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Economic Potential of Irrigated Improved Citrus Seedlings in Nigeria

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Abstract
Sourcing of viable seeds from quality rootstocks had been the major constraints in profitable citrus seedling production in Nigeria. 250,000 rootstock seeds extracted from 17,500kg of rough lemon fruits, treated with benlate were planted on the field in February, 2014 with adequate watering for optimum germination. Surface irrigation system using indigenous pipes connected to 100m^3 reservoir was adopted for water supply thrice weekly. The three month old seedlings were transplanted into the main nursery in May, 2014 at 30 cm by 30 cm spacing. Budding activities using satsuma, sweet orange and tangelo budwoods were carried out three months after transplanting, having attained a pencil size in July, 2014. Bud takes were evaluated six weeks after budding and found to have achieved more than 65% success, thereby confirming rootstock / budwood compatibility with minimal deformation at the points of union. Economic analysis and total energy consumption of the processes were determined. Results indicated that 21,667kg of seedlings were produced at a value price of $2.29/seedling, gross value of production at $49505. 71; total cost of production at $7499. 13; Net Return of $82506. 66 in 5yr period and internal rate of returns (IRR) > 70%. Energy use efficiency was 1.96; energy specific, 1.56; energy productivity, 0.64; net energy gain, 8630.51 with corresponding water and energy productivity of 0.51. Non-renewable energy constitutes more than 49% of the total energy input. Overall result showed that improved irrigated citrus seedling production is a viable entrepreneurship with an IRR of higher value than the current interest rate.

INTRODUCTION
Improved citrus seedling production in Nigeria is faced with so much constraint thereby constituting threats to orchard establishments and particularly fruits and juice production. Citrus production was originally associated with northeastern India (Ortese et al., 2012) with Rutacceau as the predominant grown species. However, literature has shown that Nigeria citrus annual production stands at 105 million metric tons and ranked as the 9th world best producer (Ortese, 2012). Interestingly, Citrus production in Nigeria is mainly established during the months of May and June in the south and July in the north, possibly due to non-availability of supplemental irrigation despite the diverse weather profiles and abundant water resources sufficient to accommodate unrestricted and indeterminate plantings. Basically, two major rootstocks are used in Nigeria. They are Cleopatra Mandarin in the south and Rough Lemon in the north. This is due to genetic resistance to soil borne diseases, rootstock/budwood compatibility and weather hazards. Succinctly, expected income generated from citrus fruit production makes agricultural financing non-attracting due to excessive overheads or production cost which could have been minimized using grassroots indigenous technology for provision of inputs. Most service-providers produce potting and other planting materials at cut-throat prices, thereby raising the production cost per unit of product beyond the reach of the average farmers, thus denying the farmers efficient use of their resources in agricultural business. It is therefore obvious that product optimization and consideration of the economics of production are paramount, not only in terms of energy involvement but also in terms of income generation. Most energy papers concentrate mainly on the use of questionnaires which may not be very accurate due to lapses or error of judgment or assumptions from the farmers. Moreover, research has reported the influence of energy use on production cost (Fadavi et al., 2011; Liu et al., 2010; Longhman Pour et al., 2013; Yilmaz et al., 2005, and Conaki et al., 2009; Jekayinfa et al., 2013; Sara et al., 2011) of various crops (Potato, Apple, Grape, Carrots, Maize, Silage, Pine-apple and Citrus) with little or no information any on tropical fruit tree seedling production which serves as fundamental stocks for orchard establishment and fruit production. Principally, economic indices and energy use considerations are included in this study.

