlife food. Our native oaks, however, are often low and erratic producers. In addition to native hardwoods, there is a need for more dependable mast producers which could be planted and managed for game food. A superior mast producer should meet the following specifications: (1) Produce a "choice" food for the wildlife species desired; (2) Be a heavy and dependable producer; (3) Begin producing at an early age; (4) Not be subject to excessive damage by insects, weather or decay; and (5) Be relatively unimportant as a food for non-game species, particularly grackles and other flocking birds.

The introduced sawtooth oak, *Quercus acutissima,* has qualities that meet these specifications. This oak is native to Japan, Korea, China, and the Himalayan area. It is described as a round-headed tree reaching 80 feet at maturity. The leaves have the appearance of chestnut leaves. The white oak-sized acorns require two years to mature.

This oak has long been used as an ornamental in the Northeastern States. It is in supply by ornamental nurserymen (Mattoon). Records indicate its complete adaptation in Massachusetts and West New York. Recent plantings indicate its adaptation to southeastern conditions also. A specimen at the U. S. Plant Introduction Station at Savannah, Georgia planted in 1923 is 18 inches D.B.H., 50 feet high and has a spread of 75 feet.

Two accessions are being studied. One is on the campus of the University of Georgia at Athens. This planting has erroneously been called the chestnutleaf oak of North Africa, but recently has been identified as sawtooth oak, *Quercus acutissima* by F. H. Meyer of the New Crops Research Branch of the Agricultural Research Service in Washington. The other accession is Plant Introduction No. 168939. Plantings of this

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accession were made throughout the Northeastern and Southeastern United States 10, 15, and 20 years ago by the U. S. Forest Service, various State Game and Fish Agencies, Experiment Stations, and the Soil Conservation Service. Follow up studies have been made on very few, if any, of these plantings.

PLANTING AT ATHENS, GEORGIA

The Athens accession consists of 21 nursery grown seedlings planted as ornamentals on the University of Georgia campus about 1937. Some of these are planted on unfavorable sites where grading removed all of the A soil horizon and in some cases much of the B horizon. On poor sites, they now reach an average height of 18 to 20 feet. Individual trees in favorable soil locations have reached 30 feet, are vigorous, and appear to be completely adapted. Acorn crops have been produced every year since 1957 at least. In 1959 and 1960, the crop was picked up the last week of September through the first week of October. Forty pounds were collected from 4 trees in 1959, 80 pounds from 6 trees in 1960, and 126.1 pounds from 6 trees in 1961. In 1961, the acorns begin dropping about September 1, and all had fallen by October 6. Eighty-nine percent of the acorn crop fell between September 15 and 30. Fifteen of the 21 trees on the Athens Campus made fair to excellent crops. The remaining 6 trees had very light crops. Yield data by trees in this planting is presented in Table III.

Fresh acorns averaged 70 per pound in 1960 (Davison and Powell), but varied on individual trees from about 50 to 85 per pound in 1961.

The abundant and regular acorn crops and their apparent resistance to decay and insect damage observed by W. C. Young led him to propagate them for further observation, both as a wildlife food tree and a possible timber species. Acorns were collected in the Fall of 1957 and grown under nursery conditions near Athens, Georgia. Germination was near 100 percent from fall planted acorns. They grew off well, some reaching a height of 24 inches the first season. They transplanted easily —again nearly 100 percent survival in a group of 20 trees.

Further tests were conducted the following year at the Americus, Georgia, Plant Materials Center. Acorns were planted in the fall in 3-foot rows at one-inch spacing in the row. They reached an average height of 18 inches the first growing season. From 40 pounds of acorns, 2,300 seedlings were produced. This is equal to about 57 plants per pound of acorns, as 85 percent of the acorns made plantable nursery stock (Powell).

