



**US Army Corps
of Engineers**

**ENVIRONMENTAL IMPACT
RESEARCH PROGRAM**

TECHNICAL REPORT EL-86-22

CHUFA (*Cyperus esculentus*)

Section 7.4.1, US ARMY CORPS OF ENGINEERS
WILDLIFE RESOURCES MANAGEMENT MANUAL

by

Wilma A. Mitchell, Chester O. Martin

Environmental Laboratory

DEPARTMENT OF THE ARMY

Waterways Experiment Station, Corps of Engineers
PO Box 631, Vicksburg, Mississippi 39180-0631



July 1986

Final Report

Approved For Public Release; Distribution Unlimited

Prepared for DEPARTMENT OF THE ARMY
US Army Corps of Engineers
Washington, DC 20314-1000

Under EIRP Work Unit 31631



Destroy this report when no longer needed. Do not return
it to the originator.

The findings in this report are not to be construed as an official
Department of the Army position unless so designated
by other authorized documents.

The contents of this report are not to be used for
distribution, reproduction, or promotional purposes,
in whole or in part, without the express or
official endorsement or approval of the use of
government for profit.

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188 Exp. Date: Jun 30, 1986	
1a. REPORT SECURITY CLASSIFICATION Unclassified		1b. RESTRICTIVE MARKINGS			
2a. SECURITY CLASSIFICATION AUTHORITY		3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited.			
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE					
4. PERFORMING ORGANIZATION REPORT NUMBER(S) Technical Report EL-86-22		5. MONITORING ORGANIZATION REPORT NUMBER(S)			
6a. NAME OF PERFORMING ORGANIZATION USAEWES Environmental Laboratory		6b. OFFICE SYMBOL (if applicable)	7a. NAME OF MONITORING ORGANIZATION		
6c. ADDRESS (City, State, and ZIP Code) PO Box 631 Vicksburg, MS 39180-0631		7b. ADDRESS (City, State, and ZIP Code)			
8a. NAME OF FUNDING/SPONSORING ORGANIZATION US Army Corps of Engineers		8b. OFFICE SYMBOL (if applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER		
8c. ADDRESS (City, State, and ZIP Code) Washington, DC 20314-1000		10. SOURCE OF FUNDING NUMBERS			
		PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT ACCESSION NO. EIRP 31631
11. TITLE (Include Security Classification) Chufa (<i>Cyperus esculentus</i>): Section 7.4.1, US Army Corps of Engineers Wildlife Resources Management Manual					
12. PERSONAL AUTHOR(S) Mitchell, Wilma A., and Martin, Chester O.					
13a. TYPE OF REPORT Final report		13b. TIME COVERED FROM _____ TO _____	14. DATE OF REPORT (Year, Month, Day) July 1986		15. PAGE COUNT 18
16. SUPPLEMENTARY NOTATION Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.					
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)		
FIELD	GROUP	SUB-GROUP	Chufa <i>Cyperus esculentus</i>		
			Sedges Plant materials		
			Cyperaceae (Continued)		
19. ABSTRACT (Continue on reverse if necessary and identify by block number)					
<p>A report on chufa (<i>Cyperus esculentus</i>) is provided as Section 7.4.1 of the US Army Corps of Engineers Wildlife Resources Management Manual. The report was prepared as a guide to assist the Corps District or project biologist who may wish to establish chufa plots for wildlife on project lands. Major topics include plant description, distribution, habitat requirements, wildlife value, establishment, and maintenance.</p> <p>Chufa is an introduced sedge used primarily for wild turkey (<i>Meleagris gallopavo</i>) and waterfowl management in the Southeast. A description of the sedge and its naturalized range is given in this report. Soil, moisture, and shade requirements are specified, and the value of chufa as a wildlife food is discussed. The establishment of chufa for wild turkey and for waterfowl is described under separate headings. The method outlined for establishing upland stands includes site selection and preparation, plot design, planting</p> <p style="text-align: right;">(Continued)</p>					
20. DISTRIBUTION/AVAILABILITY OF ABSTRACT <input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS			21. ABSTRACT SECURITY CLASSIFICATION Unclassified		
22a. NAME OF RESPONSIBLE INDIVIDUAL		22b. TELEPHONE (Include Area Code)		22c. OFFICE SYMBOL	

18. SUBJECT TERMS (Continued).

Habitat development
Wildlife cover
Waterfowl management
Tubers

Wildlife foods
Turkey (*Meleagris gallopavo*) management
Food plots
Nutgrass

19. ABSTRACT (Continued).

instructions, and plot maintenance. Guidelines are given for establishing chufa for waterfowl by enhancing natural stands through proper management of water levels. Cautions and limitations of growing chufa are also pointed out.

