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VOLUME 17

ISSUE 4

VERSION 1.0



GLOBAL JOURNAL OF SCIENCE FRONTIER RESEARCH: D
AGRICULTURE & VETERINARY



GLOBAL JOURNAL OF SCIENCE FRONTIER RESEARCH: D
AGRICULTURE & VETERINARY
VOLUME 17 ISSUE 4 (VER. 1.0)

OPEN ASSOCIATION OF RESEARCH SOCIETY

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Efficient Production of Goat and Sheep Embryos under Similar in Vitro Conditions

By José Carlos Ferreira-Silva, Marcelo Tigre Moura, Pábola Santos Nascimento, Pamela Ramos-Deus, Maiana Silva Chaves, Luis Rennan Sampaio Oliveira & Marcos Antonio Lemos Oliveira

Universidade Federal Rural de Pernambuco

Abstract- In vitro embryo production (IVP) protocols often require species-specific adaptations, in order to obtain embryonic development at high rates. However, these differences in IVP protocols make interspecific comparisons more susceptible to technical factors. The work aimed to compare IVP embryo production in small ruminants (e.g. goats and sheep) using identical in vitro oocyte maturation and fertilization. Oocytes were retrieved, matured, and fertilized under identical media and atmosphere conditions, while embryos were cultured under different conditions. Goat embryos were cultured in KSOM medium under co-culture, while sheep embryos were cultured in SOF medium under low oxygen tension without feeder cells. Cleavage, morula, and blastocyst development were similar for both goat and sheep, suggesting that oocyte maturation and fertilization conditions allowed a similar developmental potential for small ruminant species.

Keywords: fertilization, maturation, *Capra hircus*, *Ovis aries*, embryogenesis.

GJSFR-D Classification : FOR Code: 630102



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Efficient Production of Goat and Sheep Embryos under Similar in Vitro Conditions

José Carlos Ferreira-Silva ^α, Marcelo Tigre Moura ^σ, Pábola Santos Nascimento ^ρ,
Pamela Ramos-Deus ^ω, Maiana Silva Chaves [¥], Luis Rennan Sampaio Oliveira [§]
& Marcos Antonio Lemos Oliveira ^X

Abstract- In vitro embryo production (IVP) protocols often require species-specific adaptations, in order to obtain embryonic development at high rates. However, these differences in IVP protocols make interspecific comparisons more susceptible to technical factors. The work aimed to compare IVP embryo production in small ruminants (e.g. goats and sheep) using identical in vitro oocyte maturation and fertilization. Oocytes were retrieved, matured, and fertilized under identical media and atmosphere conditions, while embryos were cultured under different conditions. Goat embryos were cultured in KSOM medium under co-culture, while sheep embryos were cultured in SOF medium under low oxygen tension without feeder cells. Cleavage, morula, and blastocyst development were similar for both goat and sheep, suggesting that oocyte maturation and fertilization conditions allowed a similar developmental potential for small ruminant species. Goat and sheep embryos can be produced at comparable efficiencies under identical oocyte maturation and fertilization conditions, suggesting that an IVP protocol that can be used for both goat and sheep could be achieved in the near future. This IVP protocol for small ruminants could be used to address species-specific embryo metabolism adaptation to in vitro conditions.

Keywords: fertilization, maturation, *Capra hircus*, *Ovis aries*, embryogenesis.

I. INTRODUCTION

In vitro embryo production (IVP) is an important tool to address early embryonic development in mammalian species (Galli et al., 2014). Moreover, IVP became attractive for commercial applications such as increasing progeny numbers from animals of high genetic merit or transgenic lines (Galli et al., 2014; Ferreira-Silva et al., 2017abc). Species-specific requirements play an important role on IVP commercial potential in livestock, since IVP efficiency remains high in cattle, variable in small ruminants and under development in swine and horses (Galli et al., 2014; Paramio and Izquierdo, 2014; Leemans et al., 2016; Romar et al., 2016).

Small ruminant species have differences in reproductive physiology, such as estrus duration, moment of ovulation and number of follicular waves

(Webb et al., 2004; Tenório Filho et al., 2007; Ferreira-Silva et al., 2017a). Furthermore, recapitulation of early embryonic development required development of IVP protocols that meet these species-specific requirements. Important differences have been observed for in vitro fertilization and embryo culture for these species (Izquierdo et al., 1998; Conceição et al., 2015/2016), while other factors remain to be compared. Moreover, other reports suggested that these differences may be overcome by protocol adaptations, particularly to embryo culture (Paramio and Izquierdo, 2014/2016).

Despite this tendency for independent development of IVP protocols for each species, this fact represents an additional hurdle for interspecific comparisons at gene expression or cellular levels, since embryos are more susceptible to protocol variations. The development of a similar IVP protocol for both goats and sheep could allow addressing relevant processes, such as species-specific susceptibility to embryo in vitro conditions (Mcevoy et al., 2003; Hill 2014). This understanding may aid the development of IVP conditions that diminish pregnancy loss and newborn death known as large offspring syndrome (Mcevoy et al., 2003; Hill, 2014). Moreover, the improvement of IVP systems may also lead to more efficient cryotolerance of such embryos (Katska-Ksiazkiewicz et al., 2004; Rodríguez-Dorta et al., 2007), which remains as a major bottleneck for IVP application in small ruminants.

Thus, using an identical protocol for embryo IVP for several species, species-specific adaptation processes to in vitro conditions may be identified and characterized. The work was aimed to compare IVP embryo production in small ruminants under similar protocol conditions.

II. MATERIALS AND METHODS

The procedures performed throughout the experiment were formally approved by the Veterinary Medicine Ethics Committee of University Federal Rural of Pernambuco (Protocol 35/2016).

Ovaries were retrieved from mix-breed does and ewes with age varying from 12 to 46 months, which were slaughtered at Suimax, in Igarassu, Pernambuco state, Brazil (latitude 08° 03' 14" S, longitude 34° 52' 52" W). Ovaries were transported in saline solution

Author ^{α σ ρ ω ¥ X}: Laboratório de Biotécnicas Reprodutivas, Universidade Federal Rural de Pernambuco, Recife-PE, Brazil.
e-mail: carlos.ztec@gmail.com

Author [§]: Universidade Federal Rural da Amazônia, Parauapebas-PA, Brazil.

supplemented with 30 $\mu\text{g mL}^{-1}$ of gentamicin sulfate at 30 °C to the laboratory within one-hour period after the slaughter.

Cumulus-oocyte complexes (COCs) were retrieved from 2-6 mm follicles by "slicing" as proposed by Bezerra et al. (2014). Follicular fluid was deposited in a petri dish containing collection medium (CM), as described by Conceição et al. (2015).

The selection of COCs was based on their morphology, as recommended by Chiamenti et al. (2013) and Conceição et al. (2015) and further washed three times in medium. Subsequently, pools of 25 oocytes were transferred to 100 μL drops of IVM medium, which was formulated by TCM-199 supplemented with 50 $\mu\text{g mL}^{-1}$ sodium pyruvate, 2.6 mg mL^{-1} sodium bicarbonate, 10% fetal bovine serum (FBS), 50 $\mu\text{g mL}^{-1}$ gentamicin sulfate, 20 $\mu\text{g mL}^{-1}$ FSH/LH (Pluset®) and 1 mg mL^{-1} PVA. COCs were placed in incubator with saturated humidity, 5% de CO_2 at 39 °C for 24 hours.

a) *In Vitro Fertilization (IVF)*

The IVF was performed using fresh semen, as reported by Conceição et al. (2016). Carefully, 0.1 mL semen was deposited in conical tubes containing 1.5 mL in modified defined medium (mDM) as described by Conceição et al. (2016). Moreover, tubes were placed in a 45° angle position, in order to obtain sperm ascending migration. After 45 minutes of "swim up", the upper 0.8 mL from each tube was aspirated and centrifuged at 350 g for 10 minutes. The supernatant was discarded and 200 μL mDM containing 10 $\mu\text{g mL}^{-1}$ heparin was gently mixed with 200 μL of sperm pellet obtained from centrifugation, as informed by Conceição et al. (2016) and Ferreira-Silva et al. (2017a).

Before IVF, oocytes were scored for cumulus cell expansion and washed in mDM. Moreover, groups of 15 to 20 oocytes were transferred to 100 μL mDM drops containing a sperm suspension of 2×10^6 under paraffin oil. Oocytes and sperm cells were co-incubated under identical to IVM conditions for 18 hours.

b) *Embryo Culture*

Goat presumptive zygotes were cultivated in Potassium simplex optimized medium (KSOM) medium (85.15 mM sodium chloride, 8.0 mM potassium chloride, 2.0 mM calcium chloride, 0.5 mM magnesium chloride, 25 mM sodium bicarbonate, 5 mM sodium lactate, 0.5 mM sodium pyruvate, 2.0 mM glucose, 4.9 mM glycine, 0.1 mM L-glutamine) and supplemented with 10% estrus sheep serum and co-culture with cultured oviduct cells under high oxygen tension of 5% CO_2 and 20% O_2 as reported by Conceição et al. (2016) and Ferreira-Silva et al. (2017a).

Sheep presumptive zygotes were denuded by vortexing in modified Synthetic oviduct fluid (mSOF) and pools of 25 presumptive zygotes were transferred to 100

μL drops of mSOF supplemented with 10% FBS under paraffin oil, as described by Bezerra et al. (2014). Embryos were incubated under saturated humidity with 5% CO_2 , 5% O_2 and 90% N_2 at 39 °C. Goat and sheep embryos were cultured for seven days, while embryonic development was assessed for early cleavage at day 3 (D3), late cleavage at day 4 (D4), morula at day 5 (D5) and blastocyst development at day 7 (D7).

c) *Statistical Analysis*

One-way analysis of variance was performed by minimum squares method by PROC GLM (for fixed variables) and PROC MIXED (for fixed and random variables) on SAS STAT package (SAS institute, Cary, NC). The data was previously analyzed for variance analysis by the Shapiro-Wilk test (variable homogeneity and residual normality). Dependent and independent variables were established based on experimental design. Statistical models considered main effects and all possible interactions. Differences with 5% probability were considered significant.

