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Full Length Research Paper

Diversity and production methods of fluted pumpkin (*Telfairia occidentalis* Hook F.); Experience with vegetable farmers in Makurdi, Nigeria

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Telfairia occidentalis **is an indigenous vegetable consumed by millions of people in Nigeria. The seeds are in high demand as they serve as food oil for making margarine. However, commercial growers in the middle belt zone of Nigeria, source telfairia seeds from south-eastern states of Nigeria. The growers claimed that seeds of the accessions grown in the area are not as viable as those from southeast Nigeria. Thus, seeds are scarce and expensive at time of planting. This survey sought to examine farmers' perception of diversity and determine the status of fluted pumpkin production as a basis for facilitating further studies, in order to help resolve the constraints to telfairia seed production. The results showed that farmers were predominantly female (78%), able to identify two cultivars 'Ugwu-elu' and 'Ugwu-ala' with their distinctive characteristics leaves, stem, fruit and seed. The crop was produced on low ridges, with two seeds planted in a hole about 6 cm deep, at a spacing of 31 x 45 cm, giving a population of approximately 71,700 plants/ha. Mulching and fertilizer use were not practised but weeding and irrigation were undertaken. Apparently, seed production is possible in Makurdi and breeders can breed for telfairia seed.**

Key words: *Telfairia occidentalis*, production method, diversity,

INTRODUCTION

Telfairia occidentalis Hook. F. (Fluted pumpkin), member of the family Cucurbitaceae is a cotyledonous plants (2n = 24) with about 90 genera and more than 700 species, which are distributed all over the warm parts of the world (Okoli and Mgbeogwu, 1983; Purseglove, 1977). It is an important leaf and seed vegetable indigenous to southeastern Nigeria, and found throughout the former forested areas from Sierra Leone to Angola and up to Uganda in East Africa. *T. occidentalis* is closely related to *Telfairia pedata* (Sims) Hook. (oyster nut) (Dalziel, 1937; Okoli, 1987) which is found in Zanzibar and along the coast of Kenya, Tanzania and Mozambique.

Among the important indigenous vegetables, telfairia seems to be widely eaten in Nigeria and cultivated for its edible succulent shoots and leaves as a backyard crop mainly by the Igbo tribe. With the spread of Igbos to other parts of Nigeria, *Telfairia* is now cultivated in almost all the parts of the country (Akoroda, 1990). In the middle belt, which is in the Guinea savanna region of Nigeria, *Telfairia* is now being cultivated not only as backyard crop but also as commercial crop during the wet and dry season.

The seeds are used as propagating materials, eaten roasted, boiled or ground to paste as soup thickener. Telfairia leaves are rich in Mg, Fe and fibres (Gupta et al., 1989; Taylor et al., 1983b; Olaofe et al., 1994) and are used as food supplements. The nutritional value of the fluted pumpkin seeds (53% fat and 27% crude protein, Taylor et al., 1983) justifies the wide consumption as reported by Ifon and Bassir (1980). The seed has an excellent pattern of amino acids 93.7% which contains higher levels of most essential amino acids (except lysine) than soyabean meal with 94.9%. Even the K and

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Na availability are higher in *Telfairia* seed (58.8%) than that of soyabean seed cake (54.9%) (Obidosa and Okoro, 1987; Esuoso et al., 1998). This indicates that *Telfairia* seed cake may be suitable to fortify foods, and the seed oil serves as food oil for making magarine. The high oil content makes it a potential source of raw material for the vegetable oil industries in Nigeria. These justify the apparent increase in its production in Nigeria. The fruit case and pulp of *Telfairia* which constitute 64% of whole fresh fruit weight can be used as feedstuff for livestock (Essien et al., 1992; Egbekan et al., 1998), and the pectin content of the pulp (1.0%) has been used in the production of marmalade (Egbekan et al., 1998). In some cases, *Telfairia* provides an appreciable cash income to small farm families (Akoroda, 1990).

Despite the high nutritional value of *Telfairia* and its importance, there is dearth of information on its methods of production and their constraints. *Telfairia* is recalcitrant in nature and seed storage is poor. The female plants are much desired by consumers and producers because of its succulent large leaves and the fact that it produces the pods. However the male to female plant varies, ranging between 0.17–1.10 and 1.00-1.10 (Onwueme et al., 1986; NIHORT, 1986; Anyim and Akoroda, 1983). It does well in the heavy rainfall area and late planting does not favour *Telfairia* production because dry season, will not allow extension of the period of crop production (Asiaba, 1982; Asiegbu, 1985). Organic manure and or inorganic fertilizers are needed for increase in leaf yield production at the rate of 30 kg N/ha, 100 kg/ha K_2O (Ossom et al. 1997, 1998) 22 kg/ha P (Obiagwu and Odiaka, 1995).