These seedlings were distributed during the winter of 1959-1960 to Soil Conservation District cooperators in the Southeast for observation. Transplanting after shipment has given excellent survival. Plantings made at Mariana, Florida on a well-drained sandy site gave a survival of 90 percent. Plantings observed in other locations in the Southeast gave equally good results. However, plantings set in the wild without site preparation or cultivation have given poor survival. The degree of preparation for planting and culture has not been determined, but for rapid productivity it appears likely that good culture will be necessary for the first few years.

PLANTINGS FROM PLANT INTRODUCTION NO. 168939

One planting of sawtooth oak now under observation was made in Choctaw County near Ackerman, Mississippi, in 1952 by the Mississippi Game and Fish Commission from seedlings furnished by the Soil Conservation Service. The planting is on an area which was formerly a "Land Utilization Project" administered by the Soil Conservation Service. The area is now administered by the U. S. Forest Service. The part of the area where this planting is located is under cooperative agreement with the Mississippi Game and Fish Commission and is being used as a public hunting area.

Sixteen trees, spaced approximately 15 by 15 feet, have survived in this orchard-type planting. The planting is on a well-drained ridge in the Upper Coastal Plains resource area. The soil is an Ora loam. The location is considered a shortleaf-loblolly pine site with a site index of 80 feet per 50 years. The average height of these oaks at 10 years is 30 feet. The growth rate is uniform for most of the trees, but a few

have made poor growth and are only about 10 feet tall. This may be due to some injury such as grazing while young. Vegetative competition has been kept down by cultivating or disking every year. Fertilizer has been applied some years, but no accurate record was kept of how much and how often.

According to Mr. John Jackson, Area Manager at that time, the first acorn crop was produced in 1957, when the trees were six years old. The first crop was light, and only the larger trees produced. Acorn crops have been regular and progressively heavier each year since.

Edward Sullivan first observed this planting in the summer of 1959. He made another visit in mid-October at which time most of the acorns had fallen and had been eaten by deer. He collected a few acorns and planted them under nursery conditions. Germination and nursery survival were 95 percent. Twenty-five seedlings were moved into a field planted a year later, and survival to date has been 100 percent.

A small direct seeding was made by Sullivan in 1960. Acorns collected in early October were held under refrigeration until planted the last week in October. They were planted about two inches deep in an old field with no soil preparation other than digging a small hole with a hoe to plant the acorns. Germination was about 80 percent, resulting in 44 seedlings by May 29, 1961. Thirty-one of these seedlings had survived through October 2, 1961. Despite heavy competition from broomsedge, these seedlings appeared vigorous and have averaged 7 inches of growth. Further trials are needed on direct seeding.

Closer observations were made on the 1960 crop at Ackerman, Mississippi. The acorns were mature and began falling in early September. By October 10, 95 percent of the acorns had fallen. This is earlier than native species. The cup and acorn usually fall together. In most cases, the acorn rolls free of the cup when it hits the ground. Fresh acorns from this planting averaged 96 per pound in 1960.

Yield data was obtained from a typical tree in the planting in 1960. when the tree was 9 years old. Since deer were feeding heavily on the acorns, it was impossible actually to count and weigh all of them. But, since the acorn cups are not eaten, a fairly accurate yield was determined by: (1) Counting all the cups under the tree, and (2) Counting and weighing enough acorns to arrive at an average number per pound, and (3) Computing the yield. The total yield from this 9-year-old tree was 31.6 pounds. This same tree produced 47.7 pounds in 1961. Not all trees in this planting produced such heavy crops in 1961. Five of the 16 trees had rather light crops; others were medium to heavy. Yield data for selected trees in this planting is presented in Table III.

Yield studies of native oaks by various workers generally show low production in pounds per individual tree. Moody (1953) gives yield figures for Louisiana oaks based on a two-year study. Some of his highest yields for individual trees were: a 40-year-old white oak, 18.5 pounds; a 57-year-old water oak, 12.5 pounds; a 58-year-old willow oak, 5.0 pounds; a 20-year-old post oak, 4.8 pounds. Averages for these species in his studies were even lower.