III. RESULTS

A total of 12 replicates was performed using 1,249 oocytes from both species. In each replicate, COCs were subjected to IVM, IVF and embryo culture. Results for retrieved oocytes, matured oocytes and those subjected to in vitro fertilization are described in Table 1. Mean oocyte retrieval and oocyte survival after IVM and IVF were similar for both species (Table 1). No notable difference was observed in cumulus cell expansion after IVM (data not shown).

Table 1: Retrieved oocytes, in vitro maturation (IVM), and in vitro fertilization (IVF) for goats and sheep under similar conditions.

In vitro Production	Goat (Mean and SD)	Sheep (Mean and SD)
Oocyte retrieval	105.75 \pm 6.53	102.58 \pm 4.46
IVM	53.18 \pm 6.25	55.16 \pm 5.60
IVF	28.41 \pm 3.75	29.33 \pm 3.96

SD: standard deviation.

Embryonic development rates were determined at days 3, 4, 5, and 7 after IVF, in order to better estimate embryo development kinetics (Table 2). Cleavage rates at days 3 and 4 were similar between species, suggesting that oocyte competence and early developmental kinetics were indistinguishable (Table 2). Moreover, embryo development at morula and blastocyst stages were also similar for goats and sheep, ruling out any effect of embryo culture condition on development kinetics (Table 2).

Table 2: Cleavage, morula and blastocyst formation for goat and sheep in vitro production under similar conditions.

Development Stage [#]	Goat (Mean and SD)	Sheep (Mean and SD)
Cleavage(D3)	23.83 ± 1.02	24.91 ± 1.72
Cleavage(D4)	22.25 ± 1.28	22.58 ± 1.44
Morula(D5)	20.75 ± 1.28	21.08 ± 1.24
Blastocyst (D7)	6.91 ± 0.79	9.16 ± 1.40

[#]Days of embryo culture after in vitro fertilization. SD: standard deviation.

IV. DISCUSSION

Goat and sheep oocytes were matured and subject to in vitro fertilization under identical conditions. In vitro embryo production represents an attractive approach to investigate preimplantation development in mammalian species (Galli et al., 2014; Conceição et al., 2015), by allowing to determine minimum culture conditions for embryo development. Furthermore, it represents an alternative source of embryos for biochemical and molecular analysis and as a platform for other approaches such as production of cloned or transgenic animals (Galli et al., 2014; Souza-Fabjan et al., 2014). Several lines of evidence demonstrate that most species require protocol adaptations for adequate embryonic development under in vitro conditions (Chiamenti et al., 2010/2012; Galli et al., 2014; Paramio and Izquierdo, 2014; Ferreira-Silva et al., 2017a).

Oocyte maturation was efficient for both goats and sheep under identical IVM conditions, as described previously in independent studies from our group (Bezerra et al., 2014; Conceição et al., 2015) and for other livestock species (Galli et al., 2014; Paramio and Izquierdo, 2014; Ferreira-Silva et al., 2017a). Although the assay used in the present study is indirect in order to determine IVM efficiency (e.g. cumulus cell expansion), further embryonic development demonstrates that eggs from both species held comparable oocyte competence.

The protocol for IVF in goat and sheep was performed using a combination of mDM medium with heparin. Previous studies in ruminant species have found particularities in their requirement for IVF conditions (Galli et al., 2014; Paramio and Izquierdo, 2014). Goats and cattle require heparin for sperm capacitation (Chiamenti et al., 2010; Galli et al., 2014; García-Álvarez et al., 2015; Ferreira-Silva et al., 2017a), while capacitation factors remain elusive for sheep (García-Álvarez et al., 2015). Due to this fact, IVF in sheep is generally performed under estrus serum-containing media (Paramio and Izquierdo, 2014; García-Álvarez et al., 2015). The results described here suggest that heparin usage for sheep sperm capacitation should be revisited in detail.

Embryo development was similar for both species, despite usage of different embryo culture media and atmosphere conditions. Embryo culture conditions play a major role on embryo quality. Since species also hold differences in their susceptibility to culture conditions (Mcevoy et al., 2003; Hill, 2014), this step on IVP protocol could represent a major hurdle to development of a IVP protocol applicable for ruminant and other livestock species. However, most reports in small ruminants use SOF medium for embryo culture (Paramio and Izquierdo, 2016), suggesting that an identical protocol for IVP in goats and sheep could be achieved in the near future.

The development of an IVP protocol that can be used for both goat and sheep may have important scientific and commercial implications. For research purposes, it further allows the investigation of species-specific embryo metabolism adaptation to in vitro conditions (Mcevoy et al., 2003; Hill, 2014). This investigation may lead to protocols that increase pregnancy rates and newborn viability (Mcevoy et al., 2003; Hill, 2014). Moreover, an improved IVP system for both small ruminant species may increase embryo cryotolerance (Katska-Ksiazkiewicz et al., 2004; Rodríguez-Dorta et al., 2007). This increased cryotolerance may be particularly achieved if embryo metabolism under improved IVP conditions leads to reduced lipid accumulation in embryonic cells (Romão et al., 2015).

This protocol could also ease media production for commercial small ruminant laboratories. In order to achieve such goals, appropriate embryo culture conditions for both goat and sheep embryos need to be identified using oocyte maturation and fertilization described above.

V. CONCLUSION

Goat and sheep embryos can be produced at comparable efficiencies under identical oocyte maturation and fertilization conditions, suggesting that a IVP protocol useful for both goat and sheep could be achieved in the near future.

a) Conflict of Interest

The authors declare no conflict of interest.

b) Acknowledgements

This study was funded by "National Counsel of Technological and Scientific Development" (CNPq) and Coordination for the Improvement of Higher Education Personnel (CAPES) grants.

c) Author Contribution

J.C.F.S., M.T.M., M.A.L.O. conceived the research; J.C.F.S., M.T.M., P.S.N., P.R.D., M.S.C., L.R.S.O. performed the research. J.C.F.S., M.T.M., M.A.L.O. analyzed the data and wrote the manuscript.

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Effect of *Moringa Oleifera* Leaf Extract (Mole) on some Reproductive Parameters of Rabbits Reared in a Semi-Humid Environment

By Ojo, O.A. & Abdurahman, K.O.

Kwara State University

Abstract- This research was conducted at the Kwara State Teaching and Research farm University, Malete, Ilorin, Kwara State. The purpose of the study was to investigate the effect of adding varying doses of *Moringa oleifera* leaf extract (MOLE) on some reproductive characteristics of male rabbits reared in a semi humid environment. A total number of 24 rabbits with an average age of 9 months and body weight of 600-800g were used in this study and randomly divided into four equal treatments (6 rabbits each) and gavaged with 0mls (Tr1, control), 30mls (Tr2), 60mls (Tr3) and 90 mls (Tr4) of MOLE. The sperm concentration, percentage normal and abnormal sperm cells, testicular morphometry and serum testosterone level were measured.

Keywords: *abnormal sperm cells, sperm concentration, testicular morphometry, moringa oleifera, testosterone.*

GJSFR-D Classification : FOR Code: 070799



EFFECT OF MORINGA OLEIFERA LEAF EXTRACT MOLE ON SOME REPRODUCTIVE PARAMETERS OF RABBITS REARED IN A SEMI-HUMID ENVIRONMENT

Strictly as per the compliance and regulations of :



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Effect of *Moringa Oleifera* Leaf Extract (MOLE) on some Reproductive Parameters of Rabbits Reared in a Semi-Humid Environment

Ojo, O.A.^α & Abdurahman, K.O.^σ

Abstract- This research was conducted at the Kwara State Teaching and Research farm University, Malete, Ilorin, Kwara State. The purpose of the study was to investigate the effect of adding varying doses of *Moringa oleifera* leaf extract (MOLE) on some reproductive characteristics of male rabbits reared in a semi humid environment. A total number of 24 rabbits with an average age of 9 months and body weight of 600-800g were used in this study and randomly divided into four equal treatments (6 rabbits each) and gavaged with 0mls (Tr1, control), 30mls (Tr2), 60mls (Tr3) and 90 mls (Tr4) of MOLE. The sperm concentration, percentage normal and abnormal sperm cells, testicular morphometry and serum testosterone level were measured. Results showed that the highest recorded values of the paired testis weight, volume and testis length were observed in rabbits given 90mls of MOLE. The testis width was significantly (P 0.05) higher in Tr4 (90mls MOLE) and lowest in Tr2 (30mls MOLE) compared to the control group. Observation showed that the sperm concentration of rabbits given 90mls of MOLE were significantly (P 0.05) improved, while the least value was recorded in Tr1 (0mls MOLE). 90mls of MOLE decreased significantly (P 0.05) the percentage abnormal sperm cells, while enhancing the percentage normal sperm cells. Testosterone concentration was insignificantly increased in Tr4 as compared to control group. At the end of the experiment, conclusion showed that *Moringa oleifera* leaf extract (MOLE) can be used at 90mls to enhance reproductive parameters in rabbit bucks.

Keywords: abnormal sperm cells, sperm concentration, testicular morphometry, *moringa oleifera*, testosterone.