PREFACE

This work was sponsored by the Office, Chief of Engineers (OCE), US Army, as part of the Environmental Impact Research Program (EIRP), Work Unit 31631, entitled Management of Corps Lands for Wildlife Resource Improvement. The Technical Monitors for the study were Dr. John Bushman and Mr. Earl Eiker, OCE, and Mr. David Mathis, Water Resources Support Center.

This report was prepared by Dr. Wilma A. Mitchell and Mr. Chester O. Martin, Wetlands and Terrestrial Habitat Group (WTHG), Environmental Laboratory (EL), US Army Engineer Waterways Experiment Station (WES). Mr. Chester O. Martin, Team Leader, Wildlife Resources Team, WTHG, was principal investigator for the work unit. Individuals who contributed information to this report were Mr. Lovett E. Williams, Jr., US Fish and Wildlife Service Cooperative Wildlife Research Unit, Gainesville, Fla.; Mr. Herman D. Holbrook, USDA Forest Service, Atlanta, Ga.; Dr. Daniel W. Speake, US Fish and Wildlife Service Cooperative Wildlife Research Unit, Auburn University, Auburn, Ala.; Mr. Robert E. Waters, USDA Soil Conservation Service (SCS), Auburn, Ala.; Mr. John Vance, SCS, Gainesville, Fla.; Dr. George A. Hurst, Department of Wildlife and Fisheries, Mississippi State University, Mississippi State; Mr. Charles Smith, Louisiana Department of Wildlife and Fisheries, Baton Rouge; Mr. James R. Davis, Alabama Department of Conservation and Natural Resources, Jackson; and Mr. S. B. Holleman, formerly of the Alabama Department of Conservation and Natural Resources, Montgomery. Review and comments were provided by Dr. Mary C. Landin, Dr. Thomas H. Roberts, and Ms. Lois J. O'Neil, WTHG.

The report was prepared under the general supervision of Dr. Hanley K. Smith, Chief, WTHG, EL; Dr. Conrad J. Kirby, Chief, Environmental Resources Division, EL; and Dr. John Harrison, Chief, EL. Dr. Roger Saucier, WES, was Program Manager, EIRP. The report was edited by Ms. Jessica Ruff of the WES Publications and Graphic Arts Division (PGAD). Drawings were prepared by Mr. David R. (Randy) Kleinman, Scientific Illustrations Section, PGAD, under the supervision of Mr. Aubrey W. Stephens, Jr.

At the time of publication, COL Allen F. Grum, USA, was Director of WES, and Dr. Robert W. Whalin was Technical Director.

This report should be cited as follows:

Mitchell, Wilma A., and Martin, Chester O. 1986. "Chufa (*Cyperus esculentus*): Section 7.4.1, US Army Corps of Engineers Wildlife Resources Management Manual," Technical Report EL-86-22, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

NOTE TO READER

This report is designated as Section 7.4.1 in Chapter 7 -- PLANT MATERIALS, Part 7.4 -- MISCELLANEOUS FORBS AND HERBACEOUS SPECIES, of the US ARMY CORPS OF ENGINEERS WILDLIFE RESOURCES MANAGEMENT MANUAL. Each section of the manual is published as a separate Technical Report but is designed for use as a unit of the manual. For best retrieval, this report should be filed according to section number within Chapter 7.