In the light of this, the objectives of the study are to determine: the availability of quality seeds, production methods of *Telfairia* by the local farmers, the constraints of production, the economics of production and to ascertain the knowledge they have on the diversity of the cultivated types of *Telfairia* which could help in crop improvement and characterization of the accessions.

MATERIALS AND METHODS

Background information on study area

This study was conducted in Makurdi metropolis the capital of Benue State located at latitude 7°37'N and 7°49'N and at longitudes 8°30'E and 8°43'E (Field survey, 1968) in the middle belt zone of Nigeria, in the Southern Guinea Savanna region. The relief ranges between 1000 m at the flood plains of river Benue to 200 m above sea level at Apil. Makurdi has a sandy and an alluvial type of soil with an average rainfall of 100 mm/year. Makurdi is in the central zone of Benue State (Figure 1) with river Benue separating the town into the north and the south banks (areas). The River Benue provides water for irrigation vegetables during the dry seasons and makes fadamas for dry season vegetable production.

Data source and questionnaires design

Primary data was collected using a structured forty four-point questionnaire, which was administered once to each respondent. The questionnaire design covered farmer's activities on their *Telfairia* plots, farm size, production inputs, techniques, and demographic issues. The study areas in Makurdi were the three major sites for dry season vegetable production, namely the north and south riverbanks and the lower Benue. Homestead farms, a common feature in Makurdi area were also observed. Subjective questions were asked from *Telfairia* producers who were target population for this study. A hundred (100) *Telfairia* producers along the riverbanks of Makurdi were interviewed on their farm sites. Quantitative data was generated for statistical analysis. Uncom-pleted questionnaires were disregarded and, fifty farmers were eventually used for analysis (Table 1).

Statistical analysis

Descriptive statistics (response frequencies, simple percentages and inferential statistics, and T-test) were used in analyzing the data. The SAS version 8 General Linear Model (SAS 1999) for correlation analysis and frequency procedure was used. Multiple regression analysis was used as a model to describe the causal relationship between the dependent variable (yield) and the independent variables. In this study, the plot size (ha), extension services, source of fund, usage of water pump, number of seed planted/hole, hilum position, plant population/ha, depth of planting in low ridges and seeding method (direct or transplant) were independent variables. Other independent variables are tribe, sex, age, farm size and cost of seed.

In quantitative terms, the relationship between the yield and factors affecting it can be expressed as:

$$Y = (x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9, E_1) \quad (1)$$

Where E_1 = error term, Y = yield, x_1 = plot size (ha), x_2 = extension services, x_3 = usage of water pump, x_4 = number of seed planted/hole, x_5 source of fund, x_6 = plant population/ha, x_7 =depth of planting, x_8 = hilum position, x_9 = seeding method (direct or transplant). The independent variable used as dummy variables are as shown in Table 2. Four functional forms: linear, exponential, semi-log and double-log functions were fitted to the data. In choosing the appropriate functional form, the regression co-efficient was examined for correct signs and significance including the coefficient of multiple determination as chosen and indicated by theoretical expectations. The significance of each variable coefficient was obtained by applying the t-test, which measures the significance of the contribution of each of the independent variables in explaining the dependent variable. The coefficient of multiple determination R^2 on the other hand, measures the ability of the explanatory variable to explain the variations in the dependent variables. The greater the R^2, the greater the percentage of the variations in the dependent variable would be explained by the independent variables. The closer the R^2 to zero, the worse the goodness of fit of the equation to the data. The F-test measures the significance of the R^2 (contribution of the overall independent variables in explaining the variations in the dependent variable). Profitability efficiency of the enterprise was analyzed using gross margin analysis with the equation below:

Gross Margin (GM) = Total Revenue (TR) – Total Cost (TC)