I. INTRODUCTION

The availability of quality source of animal protein in suitable amount and at reduced cost in most low economic countries, especially Nigeria has remained a main problem to animal production (Ahemen et al., 2013). Rabbit production is a potential solution to the problem of meat shortage (Taylor, 1980; Lebas, 1983) because of its unique qualities as a highly prolific animal, highly nutritious with low cholesterol content. An obvious limiting factor to rabbit production in regions with hot climate is the susceptibility of this specie to heat stress (Ondrukas et al., 2011). These have been reported to negatively affect their feed intake, utilization, blood parameters, hormonal secretion and

reproductive parameters (Fouad, 2005). The comfort zone for rabbit is 18 to 21°C (Habbeeb et al., 1999) so, rabbits can withstand cold weather than warmer one. The metabolic rate increased by about 20% in rabbits when exposed to high air temperature ranging from 30 to 35°C (Gonzalez et al., 1971) with a marked decrease in feed intake (Rakes et al., 1988). It has been reported that reduction in feed intake occurs during heat stress causing a drop in nutrient intake, which adversely affects reproductive response (Habbeeb et al., 1996; Marai et al., 2001). Although reactive oxygen and nitrogen species known as free radicals are essential in detoxification and immune function, an overproduction of this causes damage to valuable biomolecules such as DNA and lipid proteins (Aruoma, 1998). Oxidative stress has been known to influence reproductive function. Several strategies have been employed to reduce heat stress effect on animals. Some of which include environmental condition modification (evaporative cooling, use of sheds or fans), dietary, management and physiological modification of animals (Selim et al., 2003), but these practices are either complex to implement or expensive (Ahmad and Sarwar, 2006). There is therefore the need to exploit other practicable methods of countering the adverse effect of heat stress. Several plant extracts having different phytochemicals have been documented to have diverse antioxidant activity (Zheng and Wang, 2001) with low economic importance such as *Moringa oleifera*. *Moringa oleifera* has been documented to have multiple antioxidants with high levels such as phenolic acids (ellagic, chlorogenic, Gallic and ferulic acid), glucosinolate and flavonoids such as kaempferol, quercetin and rutin (Mbikay, 2012). It is also a valuable source of β -carotene (vitamin A precursor) and vitamins B-complex, C, D and K (Dorgan and Tandon, 1975). These antioxidants are effective in preventing oxidative damage by enhancing antioxidant enzymes which reduces production of free radicals and lipid peroxidation (Sreelatha and Padma, 2009). According to Nimse and Pal (2015), antioxidants are substances which prevent free radical effect at the same time slow down or hinders cellular damage, therefore stand as a preventive measure against the deleterious effect of these free radicals to cellular component. This study is conducted to investigate the efficacy of *Moringa oleifera* leaf extract (MOLE) as a natural source of antioxidant on

Author α : Department of Animal Production, Fisheries and Aquaculture, Kwara State University, Nigeria. e-mail: ykmelodya1@yahoo.com

some reproductive parameters of rabbits reared in a semi-humid environment.

II. MATERIALS AND METHODS

The research was conducted at the rabbitry section, College of Agriculture, Kwara State University Teaching and Research Farm, from December to February, 2015. The study lasted for a period of 9 weeks.

a) Plant Collection and Preparation of MOLE

Fresh leaves of *Moringa oleifera* were collected early in the morning at Ita-alamu area of Ilorin, Kwara State. The fresh leaves were manually removed from the stem, cleaned and made free of sand and other impurities using distilled water. The fresh leaves were spread under a shade to dry for 10 days. The dried leaves were blended into powdered using an electric kitchen blender. Finely pulverized *Moringa oleifera* leaves weighing 300g was poured into a 2.5 litre macerating flask and 1.5 litre of distilled water added. The resulting mixture was thoroughly homogenized and sieved with a cheese cloth then filtered using whatman filter paper (24cm). The MOLE was then preserved in the freezer till needed.

b) Experimental Animals and Management

The experimental animals used were twenty four (24) male bucks with an averagedly aged 9 months old, having average initial body weight ranging from 600-800g. The experimental animals were randomly allotted to four (4) groups comprising six experimental animals per treatment in a completely randomized design. Each group was divided into three (3) subgroups with 2 animals per subgroup. Experimental animals were acclimatized for ten (10) in the teaching and research farm before data collection commenced. Prior to the data collection, animal were given oxytetracycline (5%) intramuscularly twice, vitamin B complex intramuscularly and ivomec through subcutaneous route of administration. Treatment one (1) served as the control which received no extract of *Moringa oleifera*, while rabbits in treatment 2, 3 and 4 received the MOLE extract at 30, 60 and 90mls respectively via gavage method. The average temperature inside the research station at the peak of the experiment ranged from 33-36°C monitored using wet and dry bulb thermometer. The relative humidity was $46 \pm 3\%$ recorded daily using hygrometer. Feed and water was given ad libitum. The experimental layout design was completely randomised design (CRD).

c) Data Collection

After slaughtering individual rabbits, the scrotum were cut-in to expose and bring out the testes. The testes were weighed and their the testes and volumes using Archimedes volume displacement, the lengths and circumferences were determined using

thread and ruler. The epididymides were completely removed from other adjoining epithelial tissues. The cauda epididymides were then excised and several deep cuts were carried out on them to enhance the spermatozoa swim out easily. They were separately placed in glass beakers having 5ml physiological normal saline solution. The sperm cells were freed into the beakers containing physiological saline with many deep cuts made on them. The concentration of the sperm was obtained with the use of improved Neubauer haemocytometer. Percentage normal and those sperm cells which were deviations from normal were determined by conventional methods (Zemjanis, 1977). Testosterone determination was done using ELIZA method.

d) Chemical Analysis

Proximate composition of diets fed to the animals were carried out in a reputable chemical analysis laboratory through the procedure stated by Association of Analytical Chemist (A.O.A.C, 1990).

e) Statistical Analysis

Data obtained were analyzed using one way analysis of variance (ANOVA) in a completely randomized design while significant means was separated using Duncan's New Multiple test of software (SAS, 2003).

III. RESULTS AND DISCUSSION

Table 1: Proximate composition of *Moringa oleifera* leaves

Parameters	Composition
Dry matter %	91.78
Moisture content (%)	28.43
Crude protein (%)	28.43
Crude fat (%)	6.40
Crude fibre (%)	9.15
Total ash (%)	9.09
NFE	46.93

NFE- Nitrogen free extract

The results of proximate analysis in Table 1 showed that *Moringa* leaves had an appreciable crude protein content (28.43%), crude fibre (9.15%), ash (9.09%), dry matter (91.78%), NFE (46.93%), but low content of ether extract (6.40%). Dry matter content of MOLE in this study was lower than the values reported by Mutayoba et al. (2011) who reported dry matter values of 93.7%. The crude protein (CP) value of MOLE obtained in the present research is higher compared with the value observed by Olugbemi et al. (2010) which was 27.44%, although Mutayoba et al. (2011) recorded a higher (30.65%) crude protein value. The crude fat and ash values (6.40% and 9.09%) recorded in this research were higher than the values 2.11% and 7.93% reported by Ogbe et al. Crude fibre value of 9.15% reported here was higher than 5.43% which was reported in the study

conducted by Sodamade et al. (2013). These differences in values of MOLE have been observed in the previous studies stated to be due to differences in the soil type,

climatic conditions, stage of maturity and their genetic make-up.

Table 2: Testicular morphometry of rabbits fed *Moringa oleifera* leaf extract (MOLE)

Parameter	T ₁	T ₂	T ₃	T ₄	SEM	P-value
Paired Testis Weight (g)	10.83	11.50	12.67	16.00	0.84 ^{NS}	0.169
Paired Testis Volume (cm ³)	6.67	2.50	5.00	7.50	0.76 ^{NS}	0.128
Testis Length (cm)	8.67	7.75	8.67	8.75	0.22 ^{NS}	0.486
Testis Width (cm)	3.43 ^a	3.25 ^a	5.33 ^{ab}	6.50 ^b	0.44 ^S	0.001

^{a-b} mean bearing different superscript in the same row differ significantly ($P < 0.05$). T₁ = Control, T₂ = 30mls of *Moringa oleifera* leaf extract (MOLE), T₃ = 60mls of *M. oleifera* leaf extract (MOLE), T₄ = 90mls of *M. oleifera* leaf extract (MOLE), SEM = Standard error of means, NS = No significant different, S = Significant different

The influence of the *Moringa oleifera* leaf extract on testicular morphometry of rabbits are shown in Table 2. This research was used to determine the testicular morphometry and epididymal sperm indices of rabbit bucks given varying concentration of *Moringa oleifera* leaf extract (MOLE). Weight of the pair of testes in observed this study were not significantly ($p < 0.05$) affected by experimental material, having values ranging between 10.83 and 16.00 g. The observed figures are in consonance with the submissions of Bitto and Gemade (2001) who recorded a non significant influence of pawpaw peel meal (PPM) up to 30% on testicular morphometry of rabbit bucks. This is as well in agreement with the observation of Ogunlade et al. (2006) who showed a non significant difference in the weight of testis among rabbits fed fumonisin contaminated diets. Observation also showed that MOLE did not influence the testis length and testis volume of the rabbits, although those given 90mls of MOLE had the highest recorded values of both the testis length and volume respectively. There is a striking similitude between the result of this study and the report of Ahemen et al. (2013) who observed no significant ($P < 0.05$) differences among the testis length, width, weight and volume of rabbit bucks when given different doses of water spinach. The findings however, is noted to be different from the reports of Ajayi et al. (2009) who

showed significant influence of experimental diets (Blood-wild sunflower leaf meal mixture diet) on testicular length of rabbits. The mean testicular width of rabbits given 90mls of MOLE was significantly ($P < 0.05$) higher compared to those of the control (0mls of MOLE) and those given 30mls of MOLE (T₂). The information relating to morphometric parameters of the reproductive tract have been observed to give an invaluable information on adjudging the breeding and fertilizing ability of animals (Ogbuewu et al., 2009). According to Gage and Freckleton (2003), the testes size, length and width of mammals are described as favourable pointer to the present and future spermatozoa production. Knowledge of the important morphometric qualities of the reproductive organ is important to enhance the opinion and forecast not only of sperm production ability, but likewise the storage potential and fertilizing capability of the breeder male. Moreira et al. (2001) verified in a study of Santa Ines sheep, that changes in testicular length and scrotal circumference is considered viable indicators of the effect of thermal stress on gonads. In accordance with Ezekwe (1998) and Perry and Petterson (2001), testes size, length and width are high quality indicators of present and future sperm production. This enhances increased fertilizing potential in rabbits

Table 3: Semen characteristics of rabbit bucks fed *Moringa oleifera* leaf extract (MOLE)

Parameter	T ₁	T ₂	T ₃	T ₄	Std. Mean Error	P-value
Concentration (x10 ⁶ /ml)	138.50 ^a	161.75 ^{ab}	178.33 ^{ab}	190.00 ^b	6.63 ^S	0.000
Abnormal cell (%)	15.33 ^b	14.50 ^b	12.00 ^{ab}	9.50 ^a	0.76 ^S	0.001
Normal cell (%)	84.67 ^a	85.50 ^a	88.00 ^{ab}	90.50 ^b	0.76 ^S	0.001
Testosterone (ng/ml)	5.24	5.78	6.95	8.42	0.48 ^{NS}	0.073

^{a-b} means bearing different superscript in the same row differ significantly ($P < 0.05$). Keys: T₁ = Control, T₂ = 30mls of *Moringa oleifera* leaf extract (MOLE), T₃ = 60mls of *M. oleifera* leaf extract (MOLE), T₄ = 90mls of *M. oleifera* leaf extract (MOLE). SEM = Standard error of means. S = Significant different.