METHODOLOGY
This study was carried out at the National Horticultural Research Institute, Bagauda, Kano (11^{0}33^1 N, 8^0 23$^'$E altitude 476m). Seeds of rough lemon fruits were extracted and treated with benlate, seed dressing insecticide and planted in the field in February, 2014. All necessary cultural and agronomic practices were duly observed from planting to budding stage. The quantity of inputs used in these citrus seedlings production (Human Labour, gasoline fuel, machinery (Polythene bags, budding tape, soils, tools), chemicals (Insecticides), chemical fertilizers, farmyard manure, water, and seeds) were calculated per hectare and later converted to forms of energy to evaluate economic analysis, input and output total energy balance in agreement with the study carried out by Ebrahim et al., 2013) using energy equivalents developed by various researchers (Table 2).Energy indices in this study which

include energy ratio, energy productivity, energy intensity, (energy specific, net gain intensity, water and energy balance) were calculated based on equations reported by (Ebrahim et al., 2013; Sara et al., 2011; Dehshiri, 2011):

$$\text{Energy ratio} = \frac{\text{Energy output } (MJha^{-1})}{\text{Energy Input } (MJha\text{-}1)} \quad \text{- (i)}$$

$$\text{Energy Productivity} = \frac{\text{Citrus seedlings yield } (Kgha^{-1})}{\text{Input energy } (MJha^{-1})} \quad \text{- (ii)}$$

$$\text{Energy intensity} = \frac{\text{Input energy } (MJha^{-1})}{\text{Citrus seedlings yield } (kg\ ha^{-1})} \quad \text{- (iii)}$$

$$\text{Net energy gain} = \text{Output energy } (MJha^{-1}) - \text{Input energy } (MJha^{-1}) \quad \text{----- (iv)}$$

$$\text{Water and energy productivity} = \frac{\text{Citrus seedlings yield } (kg\ ha^{-1})}{\text{Water applied } (M^3ha^{-1}) / (\text{Input energy } MJha^{-1})}$$

Reports had also shown (Ebrahim et al., 2013; Ozkan et al., 2004) that for the purposes of growth and development of crops, energy demand is classified into direct energy (DE), indirect energy (IDE), renewable energy (RE) and non-renewable energy (NDE). IDE covers seeds, fertilizers, farmyard manure, chemicals (insecticides), machinery; DE encompasses human labour, water for irrigation and diesel; RE encompasses human labour, seed, manure; NRE includes gasoline, diesel, chemical, fertilizer and machinery. These were evaluated accordingly (Ebrahim et al., 2013). Energy equivalent of citrus seedling production is not found in literature, thus it was estimated as one- fourth of the energy equivalent of citrus fruit production based on the gestation period of budded citrus seedlings put at 12 months compared to economic yield period of a mature citrus tree of 4 years.Smilarly, energy equivalent of soils is not included in literature either, therefore it was observed that since nitrogen availability from soil is much lower than that of manure and chemical fertilizer, 1kg manure has been calculated to substitute 0.428 kg chemical fertilizer (Liu et al., 2010); Hulshergen et al., 2011) while 1kg soil substitutes 0.075kg chemical fertilizer. Soils with similar weight with manure during transportation requires 0.005MJ/Kg.km (Pimentel et al., 2008).Seedling population at the main nursery in readiness for budding spaced at 0.3m by 0.3 m was calculated as 111,000 per ha. Economic analysis was calculated based on the equations reported in literature (Mohammadi et al, 2008) which include gross value of productivity ($\$ha^{-1}$) = yield ($kgha^{-1}$) x $\$kg^{-1}$) – (i)

Net return ($\$ha^{-1}$) = Gross value ($\$ha^{-1}$)–Total cost of production ($\$ha^{-1}$)—(ii);

$$\text{Productivity } kg\$^{-1} = \frac{\text{Yield (kg ha-1}}{\text{Total cost}} \quad \text{---- (iv)}$$

$$\text{Benefit cost ratio} = \frac{\text{Gross value of production } (\$ha^{-1})}{\text{Total cost of production } (\$ha^{-1})} \quad \text{— (iv)}$$

Net profit value (NPV) was calculated using equation - (v):

Discount factor was evaluated using equation (vi):

$P(T) = \frac{1}{(1+r)t}$; P (T) = discount factor; r = interest rate; t = time.

Internal rate of return (IRR) was carried out by trial and error until NPV almost approaches zero.