Gross Margin of fruit equivalent of shoots/fruits produced

% Gain = (GM / TC) x 100

RESULTS

Quality seed and its availability in Makurdi

The seed quality traits mentioned by the respondents

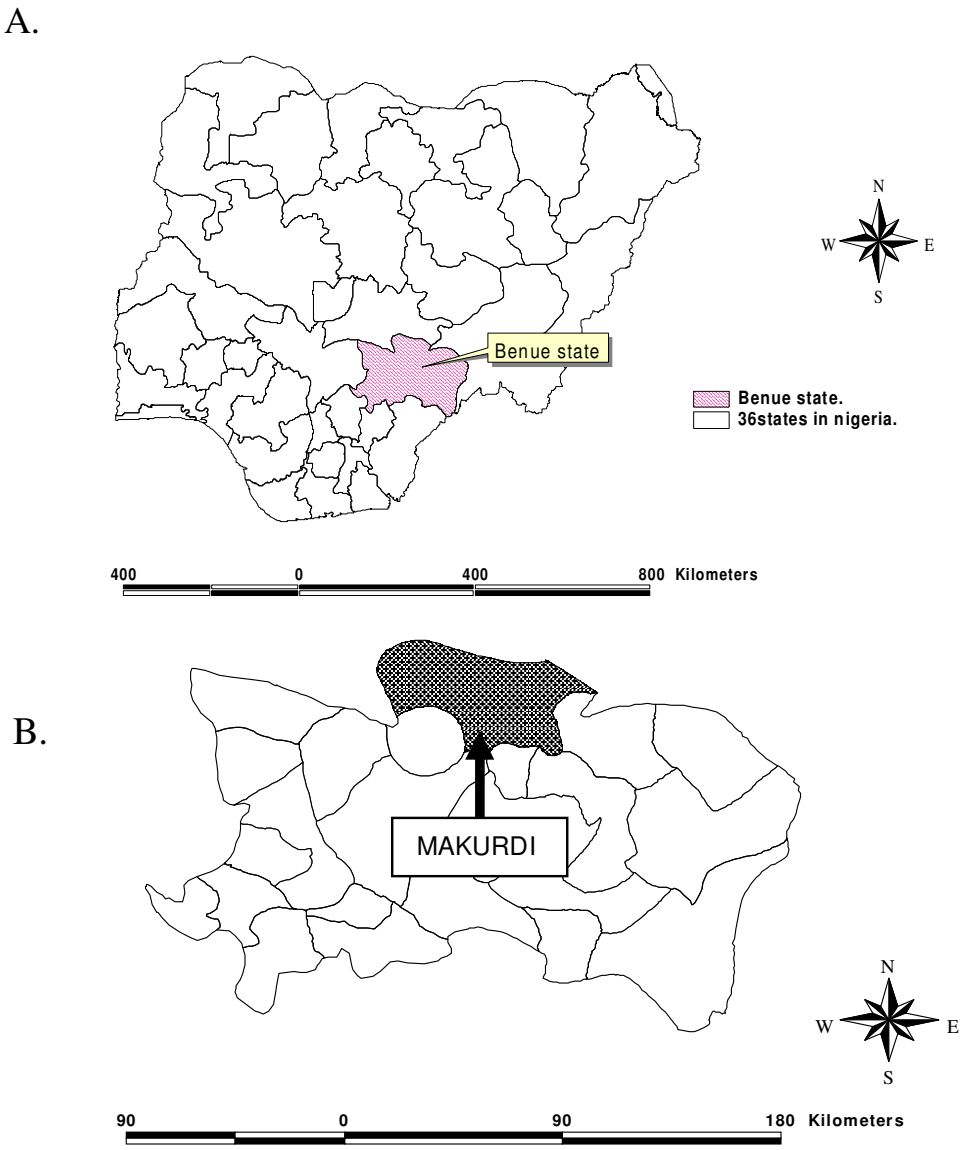

Figure 1. A. Map of Nigeria showing Benue state. B. Map of Benue State showing study area.

Table 1. Frequency distribution of fifty respondents by farm site in Makurdi.

Farm site	Frequency	Cumulative frequency	Percentage	Cumulative percentage
Home stead farms	5	5	10	10
North bank	10	15	20	30
South bank	10	25	20	50
Lower Benue	25	50	50	100

Source: Field survey (2003).

were physiological (that is, vigour, germination, emergence, time to seed maturity and storage) and genetic (variation within and among cultivars). *Telfairia* farmers assessed quality of *Telfairia* seed by how well they emerge few days after planting and subsequent establishment irrespective of the size of seed or planting method. In this survey 68% of the producers observed that quality seed had above 70% germination (Table 3).

Table 2. Expressions of dummy variables for factors affecting income from telfairia leaf producers.

Variable	Dummy = 1	Dummy = 0
Extension services	Personal experience	Other sources
Usage of water pump	Water pump is used	No water pump is used
Source of fund	Personal saving	Other sources
Hilum position	Hilum is consciously placed, downwards	Hilum is not consciously positioned (up or sideways)
Seeding method (direct or transplanting)	Direct planting	Transplanted seedling
Tribe	Benue State	Other states
Sex	Male	Female

Table 3. Availability of quality seeds among 50 responding telfairia leaf producing farmers in Makurdi.

Variables	Frequency	Percentage
Source of planting materials		
Local market	37	74.0
Distant market (Uturu in Abia State)	6	12.0
Personal farms	3	6.0
Neighbouring farms	4	8.0
Total	50	100.0
Availability of planting material		
Very regular	22	44.0
Regular	24	48.0
Moderate	4	8.0
Total	50	100.0
% Germination of telfairia seeds		
10 – 29% (very low)	0	0.0
30 – 49% (low)	1	2.0
50 – 69% (medium)	15	30.0
70 – 89% (high)	28	56.0
90 and above (very high)	6	12.0
Total	50	100.0

The main *Telfairia* market in Makurdi is the Railway Market where 74% of commercial producers source for seeds. These seeds are also available in Wurukum, North Bank, Wadata and Mordern market in Makurdi. The fruits sold at the railway market are brought from Isi-Ukwu-ato, Uturu and Nsukka in Abia, Imo and Enugu States (these are Igbo states where the plant originated from). Some producers travel to these states to source for seeds. During planting however, the supply of planting materials through these avenues had been regular (92% of respondents).