The results of some sperm characteristics and testosterone of rabbits given Moringa oleifera leaf extract (MOLE) are presented in Table 3. The sperm concentration of rabbit bucks given MOLE is significantly ($P < 0.05$) influenced by the experimental diet. The values of sperm concentration observed in this research ranged from 138.50 to 190.00 x10⁶/ml and were similar to the recorded values of 136.00 to 184.00 x10⁶/ml stated by Ajayi (2009). Oyeyemi and Okediran (2007) reported that an increased concentration of spermatozoa is a signal to a possible high fertility rate by the reason of the number of spermatozoa available during service or insemination. The percentage normal sperm cells in this research ranged from 84.67 to 90.50% and were significantly affected by experimental inclusions. The percentage normal sperm cells value was significantly ($P < 0.05$) higher in T4 (90.50%) compared with T1 (84.67%), T2 (85.50%) and T3 (88.00%). Arthur et al. (1989) discovered that high quality semen samples show an average of 25% dead sperms. The average value of percentage normal sperm cells reported in this research was within the range of high quality samples. The percentage live sperm cells are those present for use during fertilization (Ajala et al., 2001). The percentage abnormal sperm cells values in this research ranged from 9.50 to 15.33%. Values obtained were within the range of 6.00 to 16.00% as reported by Ajayi (2009). The percentage of abnormal sperm cells in this research were lower than the upper limit of 20% suggested as the least quantity recommendable for good reproductive potential and fertility in either normal mating or in artificial insemination (Oyeyemi and Okediran, 2007). Ajayi et al. (2009) established the influence of quality feeding on sperm characteristics of rabbits. Oyeyemi et al. (1998) declared that quality nutrition with high percentage of protein will improve motility and concentration of spermatozoa and Moringa leaves is known to have high crude protein content. The testosterone values recorded was not significant across the treatment, although the highest recorded values were observed in rabbit group given 90mls MOLE. Testosterone hormone is produced by the interstitial cells of the testis and necessary for the completion of spermatogenesis. The result is in consonance with the report of Sajjad et al. (2007) who reported that the levels of blood serum testosterone were correlated with scrotal circumference and semen volume in buffalo bulls of 14 years of age. El-Hanoun et al. (2014), also reported that a good relationship exist between increased testosterone concentration and increased libido of male rabbits.

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Requirements for the German Retail Horticulture from an Economic Perspective. A Qualitative Approach in the Context of Service Controlling

By Christian Engelke

University of Applied Sciences

Abstract- The present paper is the first part of a study on value creation with regard to customer integration in retail horticulture. It deals with the determination of the requirements for German retail horticulture (GRH) from a business perspective in the context of applied service controlling. To this end, seven entrepreneurs of selected GRHs were interviewed in guided interviews. Previous investigations in horticulture have ignored this topic, so the current paper performs the necessary investigation of the factors influencing operational controlling in the balancing act between final sale and horticultural services. For the evaluation, Mayring's qualitative content analysis is used, supplemented by a quantitative intensity analysis (scaling structuring) and a contingency analysis. This approach serves to concretize the transcribed text passages to paint a clear and comprehensive picture of individual aspects of GRH controlling. The requirements for operational controlling are displayed in a detailed category framework. It turns out that the companies offer a consistently broad range of services to varying degrees.

Keywords: *retail horticulture, horticultural services, service controlling, value added, process organization, customer involvement, customer orientation.*

GJSFR-D Classification : FOR Code: 300399



Strictly as per the compliance and regulations of :



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Abstract- The present paper is the first part of a study on value creation with regard to customer integration in retail horticulture. It deals with the determination of the requirements for German retail horticulture (GRH) from a business perspective in the context of applied service controlling. To this end, seven entrepreneurs of selected GRHs were interviewed in guided interviews. Previous investigations in horticulture have ignored this topic, so the current paper performs the necessary investigation of the factors influencing operational controlling in the balancing act between final sale and horticultural services. For the evaluation, Mayring's qualitative content analysis is used, supplemented by a quantitative intensity analysis (scaling structuring) and a contingency analysis. This approach serves to concretize the transcribed text passages to paint a clear and comprehensive picture of individual aspects of GRH controlling. The requirements for operational controlling are displayed in a detailed category framework. It turns out that the companies offer a consistently broad range of services to varying degrees. A causal link between the categories "Service Range" and "Degree of Specialization" could not be established, since specialized companies also had a broad, generalized service-spectrum, and inverted broad-based companies spun the services into separate service divisions. Whether GRH should be "more retail-oriented" or "more service-oriented" depends on operational factors (e.g., chronicle and company management) and the competitive environment that determines the individual case. A delineation of the departments is visible in some companies when using the central category "self-contained service departments (SD)". In addition, influencing variables were disclosed that indicate a higher level of organization of individual enterprises. The overwhelming majority of companies surveyed show a homogeneous structure within the category framework, so structured controlling can be concluded.

Keywords: retail horticulture, horticultural services, service controlling, value added, process organization, customer involvement, customer orientation.

Author: Dipl.-Eng. (FH) Horticulture, Dipl.-Econ.Eng. (FH),
Friedrich-Bach-Str. 29, 31675 Bückeburg.

e-mail: c.engelke@engel-engelke.de

Dipl.- Wirtsch.Eng. (FH) Business Management / Industrial Engineering,
University of Applied Sciences, Koblenz, Germany, 2004.

Dipl.- Eng. (FH) Horticulture, University of Applied Sciences,
Osnabrück, Germany, 1997.

I. INTRODUCTION, PROBLEM DEFINITION AND OBJECTIVE

The German retail horticulture (GRH) is characterized by great versatility in both products and services. Despite these obvious strengths, there is an insufficient economic understanding, with a partial, inferior economic orientation on the part of the entrepreneurs (BMELV, 2013).

While up-to-date structural data for classification (ZBG, 2013) on the market situation and the economic importance of the gardening sector along the value chain are available for horticulture (Dirksmeyer and Fluck, 2013), only a few studies are to be found that deal with the background of operational controlling and the services offered by GRH. Schwarz (2009) investigates the success of the service programme with a mix of methods from expert surveys and key figure evaluation. Von Allwörden (2006) describes changes in the market and challenges for horticultural companies and identifies successive sources of livelihood. Schöps (2013) is concerned with connections between customer satisfaction and the performance criteria of GRH. Bitsch (2006) is concerned with the factor that is very important for services.

According to the results of the Centre for Horticulture's business comparison (2013), sales in GRH rose in the period 2010–2012, but its profit and net profit development were significantly less favourable than those of other horticultural projects. This indicates higher personnel costs, which account for a large part of total costs. Service providers have a much higher wage rate (including the calculation of wage costs for family workers), accounting for 33.8% of their operating incomes, compared with 29.1% for retailers (ZBG, 2013).

Against this background, GRH must further optimize its performance processes in order to continue to generate sufficient income in the future. This also requires good controlling, which in turn requires management skills.

The present work is intended to reveal deeper insights into the influencing factors of GRH's operational

controlling. As the first part of a study on “value creation, taking into account customer integration”, the focus is on the horticultural services.

II. THEORETICAL PRELIMINARY CONSIDERATIONS

The research question should be approached qualitatively in order to (a) work with small numbers of cases (Becher, 2007) and (b) achieve a deep, complete understanding of the GRH. In qualitative research, a distinction is made between two fundamental analyses: deduction is used to test an individual case against a general theory, whereas in the case of induction, a general statement is generated from individual cases. A deductive derivation “allows the identification of significant (not coincidental) connections between social phenomena and the area in which these relationships occur” (Gläser AND Laudel, 2010). In contrast, inductive research looks for “causal mechanisms that produce certain effects under certain conditions”(Gläser AND Laudel, 2010). Since the present study was initiated by means of basic assumptions, but these are not statistically confirmed, the aim of this study is to define new theoretical approaches from individual cases.

In contrast to quantitative research, qualitative hypotheses are not tested. These are only formed during the research process and are therefore preceded by quantitative research (Becher, 2007).

Recapitulating, that internal factors, such as the product portfolio (Vahs, 2009), affect the structural organization, there is no safe ground, if and in which way the services do. We know, that servicing requires to consider specifics, particularly the uno-actu-principle, intangibility, influence of customer (Choi, Nazareth & Jain, 2010 e.g.), which differs to the manufacturing sector. Getting the fact, that there is an increasing relevance of the services in the companies, and the portfolio are changing, the strong heterogeneity on GRH is accordingly a consequence. Principally, the companies face the risk of complexity when overloading the number of services within the portfolio (Gann & Salter, 2000), especially when the structural

organizational is not customized. Assuming, that the number of services in GRH is increasing in the past (Zentralverband Gartenbau, 2017), and the level of organization is low (Gabriel and Bitsch, 2014), we formulate:

- 1) GRHs have a broad range of services.
- 2) There is no clear demarcation of the departments at the individual company level.
- 3) Controlling has a subordinate role in GRH.