Collins (1959)in presenting some average yields and weights of oak mast from various sections of Louisiana gives averages for different species ranging generally from one-half pound to about five pounds. However, he lists some high yield averages from studies in Concordia Parish as follows: Water oak, 93.3 pounds and willow oak, 20.6 pounds. No ages are given for trees in this report, but he states that substantial acorn yields cannot be expected below the age of 25 years on the oaks he studied in Louisiana.

Table I compares some yield data of native oaks with the sawtooth oak.

Another 1952 planting of this species is located in Perry County, Mississippi in the DeSoto National Forest. This planting was also made by the Mississippi Game and Fish Commission in their Leaf River Game Management Area. It is located in the Lower Coastal Plains land resource area on a Ruston soil type. This is considered a slash-longleaf pine site.

These oaks average 20 to 25 feet in height, somewhat smaller than the Ackerman planting. No yield data has been collected, but these trees have been producing heavy crops of acrons for at least two or three

years. Management has been similar to the planting on the Choctaw Area.

Still another planting is described by R. F. Dugan, Soil Conservation Service Biologist, Roanoke, Virginia, on Virginia Game Division lands as consisting of about a dozen trees, 15 to 20 years old. They average 12 to 15 feet in height and have been producing acorns in abundance for the last few years.

RESISTANCE TO INSECT DAMAGE

Sawtooth acorns at Athens and Ackerman revealed no damage by insects. Ten pounds of these acorns from the 1960 crop held in plactic bags until January were practically free from acorn weevil larvae. Germination was excellent from these acorns, and high germination percentage has been obtained in other plantings as mentioned elsewhere. Three hundred acorns (3.3 pounds) from the Ackerman, Mississippi planting were cut open and examined for insect damage. These were selected at random from acorns collected throughout the period of acorn fall. None of these acorns showed insect damage. It is recognized, of course, that this is not sufficient evidence to say that they are completely insect resistant. The fact is worth noting since it is known that insects damage a large percentage of several species of native oak acorns.

Collins (1959) states that in a 9-year study on their Red Dirt Game Management Area in Louisiana, 25 percent of all acorns reaching maturity were unsound due to acorn weevil damage. Downs (1949) reports 30 percent loss of native acorns by insects. In Missouri (Dalke, 1953), the percentages of unsound acorns for one year ranged from 31.2 to 78.1. For another year, it was from 42.1 to 50.3 percent.

USE BY WILDLIFE

Deer utilization of sawtooth acorns was heavy at the Choctaw Wildlife Area. It was almost impossible to collect acorns from the ground due to nightly feeding by deer. Earlier work done in Virginia showed that captive deer preferred sawtooth acorns over white oak acorns (Steiner). Dugan reports from a Virginia planting that many of the acorns never reach the ground because they are taken by squirrels as they ripen. Those that do reach the ground are immediately cleaned up by deer. No squirrel use was noted in 1960 in the Choctaw Area, but some squirrel cutting was noted in 1961. This planting does not have good squirrel habitat surrounding it. Some of these acorns were fed to free ranging gray squirrels in Canton, Mississippi, by Edward Sullivan and in Athens, Georgia, by Verne E. Davison. Squirrels ate them readily.

Red-bellied woodpeckers did not eat these acorns, but they readily ate water oak acorns at Davison's feeding station. Blue Jays could not hold them in their bills due to size and smoothness. It is not known whether or not grackles can eat them.

Samples of 1960 acorns from Athens and Ackerman were analyzed chemically. Another sample from Athens was analyzed in 1961. Table II compares this data with native species.

SUMMARY

The introduced sawtooth oak, *Quercus acutissima*, has a high potential as a superior acorn producer for wildlife. It is well adapted to the climatic conditions of the Southeast. Stands of trees up to 10 or more years old are known from varying locations. Acorn production is regular and moderate to heavy. Considering the age of the trees on which production estimates are based, it greatly exceeds the production of native species as reported. The acorns are apparently free from serious deterioration due to insect and weather damage. It is an attractive ornamental. Sawtooth acorns are readily taken by both squirrel and deer. The trees are easily propagated and transplanted with good survival when properly handled. Growth rate is good. Production begins early, some trees producing as early as the 6th year and continuing with unusual regularity. The acorns are large, averaging 70 to 96 per pound. The suitability to varying edaphic conditions has not been established, but there appears to be no restrictions on well drained upland soils of either the Coastal Plains, Piedmont or Appalachian provinces.