Cultivated *Telfairia* types planted by producers in Makurdi

From the survey, two types of *Telfairia* 'Ugwu-ala' (low-land telfairia) and 'Ugwu-elu (upland telfairia) were identified by 52% respondents. The identified *Telfairia* types are cultivated because of their different characteristics (14%), which compensateone another. The 'Ugwu-ala' with wide leaves and thick stem has slow growth rate while 'Ugwu-elu' with small leaves and thin vines has fast growth rate (Table 4), which allows for frequent harvest. Indicators of genetic seed quality identified by respondents were fruit size/maturity, seed colour and seed condition, leaf size, thickness of vine and condition of seed in the fruit.

Production methods of *Telfairia* occidentalis

The leaf production variables mentioned by respondents were time taken to initial harvest, season of leaf production, and frequency of harvest. Even though these were their direct responses, the factors mentioned can be

Table 4. Characteristics of cultivated telfairia types as reported by 50 responding telfairia leaf producing farmers in Makurdi during November 1999-February 2000.

Plant part	'Ugwu-ala'	'Ugwu-elu'
Leaves	Succulent wide leaves in high demand	Small leaves
Stem	Thick stem and very prolific slow growth rate	Thin long stem with high growth rate
Fruit	Small fruits Pulp colour is white or cream	Big fruits Pulp colour is light to deep orange
Seed	Seed colour is black Seed size is small Seed is smooth Seed does not split nor germinate easily in the pod	Seed colour is brown Seed size is big germination of seed is fast Seeds split and germinate easily in the pod

Table 5. Monthly activities of 50 responding *Telfairia* leaf producing farmers in Makurdi during November 1999-February 2000.

Activity	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug	Sept
Land Clearing	56*	10	4	16	8	6	-	-	-	-	-	-
Hole Digging	-	62	4	14	6	8	6	-	-	-	-	-
Planting	-	62	4	12	8	8	4	2	-	-	-	-
Watering	-	33	37	15	11		2	2	-	-	-	-
Weeding	-	-	33	27	12	14	4	4	4	2	-	-
Fertilizer application	-	-	40	8	16	16	8	8	-	-	4	-
Harvesting	-	-	33	29	12	4	8	2	8	4	-	-

Values are percentage response.

Table 6. Basic farm size of *Telfairia* plots in Makurdi.

Farm characteristics	Min	Max	Mean	Std. Dev.
Usual farm size at start Of telfairia enterprise (ha)	0.002	1.73	0.25	0.40
Present farm size at time of survey (ha)	0.004	2.0	0.29	0.47
Initial take-off cost (₦)	500	45,000	10,650	11,479

Std. Dev. = Stadard deviation; Ha =Hectares; ₦ =Naira; ₦130 = 1Dollar.

interpreted in terms of size of leaf, number of leaf, length of vine and thickness of vine. In the production of *Telfairia*, hoes, cutlasses, pumping machine, watering cans or buckets and small knives for harvesting are used. *Telfairia* production is throughout the year, with peaks at different times depending on the season (Table 5), and can be referred to as a dry season enterprise in Makurdi. Seasonal activities start in October with land clearing, and by November hole digging is at its peak. Seventy eight percent (78%) of the respondents plant *Telfairia* during the dry season between November and February with heavy watering in November through to May. Harvesting starts in December, and lasts for a period of 8 months (December to July). Few respondents plant between April and July as rainy season production in homestead farms. The average size of plot and the take off cost of *Telfairia* production by respondents is as shown in Table 6. Plot sizes of respondents that are more than half a hectare are either hired or leased (14% respondents). Two cropping patterns in *Telfairia* production identified were sole cropping (59% respondents) and intercropping with other vegetables such as pepper, okra, waterleaf, maize, amaranth, tomatoes and garden egg (41% respondents). Planting on flat and on low ridges are prominent methods of tillage practices (88% of the respondents), while 12% plant on beds and on mounds. There were no standardised or formalised techniques of producing *Telfairia*. For instance, more than half (56%) of the respondents plant seeds with hilum position placed downward, upward or sideway (Table 7). The total number of seed/seedlings per hole ranged from 1 to 3 seeds, with a mean number of 2 seeds per hole (Table 8). With 2 seeds planted per hole germination of at least one seed is guaranteed. Seeds are planted directly (90%

Table 7. Distribution of production methods of 50 responding *Telfairia* leaf-producing farmers in Makurdi.