In some areas of the project, there was no published knowledge. For example, no results were found that identified at which point and to what extent the customer is integrated into the value-added process. This total lack of knowledge associated with limited research resources necessitates an explorative approach (Bitsch, 2000).The aim of the work is to obtain an in-depth knowledge of the operational controlling in GRH via an exploratory survey of managers and, if necessary, to carry out further investigations at a later date in the same companies.

a) Selection of companies

In a qualitative survey, the content of the interview partners (IP) is the focus. In contrast to quantitative research, the sample selection is limited to smaller numbers (Becher, 2007). In Germany, there are about 10,000 GRH (Dirksmeyer and Fluck, 2013). The challenge was to identify companies that were willing to open themselves to the research project. After scouring the trade press and the internet, as well as having individual talks with industry representatives, eight owners or managing directors of traditional retail horticulture were selected as potential participants and addressed in person. Seven were willing to participate. The companies in question are well-known or have good reputations in the specialist sector, so it can be assumed that these are comparatively well-established and successful enterprises. It should be noted that the study does not pursue benchmarking (see Kotler and Bliemel, 2001), since neither competition nor value added has been known to date. Table 1 below gives an overview of the companies.

Table1: Overview of the companies

Company	1	2	3	4	5	6	7
Legal form	PLC	PLC	IC	IC	IC	PLC and IC	PLC and IC
Owner / GF	CEO	CEO	Owner	Owner	Owner	CEO	CEO, Owner
Training	H, DH	H, DE	H, Master	H, DH	H, Master	H, Master	H, Master
Age	No. Rec.	No. Rec.	No. Rec.	51	59	49	No. Rec.
Employee	50	26	10	14	19	14	18
Training places	7	8	1	1	5	0	5
History	1900	1938	1957	1952	1929	1938	1928/1950
Introduction to services	always	always	approx. 2008	approx. 1991	No. Rec.	approx. 1972	approx. 20 years
Independent divisions	1	2	1	1	1	2	2

Legend: CEO = Managing Director, Dipl.-Economist = DE, Dipl.-Engineer Horticulture = DH, H = Horticulture, IC = Individual companies, Master = Training as Horticulture master, No. Rec. = No Records, PLC = Private limited company.

Source: Own presentation, based on organizational chart, interviews, and internet research.

III. RESEARCH DESIGN AND METHOD SELECTION

The present study deals with the first research section of a more comprehensive research project in the form of expert surveys and semi-standardized guidance interviews. It is part of multiple case studies and is to be continued in subsequent studies on the same companies, but on other topics (see Yin, 2009).

a) Research Design

The study uses a mixture of methods from qualitative content analysis as the core of the evaluations, supplemented by quantitative intensity and contingency analysis, as well as document analysis, internet research, and a simple competition analysis.

The surveys were carried out in March 2012 and February–March 2013 and followed a fixed schedule: first, an appointment was made; the questionnaire was sent in advance, and the actual survey followed. The interviews usually took place in a single meeting in the business premises in a quiet atmosphere over 1.5–2 hours. In a conversation, another participant came from the management. An attempt was made to take a neutral questionnaire in order to reduce the influence of the researcher. The researcher did not know the companies, except for participant 4, at the interview date. Before the interviews took place, the topic was introduced, the handed-out organizational chart was discussed, and approval was sought for an audio recording. The 16 questions of the survey were formulated in a general way and were read individually to the IP so that a free, narrative conversation could develop. In the case of unclear answers, questions were asked to get more information. At the end, a discussion took place.

Two pilot surveys were conducted and evaluated before the start of the investigations. The questionnaire and the course were adapted from these experiences. In addition, this gave the researchers the opportunity to familiarize themselves with the interview and to practice the interview techniques in order to create an informal atmosphere and promote the willingness to communicate. The data from the two pilot surveys are not included in the results.

b) Evaluation Methods

The interviews were evaluated using May ring (2010)'s qualitative content analysis. The interview recordings were first transcribed and then shortened without loss of content in order to achieve better readability. The individual statements (text passages)

were subsequently analysed and finally assigned (coded) to the main categories described below.

From the pre-formulated basic assumptions, five main categories (MK) were initially given, which are based on the interview guide thread. These are "operational organizational structure", "range of services", "status and priority of operational controlling", "customer involvement", and "value added/business processes". During coding, new contexts became visible, with the result that further ICTs and subcategories (UK) emerged: for example, "value of the personnel selection", "delegation degree", "work organization", and "statistics and handling of key figures". An analysis of intensity, embedded in the qualitative content analysis at this point, finally separated into further subcategories. The coding process was repeated until all the text passages from the previous UK were now at the lowest level, called scaling, for example, "unstructured", "structured", and "unclear" (see Table 4). These continuous feedback loops (spiral loops) lead to a refined category framework, which can be called the actual result (May ring, 2010). In order to increase the meaningfulness of the qualitative results, further measures have been taken, which are discussed below.

First, explicit rules for stable text coding (May ring, 2010) have been set and clearly defined. This included the regular creation of a coding guide with definitions, anchor examples, and coding rules for each individual category. The reliability shows the extent of the scatterings during repetitions (intractability). The encoding process was repeated once by Researcher 1. If the results are the same, this indicates a high degree of reliability. Using the test-retest method (Gremier, 2004), the correlation between the measurements can be demonstrated. In two different stages, the degree of consistency (reliability index) is calculated. To ensure objectivity, all encodings were carried out independently by a second researcher and checked for consistency (inter-coordination reliability). In the present study, several test retests were carried out. A value of >80% is regarded as a reliable and secure match (Becher, 2007). Categories with lower values are not taken into account in further research steps. In this study, however, all values are presented. Table 4 shows the procedure (excerpt).

The reliability index can be calculated in two stages, which differ in that the second includes the number of categories. Thus, the results become more accurate. The following results refer to Perrault and Leigh (1989)'s Reliability Index (2):

$$Reliability\ index\ (2) = \sqrt{\left(\frac{a}{b} - \frac{1}{c}\right) \frac{c}{c-1}}$$

where a is the number of content matches, b the total number of arguments to be encoded, and c the number of categories.

As a quantitative analysis step, an intensity and contingency analysis was performed using MAXQDA10. While the former refines the scaling (for example, high-medium-low-unclear), the contingency analysis shows the frequency of the encoded text segments. The weighting of the categories increases with the number of entries in an interview. Cross tables were used for the evaluation, in order to make it possible to compare several versions with each other. This multi-step approach has the advantage that the statements of the IP can be interpreted from different angles. Thus, a numerical evaluation could better define the scale points in order to achieve a more accurate overall picture of the individual GRHs.

The scaling, as well as the entire research, was subject to fixed rules so that traceability and verification of the quality criteria were possible (Titschler et al., 2009). It should be noted that the listed components do not claim to be representative. Not all criteria were analysed, but the competitors and company-related factors were limited. Due to the qualitative nature and the small number of cases, a statistical evaluation with representative statements is usually not possible. The

criticism of a lack of generalization should be countered by the rules-based approach (Mayring, 2010).

For completeness, an analysis of company documents (organization chart, order sheets, hour notes, etc.) as well as photo recordings were carried out. Internet research was carried out for the preparation and subsequent evaluation of the surveys. This knowledge should facilitate conversation.

IV. QUALITATIVE RESULTS

An overview of the results of the first research section is shown in Tables 2 and 3. The MK was selected as "Stand and Priority of Operational Controlling". In the top line, the ciphered interview partners 1-7 are listed. Below are the categories "Organizational structure", "Process organization" with the respective UK, the "market situation" with individual components of a competition analysis, and "company and owner" with subjective assessments of the researcher. Due to the various questions, different scales are used, which are described in more detail in the legend.

Table 2: Overview of the category "Status and priority of company controlling" and the individual sub-categories as well as the market situation and the evaluation of the company and interview partners

Company	1	2	3	4	5	6	7
ORGANIZATIONAL STRUCTURE							
Accounting							
Commercial clerk	✓	✓		✓	✓	✓	✓
Own financial accounting	✓	✓		✓			
Own accounting	✓	✓	✓	✓			✓
Own payroll accounting	✓	✓		✓		✓	✓
Use of IT							
Own IMS system		✓	✓		✓		
Special software for services	✓	✓			✓	✓	
Computer Checkout	✓	✓	✓	✓	✓		✓
Interfaces Soft-/Hardware	✓	✓	✓	✓	✓		
Long-term target direction	✓	✓	✓		✓	✓	✓
Own service department	✓	✓				✓	✓
Succession regulation		✓			✓		✓
PROCESS ORGANIZATION							
Order processing		+	+	+	-	+	+
Accountancy	No. Rec	+	+	unclear	+	+	No. Rec
Documentation	-	+	No. Rec.	+	+	+	No. Rec
Value of the tax consultant	+	-	unclear	-	+	+	+
Preliminary calculation	+	+	+	+	-	+	+
Post-calculation	-	+	-	-	+	+	+

Statistics, handling of key figures	-	+	+	+	+	-	+
Use of the CCA	(+)	+	-	(+)	(+)	+	+
MARKET SITUATION							
Competition	3	4	3	3	2	2	2
Catchment area and potential	2	2	2	2	2	2	2
Availability, location	2	3	4	3	2	2	4
Image	3	1	2	2	1	2	2
COMPANY AND INTERVIEW PARTNERS							
Impression of Company	3	1	2	3	2	3	3
Impression of Owner	3	2	3	3	2	2	2
Impression of Office	2	1	No. Rec	3	2	2	3
Impression of Homepage	4	2	4	3	3	3	2

Legend: ✓ = available, + = structured, - = unstructured, * + = tight, - = low, ** + = available, (+) = Partly available, -= unavailable, Numbers 1–6 = grades, No. Rec. = No Records, CCA = Cost Centre Accounting, IMS = Inventory management system, IP = Interview partner.

Source: Own creation, based on interviews, internet research, and document analysis and own subjective evaluation based on established criteria.

a) Organizational Structure

The first lines show the status of accounting. It can be seen that the companies mainly have their own accounting and their own payroll accounting. A separate financial accounting can be found in three companies, and commercial employees are employed in almost all companies.