RESULTS AND DISCUSSIONS

Table 1 shows the cultural practices of improved irrigated citrus seedling production. The period covered December to September. December is peculiar because rough lemon fruits are normally available for harvest and processing within November and December. The various inputs used in the production of improved citrus seedling and their corresponding total energy equivalents with percentage and output potential are recorded in Table 3. Budding activities exhibited a significant share with 38.3% of all the labour inputs followed by the time expended in the preparation of polythene bags. This trend reveals the need to develop a small scale machine for polythene production to further minimize cost and save energy. Similarly, nitrogen played a dominant role in the application of fertilizer with 87.2% of total chemical fertilizers used. However, organic manure or conversion of both crop and animal wastes into compost stands out as the viable means of reducing the use of chemical fertilizers. Generally, the use of diesel was highest at 14% of the total input followed by fertilizers and transportation and tools constituting the least at 0.01% in agreement with Loghmanpuor et al, 2013); Burham et al , 2003); Sara et al, (2011). Total energy input in the form of direct, indirect, renewable and non-renewable energy is shown in Table 4. The amount of energy associated with direct, indirect, renewable and non-renewable energy were 6570.1 $MJha^{-1}$; 12,711.6 $MJha^{-1}$; 4570.88 $MJha^{-1}$; and 23, 324.38 $MJha^{-1}$ respectively showing non-renewable energy as the predominant energy suggesting that improved citrus seedlings cultivation was highly dependent on non-renewable energy (Gasoline, chemicals fertilizers and machinery).Therefore effective management of gasoline, chemicals fertilizers and machinery is essential to enhance reduction in the use of non-renewable energy in tandem with the work of Loghmanpuor et al., (2013) .Average yield of improved citrus seedling was 21,667$kgha^{-1}$ (Table 5). Loghmanpuor et al., 2013) reported that output energy ratio is often used in energy balances in describing energy efficiency in agricultural production, and was adopted in this study. Energy indices (energy use efficiency, energy specific, energy productivity, net energy gain and water and energy productivity) of improved citrus production are shown in Table 5. Energy efficiency was calculated as 1.96 indicating optimum use of energy in the cultural systems of improved seedling production. Energy specific was 1.56MJkg $^{-1}$ showing that 1. 56 MJ was required to cultivate 1 kg of improved citrus seedling. Energy productivity was 0.64 kgMJ^{-1} meaning that 0.64 kgMJ^{-1} of output was obtained per unit of energy in confirmation with Ebrahim et al., (2013). Net gain was 8630.51 MJha^{-1} with corresponding water and energy productivity as 0.51gm^{-3} MJ^{-1}. Cost and return components of improved citrus seedling production are shown in Table 6. Energy expended in any agri-business without cost and return analysis could spell doom for a viable project. Cost price per kg of citrus seedling was calculated at $2.29. Gross value of production, total cost of production, net return, benefit cost ratio, NPV, and IRR indicate $49505.71, $7499.14, , 5.6, $2506.66 and 70% respectively as indicated in Table 6. Therefore, improved irrigated citrus seedling was highly cost effective under irrigation, thereby suggesting that economic success in citrus seedling production was enhanced by extensive level of basic cultural management

CONCLUSION

Citrus fruit cultivation in Nigeria has not properly integrated energy use as key indicators of economic success. Similarly, improved citrus seedling production inputs are not well documented to enhance energy input evaluation. However, this study has revealed the need for further research in the area of economic analysis and energy use components of citrus seedling production thereby bridging an enormous gap militating against production. Generally, the BCR, NPV and IRR recorded in this work provided an eye-opener in following up all necessary inputs in agricultural productivity as this will encourage proper costing and return analysis.

Table 1: **MANAGEMENT PRACTICES OF IRRIGATED IMPROVED CITRUS SEEDLINGS PRODUCTION**

Production Practices	**Periods/Duration and Procurement**
Transportation of fruits	November/December
Extraction of seeds	December/January
Seeds Dressing and Drying	January
Land Preparation	January/February
Planting of Seeds	February
Mulching of Seeds	February
Fertilizer Application	February-APN
Weeding	March-August
Insecticide Application	March-August
Irrigation Water supply	February-June
Pruning	May-June
Budding	July- September
Lifting and Potting of Seedlings	August-September
Production of Polythene bags	July- September
Procurement of Soils	July- September
Procurement of Farmyard Manure	July- September

Table 2: Energy Consumption and Energy Input-output Relationship for Irrigated Improved Citrus Seedlings