Variables	Frequency (n = 50)	Percentage (total = 100)
Seed position on telfairia	0	0.0
Hilum up	21	42.0
Hilum down	1	2.0
Hilum sideways	28	56.0
Planting seed any how		
Mode of water supply	13	26.0
Watering can/bucket	8	16.0
Water pump	11	22.0
Both	18	36.0
No response		
Frequency of the use of water pump		
Every day	3	8.3
Once a week	27	75.0
Once in two weeks	6	16.7
Do not know	14	28.0
Time of initial harvest of telfairia shoots		
3 weeks after emergence	3	6.0
4 weeks after emergence	13	26.0
5 weeks after emergence	6	12.0
6 weeks after emergence	28	56.0
Harvesting intervals of telfairia shoots		
Everyday	4	8.0
Once a week	6	12.0
Once in 2 weeks	18	36.0
Once in 3 weeks	16	32.0
Once in 4 weeks	6	12.0
Storage of telfairia leaf		
Put under shade and water regularly	5	10.0
Put in local basket under tree and sprinkle regularly	13	26.0
Put in a bacco bag free from water	12	24.0
Put in an open shade do not sprinkle with water	20	40.0

Table 8. Basic production methods of *Telfairia* by 50 responding *Telfairia* leaf producing farmers in Makurdi.

Production method	Min.	Max.	Mean (± SD)
Total number of seed per hole	1	3	2 ± 0.57
Planting distance between plants (cm)	15	60	31 ± 9
Planting distance between rows (cm)	30	90	45 ± 16
Planting depth (cm)	2	8	5 ± 1.8

respondents) on the farm or transplanted with seedlings from personal nurseries. Plants are spaced at 0.45 x 0.31 m with a plant population of 71,429 plants/ha. An opening of 11 cm depth is made in which a hole of 6 cm depth is dug and the seed planted in it (Figure 2). *Telfairia* plants are not mulched, but are irrigated with water from river Benue and ponds around the farms. Seventy five percent of the producers irrigate *Telfairia* farms at least once a week (Table 7). Thirty four percent of the respondents adopted both watering can and water pump. Among those that use water pump, majority (82%) hire pumps. The cost of hire per day ranges between ₦200 and ₦500 ($1.5 and $3.8) with a mean cost of ₦381 ± ₦140. ($2.9± $1.07)

Twenty six percent (26%) respondents reported that pests and diseases of *Telfairia* plants in Makurdi are not severe. The study showed that no respondent used insecticide, however, 62% respondents enumerated

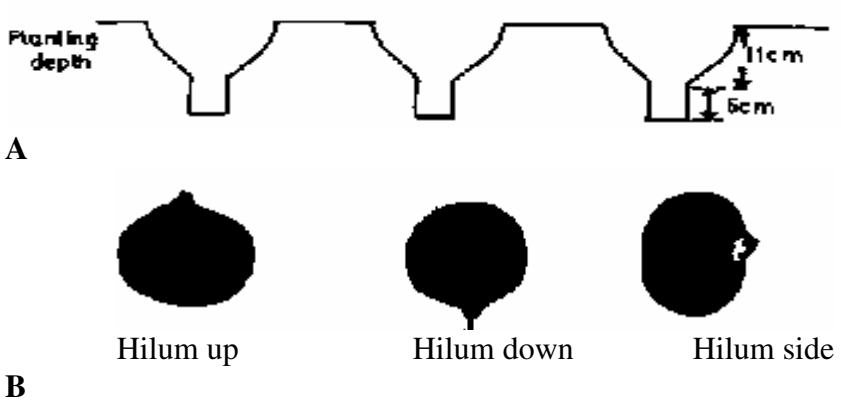

Figure 2. Sowing techniques of *Telfairia occidentalis.* A. Depth of planting. i. Opening before planting (11 cm). ii. Actual depth of seeding (5 cm); B. Hilum position during seeding.

things that sometimes destroy their crop among which are insect pests, weed, goats, termites, 'maggots' and drought. These insects and pests problems are controlled using wood ash (21% respondents) or 'Yoruba powder' also known as Piff paf (10% respondents). Some respondents (48% respondents) do not use anything to control the pests. Majority of the respondents (98%) do not use inorganic fertilizer or manure and more than half (52%) reported that fertilizer made no difference in yield. Weeding constantly by hand (78% respondents) and remoulding the very low ridges (14% of respondents) are control measures for weeds. More than half of the respondents (56%) start harvesting 6 WAE and 68% respondents harvest *Telfairia* shoots at an interval of 2 – 3 weeks. The harvest interval depends on the cultivated *Telfairia* type and the rate of growth of the plant while frequency of harvest depends on availablility and readiness of buyers.