Next, the status of the IT application is listed. The first row gives an initial clue to the focus of value creation: An inventory management system (IMS) displays the flow of goods to sales items from purchasing to dispatching and billing at the product level so that complete traceability is possible. Three companies run such a WW system, which points to the focus on retail trade. The third row shows the use of computer checkout, which is used in almost all companies. Although a IMS requires such a computer cash register, the use of a computer checkout system is also possible without IMS, since work is done on the product level, but only the goods acquisition (purchasing) is not taken into account, with the rest of the goods traffic being recorded.

The “long-term target” category is derived from the original “company objective” and includes statements on the operational development (operational/strategic), “vision”, “targets”, “corporate image” and “succession rules”. There was a long-term focus in almost all companies. The category “own service department” (“self-contained service departments” = “SD”) is derived, in addition to the handed-out organigrams, from the following UK: “documentation”, “statistics and handling of key figures”, and “use of the CCA”. Since this category leads directly to the answer to the second assumption

(see Assumption 2: “There is no clear demarcation of the departments at the individual company level”), it assumes a central position. It can be seen that companies 1, 2, 6, and 7 have their own service departments. In addition to the stationary retail, the rest also offer horticultural services (see Table 3), but without a clear demarcation in their own departments. For further discussion of the second assumption, please refer to the below section “Process organization/use of the CCA”.

b) Text statements for the category “Own service department”

i. Companies with their own service departments:

Company 2: “We are set up on three legs [...] but in principle, the three departments are autonomous and also autonomously guided by a gardening master [...] of course the room cultivation [...], consulting in objects [...]. Second area flower business [...].”

Company 6: “Otherwise, a normal separation of all cost centres takes place. This starts in the vehicle fleet, to the employees, the operating costs, the energy costs, and all the material costs. These I try to detect, the sales themselves, I try again to separate them in-house. This means that the recording of the sales in the garden irrigation is to be separated, in contrast to the interior cultivation, where only the servicing sales are detected. So, I have about six or seven different key figures in the sales distribution. With these, I can determine how many new orders we had per month and how many of them were realized in the servicing or irrigation. In addition, I can then determine how many sales were generated by the end customer or the wholesale trade.”

Company 7: So, the production, ok. The production, what runs into the production, is visible, ok.

Question: "Otherwise[...] staggered by product groups?"
Answer: "Yes."

Question: "And [...] the cemetery also runs separately?"
Answer: "[...] cemetery is indeed a separate enterprise [...] is not covered at all."

ii. Companies without their own service departments:

Company 3: Question: "So the overwintering is in the big pot?" Answer: "Yes [...]"

Company 4: "[...] for cemetery and cultivation, I have nothing."

The "succession regulation" has been clarified or initiated in three companies.

c) *Process organization*

The categories listed below indicate the degree of structuring of business operations. The "order processing" is defined with structure, order, storage, and regulation of the further processing of customer requests, customer wishes, etc. It is to find out how orders and inquiries are further processed. In addition, the general procedures and responsibilities within the companies should be clarified. The questions in this context are whether there are recognizable structures, or how to deal with customer requirements.

In almost all companies, a structured work is recognizable.

"Accounting" should point out the organization of company accounts. Are initial statements and reminders made promptly? A good structure can be seen in four establishments, but not in companies 1 and 7. A statement could not be interpreted exactly.

The "documentation" of company processes is closely related to the "order processing" and shows the degree of information processing. Indicators are, for example, the maintenance of lists, tables, and statistics, or an adequate, appropriate, and pre-printed form management procedure, in order to achieve optimal workflows. There is a high level of structuring in four establishments; no data were found in two companies; and there was no proper documentation in one company.

The "cooperation with tax consultants" category shows that there is a close level of cooperation in four firms, but only a small one in the case of 2 and 4.

The following line answers the degree of structuring of the "pre-calculation". This also includes the question of price policy, and how this is done in the company. The criteria were the existence of fixed calculation factors, documentation (written or verbal), the way in which requests were calculated, and the ability to recognize fixed responsibilities. In six

companies, a consistently structured approach can be identified.

The category "Post-calculation" shows a different result. The following questions were used as criteria: "Is there a regular recalculation of the orders?", "Are clear responsibilities in the value chain recognizable?", and "What is the degree of documentation and use of cost accounting systems?" A structured approach can only be identified here in four companies.

The category "statistics and management of operational key figures" is defined by statements such as "working with numbers", "interest in key figures", "regular statistical evaluations are made", and "bookkeeping". It is shown that five companies meet the requirements, and an assignment to "structured work" became clear.

Information on the spectrum of the offered services (see Table 3) is summarized in the category "use of the CCA". The cost types (here bookings) are created according to the cost and performance calculation (cpc) for individual cost centres (here departments) (Horváth, 2009). CCAs used to prepare the cost calculation, that is, to monitor costs in the individual operating departments and to control profitability. The UK are divided into "existing", "not existing", and "partly existing". The latter is of equal importance to the fact that a breakdown of individual business areas is only to be seen in the basic text.

A separate CCA can be seen in companies 2, 6, and 7; in three others, it is in its beginnings. This shows the context in which the CCA is applied in the companies that also have their own service departments (departmentalization). The second assumption is thus rejected, although it depends on the particular case. The assumption presupposes that (a) different activities are offered in addition to retail trade, (b) the company accounts can do this, and (c) the employees' business skills allow it. The following interview questions were used for the review: "What activities are offered in your company?", "How do you determine whether an order has been profitable?", and "You have prepared an overview of the employees for me. Can we assign these to their areas of responsibility, possibly departments? (Organizational chart)". For more information on the use of the CCA and "own service department", see Figure 1. Until now, the coding of the text passages within the framework was carried out according to fixed, objective rules. In the course of the evaluations, further categories were developed, which were determined not by objective, but by subjective impressions of the researcher. The aim of this approach is to obtain further, deeper insights. Each of the following categories has been individually evaluated according to the principle of

free interpretation and has been given a school grades 1-6¹.

d) Results of the Market Situation

In order to analyse the market situation, individual parameters of a competition analysis according to Reymann (2009) were processed and represented in the form of ordinal scales (school grades 1-4²). The following competitor-related and company-related factors were used. A competitor-related factor was used: "number of competitors". In addition, a number of company-related factors were used: "catchment area", "potential" as measured by the "number of inhabitants" (city and county), "purchasing power index 2011", "population structure and employment structure", "purchasing power growth rate 2011-2012", "accessibility" and "location" with the approach and parking situation, as well as "image" (see MBR, 2010; Federal Statistical Offices, 2013; IHK Würzburg-Schweinfurt, 2013). The ratings of the companies are described below. The main strengths and weaknesses are given in Table 3.

Company 1 is in a major city. It is exposed to a major competitive environment in all departments of its range of services (Grade 3). The urban catchment area is very large, with about 3.3 million inhabitants (EW). The purchasing power index of 92.1% is rather low but experienced a rise of 4% in 2011-2012 (Grade 2). The company is in a good location, well-frequented, and accessible. Parking is available at a directly adjacent shopping market. This is classified as Grade 2. It is a traditional company, is very well-known, and has a good external presentation. The operating climate was somewhat cool and distant on the days of the evaluations, both among the employees and in their relationship with their supervisor (Grade 3). Due to the high number of employees (50-plus to be trained) and the broad range of services (see Table 3), sole management is a challenge, although this structure has been consciously built up in recent years. This is classified as an outstanding weakness. A systematic CCA is only available in basic features. The architecture is partly obsolete, does not correspond to the state of ergonomics, and limits the productivity of work. No succession has been made, but this is not yet up to date due to the age of the owner.

Company 2 is in a medium-sized city with about 313,000 inhabitants and is characterized by great competition in individual business segments. Thus, 51 florist shops

and 10 GRHs were identified within a radius of 10 km. This is judged as an outstanding weakness (Grade 4). The purchasing power index is 97.1%, an increase of 3.7% (2011-2012). The catchment area is in the Rhine-Neckar metropolitan area and thus very favourable (Grade 2). In a mixed residential area on the main road, the accessibility and parking situation are satisfactory (Grade 3). The image is very good, and the management made an optimal impression. This is classified as an outstanding strength (Grade 1). The succession is initiated.

Company 3 is rurally located in the metropolitan region of Hamburg, which has about 5 million inhabitants. The purchasing power index is 121% in the Harburg district, with a growth rate in 2011-2012 of +3% (Grade 2). These favourable conditions mean that the environment has numerous competitors from the adjoining city (Grade 3). The approach is rather cumbersome and to be assessed as an outstanding weakness, though the parking situation is good (Grade 4). As a traditional family business, the person of the owner plays a decisive role in the external and internal presentation; the mood on the day of the review was very good. This is seen as a satisfactory strength (Grade 2). No succession has been made, but this is not yet up to date due to the low age of the owner.

Company 4 is in a medium-sized city with about 32,000 inhabitants and close to the metropolitan region of Hamburg, which has about 5 million inhabitants. The purchasing power index is very favourable at 117%, with growth of about 3% in 2011-2012 (Grade 2). The number of competitors is manageable, but there is a very strong and committed competitor in retail and floristics (Grade 3). The company is characterized by strong in-house production. The approach and parking situations are satisfactory due to the location in a mixed residential area (Grade 3). The positive image of the "producing nursery" and the personality of the owning family are at the forefront and are seen as satisfactory strengths (Grade 2). However, the operational structure, based on family changes, personnel shortages, and an increasing focus on the service sector, is difficult to see at present as a weakness. No succession has yet been initiated.

Company 5 is located on a main road in the rural area of Bavaria (Grade 2). Purchasing power in Landsberg am Lech has an index of 112% and a growth rate of 4% in 2011-2012 (Grade 2). With very few competitors, the competition situation is favourable for the company (Grade 2). Its focus is on retail and very strong self-production. Its image is seen as an outstanding strength due to the highly active involvement of the owner (Grade 1), while the low service spectrum is classified as a weakness. The succession has been initiated.

¹The German school system categorizes 6 grades: 1 (= best), 6 (= worst)

²For this ordinal scale, we choose 4 grades: 1 (= outstanding strength), 2 (= satisfactory strength), 3 (= not satisfactory strength), 4 (= very low strength).