CHUFA (*Cyperus esculentus*)

Section 7.4.1, US ARMY CORPS OF ENGINEERS
WILDLIFE RESOURCES MANAGEMENT MANUAL

DESCRIPTION	3	Site Selection	7
DISTRIBUTION	5	Site Preparaton	7
HABITAT REQUIREMENTS	5	Propagules	9
Soils	5	Planting	10
Moisture	5	MAINTENANCE	10
Shade	6	WATERFOWL MANAGEMENT	11
WILDLIFE VALUE	6	CAUTIONS AND LIMITATIONS	12
ESTABLISHMENT	7	LITERATURE CITED	13

Chufa is an introduced sedge (Family Cyperaceae) used primarily for wild turkey* and waterfowl management in the Southeast. The tubers are eaten by some songbirds and many species of mammals, waterfowl, and upland game birds. Mature tubers have a peanut, coconut, or almond flavor and are commonly referred to as chufas or nuts. Other frequently used names are yellow nut-grass, rush nut, and ground almond.

DESCRIPTION

Chufa is a robust, fast-growing perennial with smooth, yellowish, 3-angled stems, 8 in. to 2 ft (2 to 7 dm) tall (Fig. 1). The bright green basal leaves, approximately 0.3 in. (8 mm) wide, reach or exceed the length of the main stem. Although rather stiff when young, leaves become lax and ribbon-like with age. Arising from the base of the inflorescence are 3 to 7 conspicuous, unequal, leaf-like bracts 2 to 10 in. (5 to 25 cm) in length; several bracts are distinctly longer than the others.

The inflorescence consists of 5 to 10 unequal stalks bearing terminal spikes with pinnate spikelets. The small seeds are yellowish, 3-sided achenes

* Scientific names of wildlife species are provided in Table 1 (page 8).