Input	Quantity/Unit Area (ha)	Energy Equivalent MJ/(Unit)	References
Human Labour (h)	**913.3**	**1.96**	**Singh et al., 2002**
Land Preparation	10		
Extraction of Seeds	21.3		
Planting	6		
Irrigation	90		
Weeding	20		
Insecticides	10		
Pruning	100		
Preparation of bags	240		
Budding	350		
Transplanting	50		
Fertilizer	6		
Irrigation Water (m^3)	144	1.02	Rafiee et al., 2010
Seed (Kg)	100	3.6	Beheshi et al., 2010
Insecticide (kg)	8.3	101	Eldal et al., 2010
Soils (t)	20	53	Rafiee et al., 2010
Manure (t)	4	303	Esengun et al., 2007
Diesel (L)	100	47.8	Kitani, 1999
Poly bags (Kg)	2	202	Tippavawong, 2003
Fertilizer (kg)			
- Nitrogen	60	60.6	Singh et al., 2002
- Phosphorus	30	11.1	Singh et al., 2002
- Potassium	30	6.7	Singh et al., 2002
Budwood (kg)	100	0.2	Pellizzi, 1992
Budding tape (nylon) (kg)	5	202	Tippavawong, 2003
Gasoline (Petrol) (L)	200	42.3	Cervinka, 1980
Transportation (kg.Km)	500	0.01	Pimentel, 2008
Tools	21.7	0.1	Wen, 1987
Yields (kg)	21,667	1.96	Kitani, 1999

Table 3: Energy Equivalent for Input-Output In Irrigated Improved Citrus Seedlings

Input	Total Energy Equivalent MJ	Percentage (%)
Human Labour (h)	**1790.7**	**3.14**
Land Preparation	19.6	1.1
Extraction of Seeds	41.75	2.3
Planting of Mulching	11.76	0.7
Irrigation	176.4	9.9
Weeding	39.2	2.2
Insecticides	19.6	1.1
Prunning	19.6	10.9
Preparation of bags	470.4	26.3
Budding	686	38.3
Transplanting	98	5.5
Fertilizer	11.76	0.7
Irrigation Water (m^3)	146.88	0.3
Seed (Kg)	360	1.06
Insecticide (kg)	839.96	2.5
Soils (t)	1060.9	3.1
Manure (t)	1212.4	3.6
Diesel (L)	4780	14
Poly bags (Kg)	4035	11.9
Fertilizer (kg)	4170	12.3
- Nitrogen	3636	87.2
- Phosphorus	333	8
- Potassium	201	4.8
Bud wood (kg)	20	0.06
Budding tape (nylon) (kg)	1008.75	3
Gasoline (Petrol) (L)	8466	25
Transportation (kg.Km)	2.5	0.01
Tools	2.17	0.01
Yields (kg)	42,466	

Table 4: **Total Energy Input In Form of Direct, Indirect, Renewable and Non-Renewable Energy For Irrigated Improved Citrus Seedling Production**

Form of Energy	Quantity MJ ha^{-1}	Percentage (%)
Direct	6570.1	13.93
Indirect	12711.6	26.95
Renewable	4570.88	9.69
Non-Renewable	23,324.38	49.44

Table 5: **Analysis of Energy Indices In Irrigated Improved Citrus Seedlings Production**

Category	Unit	Value
Seedlings	Kg/ha	21,667
Input Energy	MJ/ha	23,835.73
Output Energy	MJ/ha	42,466.24
Energy Use Efficiency		1.96
Energy Specific	MJ/ha	1.56
Energy Productivity	Kg/MJ	0.64
Net Energy Gain		8630.51
Water and Energy Productivity	g/M^3.MJ	0.51

Table 6: **Estimation of Analysis of Irrigated Improved Citrus Seedlings Production**

Cost and Return Components	
Yield (Kg/ha)	21,667
Sale price (₦/kg)	461.54
Gross value of Production (₦/ha)	10,000,153.90
Total Cost of Production (₦/ha)	1,514,825.00
Net Return (₦/ha)	8,485,328.90
Benefit cost ratio	6.60
Productivity (kg/ha)	0.01
NPV (5yr)	16,666,344.40
IRR	70%

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