Respondents obtain information on production techniques mainly from older farmers (51.1%) who have experience in the enterprise. On storage however, it was observed that *Telfairia* leaves do not store for longer than 14 days (68 % respondents) as the leaves wilt easily. The common method of leaf storage among respondents is in the use of an open shade without the sprinkling of water (40% respondents). Other methods are the use of local basket under tree and sprinkling water regularly (26.0%), the use of 'bacco' bags free from water and the use of under shade and water regular sprinkling of water (10%). Though most respondents (60%) do not produce fruits, few respondents (40%) store-harvested fruits under a tree or a cool place (12%) or leave the fruits on the plant until planting time (22% respondents) for 1– 3 months before planting. More than half of the respondents (56%) start harvesting 6 WAE and 68% respondents harvest *Telfairia* shoots at an interval of 2 - 3weeks. The harvest interval depends on the cultivated *Telfairia* type and the rate of growth of the plant while frequency of harvest depends on availablility and readiness of buyers.

The only method of storing seeds is to dig a hole, and pour the seeds in the hole in a swampy place (58% respondents). Funds for *Telfairia* leaf production viz a viz seed production is mainly from personal savings according to 80.4% of the producers.

Factors affecting yield of telfairia shoot production in Makurdi

To determine the factors that affect the yield of *Telfairia* shoots from the survey, four functional forms were used in the regression analysis Yield = (x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9, E_1) and only two, semi-log and linear were significant at p = 0.05 (Table 9). The independent variables were hilum position, plot size (ha), extension services, usage of water pump, number of seed planted, plant population, depth of planting and seeding method (direct or transplanting). The semi-log gave the best fit with R^2 value of 0.52, and the F-value was significant at 1% level, which was preferred because it had the highest value of R^2 = 0.52. Significantly, the plot size, usage of water pump, plant population, depth of planting and seeding method explain the 52% variation in yield at p = 0.05.

The positive sign on the coefficient of the plot size and plant population implies that the larger the plot size and as the plant population density increases, the higher will be the yield generated. Also the positive sign on depth of planting indicates a positive relationship with yield. Increasing the depth of planting for example (from 2 to 8 cm) increases leaf yield of *Telfairia*. The negative sign on the usage of water pump confirms the observation on the field, that the use of irrigation is minimal and when irrigation is not often used, there will be decrease in yield. For large-scale farmers therefore, optimum yield may not be achieved if irrigation is not used during dry season

Table 9. Regression analysis for shoot yield of 50 responding telfairia leaf producing farmers in Makurdi

Independent variables	Functional form	
	Linear	Semi-log
Constant term	39.2 (37.0)	-215.8 (176.3)
Plot size (hectares)	67.1(15.5)*	21.2(3.7)*
Extension services	-15.1 (17.0)	1.4 (15.4)
Usage of water pump	-14.8 (17.4)	-26.9 (15.4)***
Number of seed planted/hole	-1.0 (13.1)	-5.3 (17.5)
Plant population/	0.003 (0.002)**	34.9 (14.5)**
Depth of planting in low Ridges (cm)	3.4 (3.9)	36.0 (16.7)**
Hilum position	-14.1 (15.2)	-9.3 (13.4)
Seeding method (direct or transplanting)	-44.6 (25.2)***	-0.04 (0.02)***
R^2	0.39	0.52
R^{-2}	0.27	0.43
F	2.90**	5.53**

* = Significant difference at p< 0.05; ** = Significant difference at p< 0.01; *** = Significant difference at p< 0.001; Figures in parenthesis are the standard error.

cropping.

Associated constraints and prospects of *Telfairia* shoot/fruit production in Makurdi

Problems identified by respondents in the production of *Telfairia* are short supply of quality seed (25.9%), labour shortage (15.7%), lack of technical advice (4.6%), weed infestation (3.7%), lack of alternative land (2.8%), inadequate funding (1.9%), scarcity of fertilizer (1.9%), rodents (0.9%) and poor sales during the rainy season (0.9%). However, 0.9% believe that they do not have any problem.

Seventy eight percent of the respondents considered the prospects in *Telfairia* production to be high, while 22% feel it is moderate. The least significant of all the problems is that of low sales during the rainy season (0.9%) and rodents disturbance (0.9%), while the scarcity of quality seeds ranked highest (25.9%). Paramount in the minds of respondents (76%) in cultivating *Telfairia* leaves is the seasonal profitability. Most respondents (78%) believe that the enterprise has very bright and promising future because of its high profit margin.