TABLE I.

ACORN BEARING AGE AND FREQUENCY OF SAWTOOTH AND SOME NATIVE OAKS (ADAPTED FROM MISC. PUB. 654, U. S. D. A., WOODY-PLANT SEED MANUAL).

	Seed Bearing Age			Seed Year Frequency	
Quercus Species	*Min. (Years)*	*Optimum (Years)*	*Max. (Years)*	*Good Crops (Years)*	*Light Crops (Years)*
White oak	20	75 to 200	300	4 to 10	Intervening
Northern red oak	25	50 to 125	200	2 to 3	Intervening
Scarlet oak	20	50 to 125	150	Irregular	Irregular
Southern red oak	25	50 to 75	125	1 to 2	Intervening
Shingle oak	25	30 to 75	125	2 to 4	Intervening
Water oak	25	50 to 125	175	1 to 2	Intervening
Pin oak	20	40 to 75	125	1 to 2	Intervening
Post oak	25	50 to 150	250	2 to 3	Intervening
Black oak	20	40 to 75	100	2 to 3	Intervening
Sawtooth oak	6	Unknown	Unknown	Regular	

TABLE II.

CHEMICAL ANALYSIS OF SAWTOOTH OAKS COMPARED WITH NATIVE SPECIES.

Species	*Protein*	*Fat*	*N-Free Extract*	*Crude Fiber*	*Ash*	*Moisture*
*Sawtooth oak Ackerman, Miss. sample, 1960	2.69	1.68	47.96	4.02	1.42	42.23
Sawtooth oak Athens, Ga. sample, 1960	3.63	1.94	47.30	7.11	1.74	38.38
**Sawtooth oak, Athens, Ga. sample, 1961	3.0	1.4	48.2	6.5	1.4	45.4
***White oak	6.30	5.60	69.72	15.54	2.72	
Post oak	5.94	6.33	70.01	14.92	2.54	
Live oak	6.26	6.61	70.20	14.06	2.92	
Southern red oak	5.41	14.85	59.03	18.00	2.69	
Bluejack oak	6.81	20.46	55.20	15.24	2.18	
Blackjack oak	6.56	15.50	55.31	20.25	2.38	
Water oak	4.46	23.18	55.33	15.45	1.57	
Willow oak	4.74	20.51	55.08	17.75	3.88	

*Analysis made by Dr. E. M. Etheridge, State Chemist, Mississippi State University.
**Analysis made by Georgia Department of Agriculture, Laboratories Division, Atlanta, Georgia.
***Averaged from a combination of several studies presented in Table I, "Acorns in the Diet of Wildlife", Goodrum (see references).

TABLE III.

ACORN YIELDS FROM SELECTED TREES OF TWO SAWTOOTH OAK PLANTINGS, 1961 SEASON.

Athens, Georgia planting — Approximately 24 years old (Trees selected from heaviest producers).		*Ackerman, Mississippi planting—10 years old (Trees selected at random from 16-tree planting).*	
Tree No.	*Total Yield*	*Tree No.*	*Total Yield*
4	50.3 lbs.	5	44.1 lbs.
7	10.2 lbs.	6	38.0 lbs.
10	15.9 lbs.	7	47.7 lbs.
13	10.7 lbs.	10	7.0 lbs.
14	27.0 lbs.	11	4.2 lbs.
15	12.0 lbs.	12	28.3 lbs.
		14	37.2 lbs.

1. Yields from Athens, Georgia planting determined by Verne E. Davison and based on actual fresh weight of acorns picked up weekly as they fell from trees. Yields from Ackerman, Mississippi planting determined by Edward G. Sullivan based on total count of acorn cups and average number of acorns per pound described in text of paper.

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