Company 6 is in a medium-sized city with 124,000 inhabitants, in a county with 160,000 inhabitants. The city's purchasing power index is 99.2%, with a growth rate of 3.2%. In the county, the purchase price index is 102.1%. The Main-Neckar metropolitan area offers favourable conditions (Grade 2). The company is divided into two separate entities and is run by two family members. A specialization of the retail and horticultural services took place. New niche products and innovations in the service sector are constantly being sought. The customer radius of the gardener service, therefore, extends far beyond the city limits. While the competition in the retail trade is very intense, with 34 vendors of flowers and plants, there are only four room cultivation start-ups in the large metropolitan area. Thus, the competition situation is classified as positive (Grade 2). The access possibilities are good, and the parking situation is satisfactory (Grade 2). The IP is characterized by a great commitment to customer service and an honorary office in the horticultural profession, so we can mention it as a "network" here (Grade 2). The construction of the buildings, on the other hand, is obsolete and can be seen as an outstanding weakness. No succession has been initiated.

A second company, which is managed by a family member, is also affiliated with *Company 7*. In total, several family members work in the two companies and create the atmosphere of a family business in which customer proximity is given and sought. The IP is also heavily involved in the professional honorary office (Grade 2). This company is in a city with about 43,000 inhabitants, in a district of about 156,000 inhabitants, in the metropolitan area of Rhein-Main, with about 5.8 million inhabitants. The purchasing power index of the metropolitan area is 98.6% (city 97.9%), with growth of approximately 2.8% in 2011–2012 (Grade 2). Only a manageable number of competitors in the retail and also services were identified, so the competition situation is favourable (Grade 2). The access possibilities are rather difficult due to the mixed residential area, and the parking situation is weak (Grade 4). For these reasons, it was decided to move the entire GRH to another location. This new building is planned for the year 2014 and is thus outside the research period. The prospects for the future are viewed as an outstanding strength, although the entrepreneurial risk is considered to be very high in this investment size. The succession has been initiated.

e) *Results from companies and owners*

As before, the factors that were used for the assessment of each respective category should also be shown for the categories "company", "interview partner", "impression of office", and "impression of homepage".

The following factors were used to characterize the "impression of company" category: "work organization", "delegation degree", "internal communication", "documentation", "order processing", "order and storage", "self-service", "mood and atmosphere in the company", and "dealing with the customers".

For the evaluation of the category "impression of interview partner", the following factors were used: "statistics and the handling of key figures", "company direction", "dealing with employees and customers", "own commitment/drive/involvement", and "honorary office".

For the category "impression of office", the factors "documentation", "order and filing", and "customer availability" were used.

In the "impression of homepage" category, it was necessary to compare the interviews and documentation with the content of the homepage on the basis of the factors "actuality", "appearance", "range of services", and "chronicle".

The grading of the four categories is shown in Table 2.

Category "impression of Company": The result was predominantly satisfactory, with Company 2 providing an excellent impression. In almost all criteria, it is very structured and well organized.

Category "impression of IP": Again, a good to a satisfactory result of all companies can be seen.

Category "impression of office": Company 2 made a very good impression. Company 3 could not be evaluated, since no access to the office was possible.

Category "impression of homepage": Companies 2 and 7 show a high consistency and are rated 2; the other enterprises are rated 3 or 4.

To assess the interviewees' operational orientations, three different categories were formed. These are the "range of services", the "outstanding strength", and the "outstanding weakness". In the category "range of services", a total of 17 services were mentioned by all companies: lawn care, irrigation systems, other services, nursery planting service, balcony planting service, garden planting service, terrace planting service, on-site consulting/sales, delivery, hiring service/plant hiring, gardening, cemetery work, room cultivation/hydroculture, decorations on site, own demonstration plant, project work, and cross-selling. On the basis of this total population, the share of the services that the surveyed companies offer in each case was determined from the individual company-specific nominations. As an example, Company 1 offers $n = 11$ services, which gives an offer coverage of 65% with reference to the total number of all recorded services ($n = 17$) (Table 3).

The companies provide 41% to 71% of all services, with companies 2 and 3 covering the lower

area with 41% and 47%, respectively, and companies 1, 6, and 7 the upper area, with 65% and 71% (Table 3). In principle, it can be assumed that other services are offered in the companies that did not participate in the interviews. Due to the frequency of these nominations, from which these 17 services are derived, the best procedure is to go out from regular, recurring services. First, a broad spectrum of services can be considered, which confirms the first assumption. However, the operating conditions must be taken into account. For example, Company 2 only performs seven different

services, making it a specialized operation. However, this is a broadly-based company consisting of three self-sufficient profit centres and two independent divisions, which are specialized and target-oriented in the market. Company 6, on the other hand, is also subdivided into independent operating units, but as a specialist primarily in the field of cultivation. A total of 12 different services are managed, which are also offered as a hybrid power bundle (combination of product and service).

Table 3: Operational orientation

Company	1	2	3	4	5	6	7
Range of services*	65%	41%	47%	53%	59%	71%	65%
Outstanding strength	Location	M	Image	Image	EE	Network	CE
Outstanding weakness	SO	C	Location	SO	SO	Age	WI

Legend: Age = Age of the company, CE = Corporate development, C = competition, EE = Engagement of the entrepreneur, LS = Low supply of services, M = Management, SO = Structural organization, WI = Willingness to take risks. * The figures refer to the ratio of the services listed on the operational level to the total population of the services (= 100%) mentioned in all establishments.

Source: Own creation, based on interviews, internet research, document analysis, and own subjective evaluation based on established criteria.

V. QUANTITATIVE RESULTS

As described in Chapter 3, quantitative analysis steps were implemented with the aim of confirming the meaningfulness of the results obtained from the qualitative content analysis. A built-in frequency analysis is checked by the reliability index. All coding processes were carried out by both researchers. As a result, values above 80% were predominant. They can be called reliable. According to Becher (2007), values of 70% can

be regarded as reliable for exploratory investigations when a new field of research is involved. If the quantitative evaluation is continued, categories with a consistency of less than 70% would have to be excluded from the evaluation. This is not done in the present work, since the focus is on the qualitative level. Table 4 shows an overview of the category framework for the MK "Standing and Priority of Operational Controlling" (section).

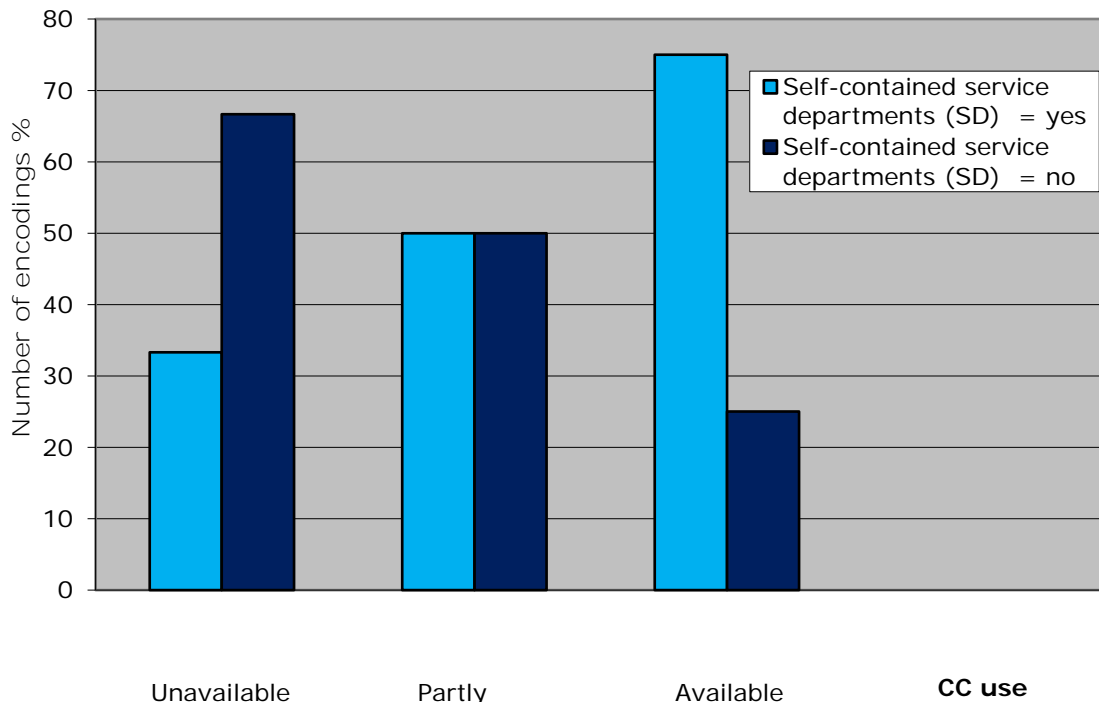
Table 4: Measure of consistency (Reliability Index 2) between Researchers 1 and 2 on the example of two subcategories of the main category "Status and Priority of Operational Controlling" *

Type	Forms	Number of content matches	Total number of arguments	Number of categories	Reliability index (2)
MC	Status and Priority of Operational Controlling				
SC	Cooperation with tax consultants				
V	low	3	3	3	100.00%
V	unclear	3	3	3	100.00%
V	closely	6	7	3	88.64%
SC	Order processing				
V	unstructured	6	7	3	88.64%
V	unclear	2	5	3	31.62%
V	structured	28	29	3	97.38%

Legend: MC = Main category, SC = Subcategory, V = Variable. *: Formula calculation (see above). Source: Own calculations.

The frequency of the nominations can be further processed by cross tables, as described in chapter 3. In the following example, the category “use of the CC

accounting” is placed in a relationship with the companies “with and without their own service department”.



Source: Own presentation, based on coded interviews. CC = Cost entre accounting

Figure 1: Ratio of the categories “use of the CC accounting” and “self-contained services departments (SD)” in the form of a cross table.