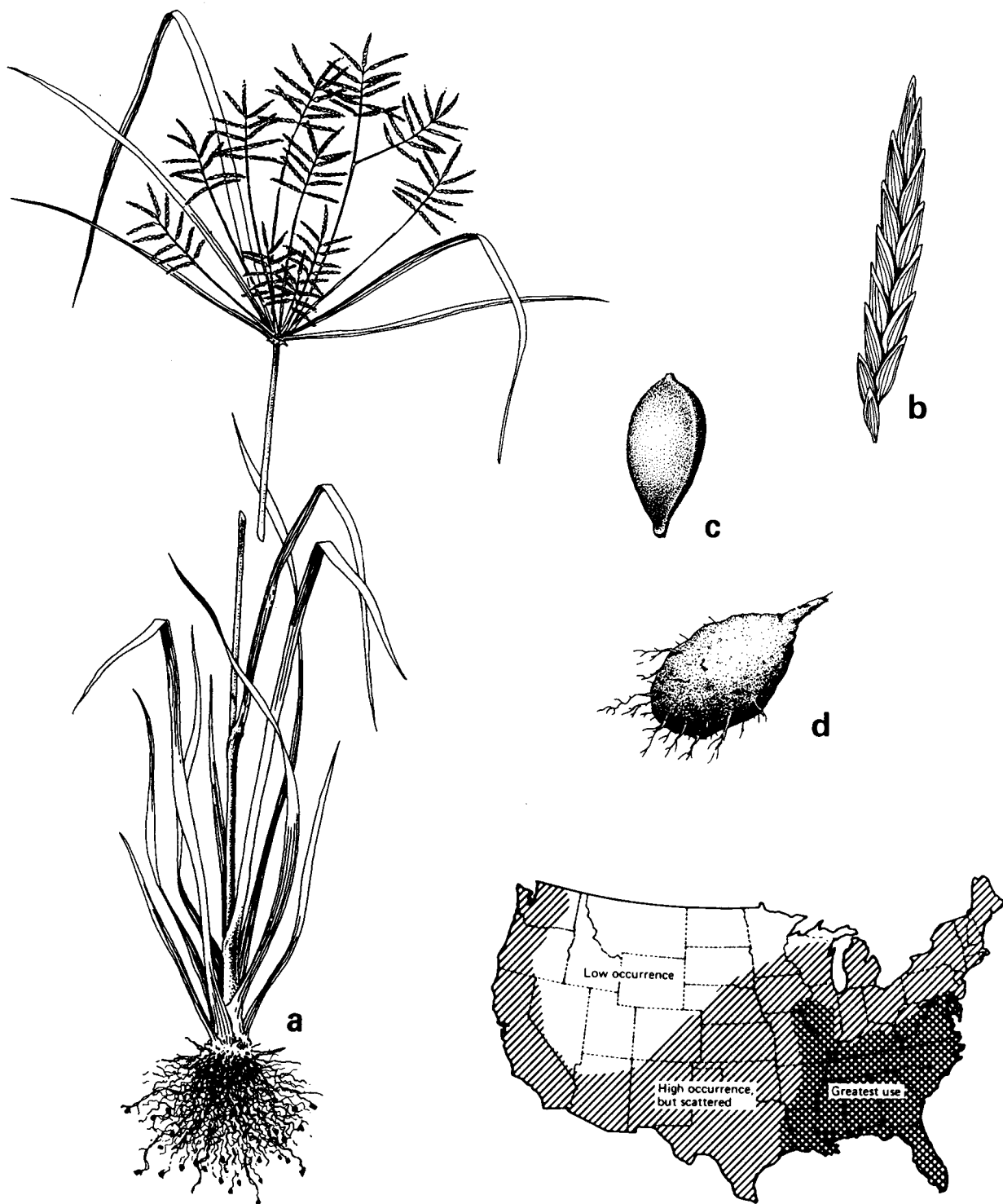


Figure 1. Distribution and distinguishing characteristics of chufa (*Cyperus esculentus*): (a) entire plant, (b) spikelet, (c) seed, and (d) edible tuber. The map shows regions of low occurrence, high occurrence, and greatest management use

that are often not viable; therefore, reproduction is primarily from subglobose tubers that are 0.25 to 0.4 in. (6 to 10 mm) long and located at the ends of slender rhizomes. Chufa is usually highly productive, and one plant may produce hundreds of tubers.

DISTRIBUTION

Although native to Africa and southern Europe, chufa has become naturalized throughout the United States except in arid regions. The species occurs in all states but is most abundant in the Southeast, the Mississippi River Valley, coastal areas, and interior regions with sufficient moisture (Fig. 1). It is also common on irrigated lands of the West.

HABITAT REQUIREMENTS

Soils

Chufa is adapted to a wide range of soil types but grows best in slightly acid to neutral soils (pH 5.0 to 7.5) of fine texture and high moisture content. Common sites are sand and gravel bars, shallow depressions, mudflats, ditches, cultivated fields, roadsides, waste places, and freshwater marshes, bogs, and shorelines. Plants will not tolerate drought or salinity (Coastal Zone Resources Division 1978, Environmental Laboratory 1978, Hunt et al. 1978).

Moisture

Plants grow best in moist soils but do not do well on sites that are extremely wet or flooded during the growing season (Merrell 1975). Wills (1970, 1971) reported that chufa occurs commonly in bottomland understories and on exposed mudflats of seasonally flooded Catahoula Lake in central Louisiana; the outer contour of the lake bed was dominated by chufa, which composed about 85% of the vegetation. Merrell (1975) determined that good tuber production depended on at least a 3-month flood-free period during the growing season at Catahoula Lake; prolonged flooding during late summer and early fall was detrimental to the growth and survival of plants. The best overall production occurred in plants growing at approximately 4 in. above the water level (Merrell 1975).

Shade

Although chufa occurs on open to partially shaded sites (Coastal Zone Resources Division 1978), growth is apparently best when plants are exposed to full sun. Wills (1970) studied chufa plots over a 5-year period at Catahoula Lake and found that tuber production was approximately 8 times greater on exposed mudflats than beneath a bottomland hardwood canopy; mean annual weights of tubers were 3658 lb/acre for exposed plots compared with 469 lb/acre beneath the canopy. Shading and root competition were thought to be the factors most likely responsible for reduced production (Wills 1970).

WILDLIFE VALUE

The tubers, seeds, and rootstocks of chufa are sought by many species of birds and mammals. The tubers are a nutritious winter food high in protein and fat; Billingsley and Arner (1970) found that tubers contained approximately 21% crude fat and 8% crude protein. In addition, plants may grow in lush stands, thus providing cover for small birds and mammals (Hunt et al. 1978).