DISCUSSION

Quality seeds are available in Makurdi, through local seed supply system and are sourced from distant markets in the southeastern states of Abia and Imo states in Nigeria. This is as a result of the origin of *Telfairia* from the eastern parts of Nigeria as reported by Akoroda (1990) and the speculation by the respondent that seeds from these parts of the country are of better quality with regards to physiological and genetic quality. Respondents had good knowledge on the diversity in physiological and genetic traits of cultivated types of *Telfairia*. With critical assessment by the farmers on the cultivated types, in Makurdi, two cultivars were identified as 'Ugwu-elu' and 'Ugwu-ala' with distinct variations in four morphological traits, the leaf, stem, fruit and seed. The distinguishing characters were the seed size (physiological quality), thickness of fruit ridge, size of the fruit, leaf size, leaf area and the thickness of vine (genetic quality). The different cultivars 'Ugwu-ala' with wide leaves, thick stem and slow growth rate compensate the 'Ugwu-elu' with small leaves, thin vines and fast growth rate, which allows for frequent harvesting. These are desired traits for commercial producers to enable them maximise profit. Other traits identified were fruit size, seed condition, leaf size, thickness of vine and condition of seed in the fruit, which are genetic and could help breeders in crop improvement, and characterization of the accessions.

Telfairia commercial leaf production in Makurdi is seasonal with few respondents producing fruits for consumption and not necessarily for propagation. Production starts between October and November to the beginning of the rainy season and ends between July and August when the river Benue starts over flooding its banks. Low ridges are made at time of planting contrary to Oluchukwu and Ossom (1988) recommendation that *Telfairia* should be planted on flat. To ensure germination and high yield, two seeds were planted directly in the soil and this is in line with the suggestion by Flood in 1978. In order to maximize the space by the river bank, and eventually have a high yield and high income from the produce, the planting distance is 45 x 31 cm with a population of 71,685 plants/ha, which differs from the

40,000 plants/ha recommended by NIHORT (1998) for fruit production and 70,000 plants/ha by Olufolaji (1999). Though staking is a common phenomenon in the backyard leaf/fruit production of *Telfairia* because of heavy rains, for commercial leaf production in Makurdi there is no staking due to the harvesting method, and this does not affect the yield (Olufolaji, 1999).

There is no fertilizer application to *Telfairia* plants, and the non-usage of fertilizer by most respondents was because of the alluvial soil deposits on the riverbanks. This alluvial soil retains water and nutrients needed by the plant. When combined with the deposited decomposed materials by the riverbank, it will release enough nitrogen (N) that could sustain plant growth. The combination complies with fertilizer requirements of *Telfairia* plants (Obiagwu and Odiaka, 1995; Ossom et al., 1997).

Though irrigated plants are mulched with grass during the dry season to reduce evapotranspiration (Okugie and Ossom, 1988), mulching was not practiced in the study area. The plants serve as cover to the root zone of the crops. Contrary to Asoegwu's suggestion in 1988 of irrigating *Telfairia* plants at three days interval, *Telfairia* plots were irrigated once every day with bucket or weekly with pumping machine. The high daily temperature and low relative humidity causes high evapotranspiration in Makurdi and requires more water for the plants. There is need therefore for *Telfairia* producers to own pumping machines to meet the water need of the plants. Since the producers do not have the funds, this could be addressed if respondents join functional *Telfairia* associations or co-operatives to facilitate bank or co-operative loans to enable them buy water pumps.

Weeding was done with hand every four weeks around the base of the plant to keep the plots weed free, and minimize pests' and disease attack on *Telfairia* plant. Though there were cases of yellowing of leaves, producers prune and discard such.

Oluchukwu and Ossom (1988) suggested the use of the length of vine as harvest indicator, but *Telfairia* growers in Makurdi use initial harvesting time (five weeks after emergence) as their indicator. The harvest interval of three weeks used by producers in Makurdi falls within the range of 2 to 4 weeks that was recommended by Asiegbu (1983) and Ossom (1986). Few fruits are harvested during the rainy season, and the dry season producers rarely harvest fruits. The reason being the method of harvest, site of production (river bank that floods at flowering) and lack of interest in seed production due to the belief that seeds from the east of Nigeria do better than those produced in Makurdi. *Telfairia* shoots are cut at the base close to a new shoot to allow an offshoot of another branch of the plant for frequent harvest.

Storage is possible for the leaves and the fruits but for a few days. *Telfairia* leaves can be stored for three days in a cool place like other leafy vegetable. Though *Telfairia* seeds are recalcitrant, and they loose viability easily (Akoroda, 1986) the fruits are stored in a cool dry place for a period of 3 months while seeds are stored for a period of 5 days, in a moist opening or close to a swampy place that is covered with soil.