Upland game birds that feed heavily on the tubers are the wild turkey (Arner and Davison 1976, Davis 1976, Holleman 1979), sandhill crane (Davison 1967, Shields and Benham 1969, USDA Forest Service 1971), and Montezuma quail (Martin et al. 1951). Chufa is considered the primary supplemental food crop planted for turkeys in the Southeast (Davis 1976). Billingsley and Arner (1970) compared the nutritive value and digestibility of commonly used fall and winter foods of the wild turkey in Mississippi and found that chufa ranked second only to spicebush (*Lindera benzoin*) in nutrient content and percent utilization. Utilization coefficients for crude fat and crude protein were over 85% for both juvenile and adult birds.

The tubers are a choice food of waterfowl, especially in the Mississippi River Valley and Southeastern States. Species that show a preference for chufa include the Canada goose, mallard, pintail, wood duck, canvasback, ring-necked duck, blue-winged teal, green-winged teal, and ruddy duck (Martin and Uhler 1939, McAtee 1939, Stanton 1957, Anderson 1959). Wills (1970) found that chufa was the single most important food for wintering waterfowl on Catahoula Lake; tubers supplied 57.5% (by volume) of foods eaten by mallards, 67.4% of pintail foods, and averaged 67% of food items taken by American

wigeon, green-winged teal, blue-winged teal, ring-necked duck, and lesser scaup. Martin and Uhler (1939) reported that chufa ranked tenth of all waterfowl foods in the United States and Canada; it ranked third in the Mississippi Valley region.

Mammals particularly fond of chufa include the raccoon, wild hog, white-tailed deer, squirrels, and skunks (Arner and Davison 1976, Holleman 1979, SCS 1979). Rodents may also dig for tubers, particularly in sandy or light, loamy soils (Martin et al. 1951). Species reported to utilize chufa are listed in Table 1.

ESTABLISHMENT

Chufa is managed primarily to provide an abundant fall and winter food supply for waterfowl and the eastern race of the wild turkey. Plantings are not encouraged in the West and Midwest because of prolific growth of the species on irrigated agricultural lands. The following information applies to the management of wild turkey habitat; management for waterfowl is treated under a separate heading.

Site Selection

Chufa plots should be well distributed and placed near suitable cover (SCS 1979). Plots may be located in forest clearings, along gas and powerline rights-of-way, and at other appropriate sites near good cover; they will receive better use if planted in long, narrow openings. Davis (1976) found that log landings and old logging roads could be disked and planted to chufa with the same success as new-ground plantings. Use of these areas for chufa production is acceptable in most forest management plans, as they are temporary operations. To discourage poaching, plots should be located well away from improved roads and area boundaries.

Plantings should initially be made on newly cleared ground. Moist sandy, loamy, and silty soils are best because turkeys have difficulty scratching the tubers from clay. Plots can be established on old-ground sites, but under these conditions chufa must be planted and cultivated as a row crop in order to control weed competition (Davis 1976).

Site Preparation

Plot design. Plots of 2 to 5 acres are required to produce enough tubers for both turkeys and other wildlife species where high turkey populations are

Table 1. Wildlife known to utilize chufa

Species	Use*	Region**
<u>Waterfowl</u>		
Canada goose (<i>Branta canadensis</i>)	M/H	W, SE
Mallard (<i>Anas platyrhynchos</i>)	M/H	W, SE, MV
Black duck (<i>A. rubripes</i>)	L/M	SE
Mottled duck (<i>A. fulvigula</i>)		GC
Gadwall (<i>A. strepera</i>)	M	SE, W
Northern pintail (<i>A. acuta</i>)	M/H	SE, MV
Green-winged teal (<i>A. crecca</i>)	M/H	W, NE, SE, MV
Blue-winged teal (<i>A. discors</i>)	M/H	SE, W, MV
Cinnamon teal (<i>A. cyanoptera</i>)	M	SW, W
American wigeon (<i>A. americana</i>)	M/H	MV, SE
Northern shoveler (<i>A. clypeata</i>)	H	W, SE, MV
Wood duck (<i>Aix sponsa</i>)	H	W, SE
Canvasback (<i>Aythya valisineria</i>)	H	W, SE
Ring-necked duck (<i>A. collaris</i>)	M/H	SE, MV, W
Lesser scaup (<i>A. affinis</i>)	M/H	SE, MV
Ruddy duck (<i>Oxyura jamaicensis</i>)	M/H	SE, W
American coot (<i>Fulica americana</i>)	L	W, SE
<u>Upland Game Birds</u>		
Sandhill crane (<i>Grus canadensis</i>)	H	SW, SE, GC
Wild turkey (<i>Meleagris gallopavo</i>)	H	SE
Northern bobwhite (<i>Colinus virginianus</i>)	L/M	SE
Montezuma quail (<i>Cyrtonyx montezumae</i>)	H	SW
Woodcock (<i>Philohela minor</i>)	L	NE
White-winged dove (<i>Zenaida asiatica</i>)	L	SW
Common ground-dove (<i>Columbina passerina</i>)	H	GC
<u>Songbirds</u>		
American crow (<i>Corvus brachyrhynchos</i>)	M	P, E, SE
Horned lark (<i>Eremophila alpestris</i>)	L	P
Curve-billed thrasher (<i>Toxostoma curvirostre</i>)	L/M	SW
Red-winged blackbird (<i>Agelaius phoeniceus</i>)	L	SE
Bobolink (<i>Dolichonyx oryzivorus</i>)	L	SE
Boat-tailed grackle (<i>Quiscalus major</i>)	M	SE
American tree sparrow (<i>Spizella arborea</i>)	L/M	SE

(Continued)

* Refers to general use patterns when chufa is available; considerable regional and local variation will occur. L = Low, M = Medium, H = High.

** Region of known use reported in the literature. W = West, SW = Southwest, NE = Northeast, SE = Southeast, GC = Gulf Coast, P = Pacific, MV = Mississippi Valley and adjacent river systems.

Table 1 (Concluded)

<u>Species</u>	<u>Use</u>	<u>Region</u>
<u>Mammals</u>		
Wild hog (<i>Sus scrofa</i>)	H	SE
White-tailed deer (<i>Odocoileus virginianus</i>)	M	SE
Raccoon (<i>Procyon lotor</i>)	H	SE
Skunk (probably <i>Mephitis mephitis</i>)	H	SE
Squirrels (<i>Sciurus</i> spp.)	M/H	SE
Fox squirrel (<i>S. niger</i>)	L	MV
Muskrat (<i>Ondatra zibethicus</i>)	M	
Nutria (<i>Myocastor coypus</i>)	M	
Pocket gopher (<i>Geomys</i> spp.)	M/H	SE
Ord kangaroo rat (<i>Dipodomys ordii</i>)	L	W

present (SCS 1979). Plots should never be less than 1/4 acre in size (Davis 1976), and at least 1 acre should be planted for every 100 acres of turkey habitat (S. B. Holleman, pers. commun., 1982). One plot for every 25 acres of woodland was recommended for areas with high turkey populations in Florida (SCS 1979).

Treatment. Soils should be tested to determine nutrient quality. Very little fertilizer will be required the first year if chufa is planted in rich soil on new ground (Holleman 1979). Average soil should be disked thoroughly, and 200 lb of complete fertilizer per acre should be applied if chufa is broadcast; less will be needed for row planting (Holleman 1979). When plants are 6 to 8 in. tall, or at the first cultivation, plots may be topdressed or sidedressed with 200 lb/acre of sodium or ammonium nitrate. Most soils require an annual maintenance application of 300 to 400 lb/acre of a balanced fertilizer such as 8-8-8, 13-13-13, or 8-24-24 (Arner and Davison 1976, Holleman 1979, SCS 1979).

Propagules

Tubers may be dug from natural stands when plants are mature (July through October) and stored for planting the following year; tubers should be stored at 5° C and kept moist but not wet (Hunt et al. 1978). Field collection is usually not cost effective because tubers are available commercially from many wholesale seed companies, especially in the Southeast.

Planting

Chufa is planted for turkeys as a supplemental food source and is not intended to replace natural food items. Tubers grown on food plots are consumed by many wildlife species; therefore, sufficient acreage should be planted at each site to ensure a plentiful supply during the critical winter period. The tubers are durable, and those not eaten during the winter will germinate the following spring (Davis 1976). On range where chufa is a new crop, streak disking along plot edges may be necessary to reveal the presence of tubers to turkeys. After initial exposure, no additional encouragement should be required (Davis 1976).