There were socio-economic factors that affected production which were also considered. The producers were within the age group that constitutes the energetic work force in the society, and are economically active and productive as also reported by Ekong (1998) in other crops. Majority of the producers are Christians and this may be as a result of the origin of the crop, which, according to Akoroda (1990) is the South Eastern part of Nigeria, an area dominated by Christians. The high percentage of married respondents, suggests that majority of the producers are likely to have moral/financial support, and encouragement from their spouses. On the contrary, the few widowed and separated respondents may loose such facilities and probably face the problem of take-off funds, and possible labour shortage. It is therefore, safe to assume that with the opportunities available, and the profile of the respondents' *Telfairia* production could be a viable enterprise. With little support from external sources and increase in the workforce, Makurdi producers may emerge as a leading supplier of *Telfairia* leaves to many parts of the country especially the northern states where at the moment exhibit a high demand for it. A high number of literate *Telfairia* producers are civil servants, and this suggests that majority of the producers are likely to be more predisposed to experimentation and receptive to new packages that will enhance production. Thus the ability to conduct personal trials makes them easy adopters of new technologies, which will increase, yield and consequently enhance income. Besides, they may be more critical of the activities of middlemen, thereby minimizing cheating and making better sales. Although some of the producers are civil servants, a good number of them take advantage of river Benue and the large expanse of land to fish and later farm other crops during wet seasons, thus providing initial take-off capital for *Telfairia* production during the dry season, when maximum economic production is achieved. At this time, the factors of production are combined in the best proportion and the enterprise is operated under conditions of increasing returns. The information on *Telfairia* market structure reveals both wholesale and retail markets from within and outside Makurdi. The mode of transportation confirms that the demand of *Telfairia* shoot from the northern state has increased.

The need to know is seen as a fundamental right which is necessary for the proper functioning and development of human beings and the social environment (Odiaka et al., 1999). It is therefore not surprising why few of the respondents who did not have formal education seek for information from fellow literate farmers while, those respondents who are not members of the *Telfairia* produ-

cers association, get their information through interpersonal links. It is possible that the behaviour of models among them offers a reinforcement that motivates others to seek for information. However, it might be necessary for the Benue State Agricultural Development Authority (BNARDA) to use the extension service system to educate *Telfairia* producers and encourage them to join co-operative societies. This will enforce sustained loyalty, provide take-off loans or facilitates bank loans, and ensure easy access to land and standardization of produce and prices. Some NGO's are promoting the participation of women in vegetable production, conservation and utilization as reported by Karim and Wee (1996) *Telfairia* producers are encouraged to identify with such organizations.

Leaf yield of the respondents varied significantly and the regression analysis on survey data listed plot size, irrigation technology, plant population, depth of planting and seeding method as factors that caused variations in shoot yield. The positive correlation between plot size and plant population implies that the bigger the plot size, the more the plant population density increased and as a result the yield increases. Also the depth of planting and seeding method indicated a positive relationship with yield. To have high yield therefore, these factors must be taken into consideration.

Other constraints were the cultivars planted with fast and slow growth rate, season of cultivation, spacing, frequency of harvest and plant population were factors that could affect leaf production in Makurdi. Seed and irrigation are major inputs and they constitute the major constraints in the production of *Telfairia* in Makurdi. This was so because other inputs such as land could be leased, labour could be from the family and no chemical such as fertilizer or insecticide was needed. Acquiring pumps by respondents could be a cheaper means of managing farms.

Commercial production of *Telfairia* shoot can start on 0.002 hectares and on an average of 0.25 hectares with ₦500.00 and ₦10, 650 respectively, which was enough to buy seeds. This initial take-off fund can come from savings from other enterprises and a gain of 83% is profitable for producers because this is aside other enterprise they also do.

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Summary and conclusion

The important indigenous vegetable *T. occidentalis* though grown and consumed in Makurdi, Nigeria, has its seed obtained in the further south because of the belief that seeds produced in the south eastern states of Nigeria do better in leaf production than seeds produced in Makurdi. The major findings are that quality seeds are available at time of planting in Makurdi. *Telfairia* producers experience high percentage germination and establishment in Makurdi. This substantiates the believe that the seeds they source from the South Eastern states of the country are truly high quality seeds. These seeds grow into vigorous plants with slow and fast growth rates differing in the size of seed, fruit, vine and the leaf, information useful to seed production agronomists and breeders for crop improvement. Method of production is quite easy and cheap with no staking, no mulching, no insecticides and no fertilizer and yet they have high yield. However, the major constraints to *Telfairia* shoot production were the high cost of quality seeds and water pumps. These constraints can be taken care of if agricultural extension and developmental workers will encourage farmers to produce seeds on their own rather than depending on seeds from the eastern part of the country. The farmers should also be encouraged into joining co-operative societies where they could have easy access to water pumps. Seeding method was one of the factors affecting yield from the survey result and this factor need s to be investigated to know the best method for the best establishment. Nevertheless, a hectare plot size for commercial production, needs a minimum take off fund of ₦210, 572 to give revenue of ₦386, 000 and a gain of 83%. Total fruit equivalent of fruits/shoots produced 2,056 fruits and the price of fruit equivalent of fruits/shoots produced ₦514, 000 with a gain of 144%. If the constraints of production are redressed, farmers could increase their farm size, to meet the ever-increasing demand for *Telfairia* shoot and fruit, within and outside Makurdi.

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