Time of planting. Chufa should be planted in spring or early summer after danger of frost is past. Planting dates range from May to the first week in July in most areas (Arner and Davison 1976, Davis 1976), but chufa may be planted as early as April 1 in parts of Florida (SCS 1979). With proper fertilization and cultivation, heavy tuber crops should be available by October (Davis 1976).

Planting methods. Tubers may be broadcast and disked under lightly or planted in rows and cultivated. They may be broadcast at 30 to 40 lb (approximately 1 bu) per acre, but more will be needed for rowed plots (Holleman 1979). Chufa nuts are usually packed commercially in 100-lb sacks; 1 bag should be sufficient to broadcast a 3-acre plot. Chufa is more easily cultivated when planted in rows, which may be spaced from 36 in. (Killinger and Stokes 1951, SCS 1979) to 42 in. apart (Arner and Davison 1979). The SCS (1981) suggested a planting depth of 1/2 in., but Holleman (1979) stated that planting depth was not critical.

MAINTENANCE

Light cultivation will help prevent competing vegetation from overtaking young plants. Chufa fields should be maintained each year by disking and fertilizing in the spring, as previously discussed (Arner and Davison 1976). After 2 to 3 years of continuous chufa production, plots should be moved to new locations for the following reasons: (1) to prevent nutrient depletion of the soil; (2) to reduce the effort required to control weeds; (3) to eliminate insect problems; and (4) to prevent disease, especially blackhead (histomoniasis), on small areas of intensive turkey use. The original plots should be

burned if possible and left fallow for at least 3 years before replanting to chufa.

Chufa stands should be protected from cattle grazing and excessive foraging by hogs during the growing season. Wills (1970) compared tuber production in exclosures and exposed plots in Louisiana and found that more than twice as many tubers (2.35 to 1) occurred in protected plots. The difference apparently resulted from consumption by hogs in unprotected areas. However, Wills (1970, 1971) stated that the extensive rooting in search of tubers probably created excellent feeding conditions for ducks not only by exposing tubers but also by tilling the feeding sites.

WATERFOWL MANAGEMENT

Chufa is best provided for wintering waterfowl by enhancing natural production through proper management of water levels. In dewatered areas that contain no natural stands, tubers may be broadcast at the rate of 50 lb/acre between March 1 and June 15. If the location and flooding regime are suitable for growth, chufa should become naturalized, and additional plantings will not be required. Plant growth and tuber production can be improved by light disking.

Sites conducive to management include shallow lake beds, subimpoundments, beaver ponds, and other shallow water areas subject to seasonal flooding. Attempts should not be made to establish chufa along steep shorelines and on lakes and reregulating pools subject to daily or weekly water-level fluctuations (e.g., most hydroelectric reservoirs). Mudflats along reservoir tributaries may be suitable for planting chufa if water can be kept off sites during the growing season.

If water is drawn off an area in early to midsummer so that shallow mudflats are exposed, good stands of chufa should be produced by September or October. Merrell (1975) stated that no flooding should be permitted during the growing season, and a minimum growth period of 3 months should be allowed for adequate tuber production. Wills (1970) found that the best crops were produced when plants were not flooded for 5-1/2 to 6-1/2 months. Lake draw-down should be initiated by July 1, and reflooding should not occur until late October or November. However, Merrell (1975) stated that short periods of temporary flooding may be desirable to reduce competition from other plants.

CAUTIONS AND LIMITATIONS

An undesirable trait of chufa is that it grows and produces best on new ground or on that planted for only 2 consecutive years. Weed invasion and insect damage in older fields seriously reduce tuber production (Davis 1976). Insects (*Bactra* spp.) are known to attack chufa, but injured plants will continue to reproduce (Coastal Zone Resources Division 1978). Light applications of granular herbicides have been used to control weeds; however, chufa is intolerant to most herbicides, and care should be taken to prevent preemergents from reaching the tubers.

Wildlife can be very destructive of newly planted chufa plots. Raccoons, deer, wild hogs, squirrels, and even turkeys will dig up the seedlings and young tubers. Chufa is difficult to establish in fields of 1 acre or less if raccoons are numerous or if turkeys feed regularly in the summer (Arner and Davison 1976). Holleman (1979) found that animals could be discouraged from damaging newly established plots by treating tubers with an asphalt-based repellent before planting; the substance will not wash off and is not harmful to wildlife, as it repels by odor. A trap and removal program may be required if damage by raccoons and hogs is extensive.

Chufa should always be protected from grazing by cattle and other domestic livestock because plants will not produce tubers until they have matured (Davis 1976, Holleman 1979). Care should be taken not to damage tops during the growing season if areas are mowed for weed control (Holleman 1979).

LITERATURE CITED

- Anderson, H. G. 1959. Food habits of migratory ducks in Illinois. Ill. Nat. Hist. Survey Bull. 27:285-344.
- Arner, D. H., and V. E. Davison. 1976. Wild turkeys on southeastern farms and woodlands. USDA Soil Conserv. Serv. Leaflet 526. 8 pp.
- Billingsley, B. B., Jr., and D. H. Arner. 1970. The nutritive value and digestibility of some winter foods of the eastern wild turkey. J. Wildl. Manage. 34:176-182.
- Coastal Zone Resources Division. 1978. Handbook for terrestrial wildlife habitat development on dredged material. U.S. Army Eng. Waterways Exp. Sta. Tech. Rep. D-78-37. 391 pp.
- Davis, J. R. 1976. Management for Alabama wild turkeys. Ala. Dep. Conserv. and Nat. Resour., Special Rep. No. 5. 53 pp.
- Davison, V. E. 1967. Attracting Birds: From the Prairies to the Atlantic. Thomas Y. Crowell Co., New York. 252 pp.
- Environmental Laboratory. 1978. Wetland habitat development with dredged material: Engineering and plant propagation. U.S. Army Eng. Waterways Exp. Sta. Tech. Rep. DS-78-16. 158 pp.
- Holleman, S. B. 1979. How to grow chufas for wild turkeys. Turkey Call Nov.-Dec.:12-13.
- Hunt, L. J., M. C. Landin, A. W. Ford, and B. R. Wells. 1978. Upland habitat development with dredged material: Engineering and plant propagation. U.S. Army Eng. Waterways Exp. Sta. Tech. Rep. DS-78-17. 160 pp.
- Killinger, G. B., and W. E. Stokes. 1951. Chufas in Florida. Univ. Fla. Agric. Exp. Sta. Bull. 419. 16 pp.
- Martin, A. C., and F. M. Uhler. 1939. Food of game ducks in the United States and Canada. U.S. Dep. Agric. Tech. Bull. 634. 156 pp.
- _____, H. S. Zim, and A. L. Nelson. 1951. American Wildlife and Plants. McGraw-Hill, New York. 443 pp.
- McAtee, W. L. 1939. Wildlife Food Plants. Collegiate Press, Inc., Ames, Iowa. 141 pp.
- Merrell, J. L. 1975. The effects of flooding on chufa (*Cyperus esculentus* L.). M.S. Thesis, La. State Univ., Baton Rouge. 116 pp.
- SCS. 1979. Management for wildlife: A supplement to wildlife standards and specifications for Florida. USDA Soil Conserv. Serv., Gainesville, Fla.
- _____. 1981. Wildlife upland habitat management, Rep. No. 645-6. USDA Soil Conserv. Serv., Jackson, Miss.
- Shields, R. H., and E. L. Benham. 1969. Farm crops as food supplements for whooping cranes. J. Wildl. Manage. 33:811-817.
- Stanton, F. W. 1957. Planting food for waterfowl. Oreg. State Game Comm. Misc. Wildl. Publ. No. 1. 17 pp.

USDA Forest Service. 1971. Wildlife habitat management handbook, Southern Region. USDA For. Serv. Handb. R8. 189 pp.

Wills, D. 1970. Chufa tuber production and its relationship to waterfowl management on Catahoula Lake, Louisiana. Proc. Southeast. Assoc. Game and Fish Comm. 24:146-153.

_____. 1971. Food habit study of mallards and pintails on Catahoula Lake, Louisiana, with notes of food habits of other species. Proc. Southeast. Assoc. Game and Fish Comm. 25:289-294.