While Table 2 shows the use of a CA as an indicator, two categories are set up in relation to one another (x-axis) in Illustration 1: “companies with and without SD” and “use of CCA available/not available/partly available”. The bar length (y-axis) indicates the frequency of the text encodings. It can be seen that enterprises with SD are more likely to have a CCA (75% of all text passages suggesting the existence of CCAs were made by companies that have an SD) and vice versa, so more entries for non-SD companies are “not available” (67%). The quantitative analysis thus allows the more differentiated statement that there is a different size ratio within the three categories and reaffirms the results of the second assumption. It is important to emphasize that the quantitative results do not correspond to the representative accuracy since the basic total of n = 7 is too small. It is only intended to support the qualitative findings.

Table 2 shows an overview of the components of operational controlling in the form of a category framework. The respective symbols in the organizational structure show that companies 1 and 2 use many of the acquired elements and thus are structured, while companies 3, 4, and 6 are less structured. When looking

at processes, however, a different picture emerges. Companies 2, 6, and 7 are clearly structured, while companies 1, 3, and 4 are rather unstructured. The categories “market situation” and “enterprise and interview person” show a predominantly good to average evaluation, even if there are in each case two excursions in both directions. These are the “outstanding strengths and weaknesses”. Overall, companies 2, 6, and 7 appear to be particularly positive and structured, while companies 3 and 4 are relatively unstructured. In the horizontal comparison of the individual categories and establishments, mostly confirmatory symbols can be seen. This suggests a structured nature as well as the flow of the processes in the companies.

VI. DISCUSSION AND OUTLOOK

The aim of this study is to examine the requirements of GRH from an economic perspective in the field of controlling horticultural services. As a result, the qualitative study shows a category framework, in which the main category “status and priority of operational controlling” is examined in more detail. Further categories are not analysed in this article, since

they are intended to serve later investigations. The basis for the qualitative evaluations is the analysis of the IP's statements, which were coded independently by two researchers. Under stringent observance of the coding rules, a category framework was developed that was supplemented by appropriate scales and quantitative examination sections. The meaningfulness can only be guaranteed with precise rules-based coding by experienced researchers. This is the case in the present work, as is the check for reliable results by constantly repeating the measurements.

The interviews included a total of seventeen different horticultural services. Although there are certainly others who did not participate in the interviews, the often very frequent repetition of the nominations can be attributed to a regularly offered services that is offered in the GRH and belongs to the product portfolio.

The large number shows that the GRH has a broad range of services, which confirms the first basic assumption. In later investigations, more precise formulations can be developed for research hypotheses, for example, "Specialization of the GRH on the core competences leads to greater economic success." A deeper knowledge of the level of service in terms of "hybrid power bundles" is also of interest.

The second assumption is that there is no differentiation between individual departments in the companies. The results in Table 1 show that three establishments are based on the stationary retail, and four establishments own their own service departments, either as parts of their own company or as legally separate companies. The question "specialization or generalization?" is not new and needs to be assessed in each particular case. A high degree of specialization of companies suggests at least a higher level of organization in company structure and process organization than is the case with broad-based companies. There is, however, no connection between the number of services offered (Table 3) and a high degree of specialization, since the more retail-oriented companies offer a large number of services (e.g. Company 5), while others, more service-oriented enterprises (e.g., Company 2, with 41%) have comparatively few services. The specialization depends on the environment and the chronicle of the company, as shown in the tables. It becomes clear that the four companies with SD have been working with services for a very long time and thus have a wealth of experience, which is reflected in a higher number of employees. It is also apparent that these GRHs also have a different legal form (corporation, private limited company, PLC). This may have been chosen for personal or other reasons, but it is probable that the legal form was selected for security reasons and risk minimization in view of the execution of services, which is associated with a higher risk in project orders. This also suggests strategic planning in the abovementioned companies,

which was confirmed by the "long-term objective" category.

The delineation of the departments requires a clear allocation of the bookings within the framework of the KLR, which is made possible by a CCA. A separate CCA is available in three companies; in three others, it is recognizable in its beginnings. At the same time, a separate service department will be operating in four companies. Here, the relationship is recognizable: enterprises with SD also more often use a CCA. The quantitative analysis with cross-tables has strengthened this assumption (see Figure 1). In view of these relationships between SD and CCA, the second assumption is that there is no clear demarcation of divisions at the individual company level. In order to derive a relevant GRH from the large number of possible service definitions, the classification into "pure service providers" or "providers of product-accompanying services (PAS)" is appropriate (Meiset al., 2010). Depending on the intensity and focal point of the embodiment, it is possible to assign the 17 mentioned services to both groups of companies; for example, the installation of irrigation systems can be offered as part of garden maintenance (Company 1) or as a specialized service (Company 6). This question can be derived from other categories in Table 2 or from the market environment.

A CCA also provides information on the status of company accounting. Of the examined companies, Companies 2, 6, and 7 show high development in all categories, leading to business-oriented enterprises. This assumption is supported by the commercial training of the managing director and the personal impression of the researcher during operation, with a tight and well-organized company and a regular office organization.

Most of the categories show a homogeneous structuring (e.g. "order processing", "recalculation", "long-term goal") in the horizontal comparison of the enterprises. In others, however, differences between the companies are identified. Thus, there are only three companies that have their own financial accounting, which has the advantage that the bookings take place in house, and thus a timely tracking of the booking procedures is possible. This suggests a higher value of company controlling in general and accounting in particular. However, the category "cooperation with tax consultants" is to be assessed differently: although close cooperation is fundamentally positive, as a regular exchange of information takes place, this does not necessarily mean a better office organization: Company 4 does the accounting itself and hands over the data at the end of the year only for the purpose of preparing the accounts for the tax consultant. Here, too, it is important to consider the company's own strategy and thus each individual case.



It should be borne in mind that in almost all establishments, a pre-calculation is carried out, but in only three companies is a post-calculation. Based on the results described, it is concluded that a structured controlling system takes place in the companies. However, the individual characteristics of each company do not reveal a clear profile. Only Company 2 occupies a prominent position in almost all categories and is very well positioned in business.

Taking into account the above-mentioned in homogeneities of individual categories, the enterprises are basically structured and organized and have shown many similarities. The third basic assumption must, therefore, be rejected.

The subjective assessments of the researcher on the market situation, the company, and the interviewee were listed in Table 2. These have tended to be positive and have the advantage of obtaining a rounded look. Soft factors such as strengths and weaknesses became visible. Image is of particular importance here. The person of the owner or manager who shapes the company is seen as a key success factor. A culture of its own will be felt.

The qualitative content analysis is a good tool to combine objective evaluations with subjective ones. Also, the use of quantitative methods is useful when a more precise statement is required. However, this requires a higher population of data to meet representative requirements. Unfortunately, this is not possible in the present study with seven companies, so the results of this examination are mainly reflected in the qualitative surveys. For the exploratory first step, however, statements on the research questions are possible on the basis of the limited sample, which is to be extended in later steps.

In the next section of the research project in which this study is embedded, a balance sheet analysis is intended to assess the company's success and to classify it according to "best practice". A subsequent process value analysis (PWA) is to reveal the value-adding processes. Only then can a holistic picture of the GRH be possible, so that it is later possible to derive a list of requirements for GRH.

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Rural Women's Involvement in Agriculture in Okpo District, Kogi State, Nigeria

By Agada Mary Ojotule & Ameh Elizabeth

Federal University of Agriculture

Abstract- The study assessed rural women's involvement in agriculture in Okpo District, Kogi State, Nigeria. Data were collected from 120 randomly selected rural women farmers using a structured questionnaire. Data were analyzed using frequencies, percentages and mean scores. Results of the study showed that cassava (80%), groundnut (75%), vegetables (62.5%), cowpea (60%), maize (57.5%) and bambaranut (56.7%) constituted predominant crops grown by the respondents while poultry (63.3%), goats (70.8%) and sheep (41.7%) were the major livestock reared. Findings also indicated high involvement of farmers in land clearing (91.6%), weeding (90.9%), sowing/planting (88.4%), harvesting (87.5%), transportation of produce/products (85.8%), processing (77.3%), marketing (79.2%) and storage (67.5%). Major constraints to participation in agriculture included limited access to land (M = 2.26), lack of access to credit (M = 2.15), limited time for agricultural activities (M = 2.07), lack of access to inputs (improved seeds, fertilizers, agro-chemicals) (M= 2.05), lack of modern storage facilities (M = 2.03) and lack of access to appropriate agricultural technologies (M = 2.00).

Keywords: rural women, involvement, agriculture, okpo district, Nigeria.

GJSFR-D Classification : FOR Code: 070199



Strictly as per the compliance and regulations of :



Rural Women's Involvement in Agriculture in Okpo District, Kogi State, Nigeria

Agada Mary Ojotule ^α & Ameh Elizabeth ^ο

Abstract- The study assessed rural women's involvement in agriculture in Okpo District, Kogi State, Nigeria. Data were collected from 120 randomly selected rural women farmers using a structured questionnaire. Data were analyzed using frequencies, percentages and mean scores. Results of the study showed that cassava (80%), groundnut (75%), vegetables (62.5%), cowpea (60%), maize (57.5%) and bambaranut (56.7%) constituted predominant crops grown by the respondents while poultry (63.3%), goats (70.8%) and sheep (41.7%) were the major livestock reared. Findings also indicated high involvement of farmers in land clearing (91.6%), weeding (90.9%), sowing/planting (88.4%), harvesting (87.5%), transportation of produce/products (85.8%), processing (77.3%), marketing (79.2%) and storage (67.5%). Major constraints to participation in agriculture included limited access to land (M = 2.26), lack of access to credit (M = 2.15), limited time for agricultural activities (M = 2.07), lack of access to inputs (improved seeds, fertilizers, agro-chemicals) (M = 2.05), lack of modern storage facilities (M = 2.03) and lack of access to appropriate agricultural technologies (M = 2.00). The study concluded that rural women farmers in the study area were small-scale producers who grew subsistence food crops, kept poultry and small ruminants and contributed about 68-92% of their labour in all agricultural operations. However, they were constrained by lack/limited access to agricultural productive resources, hence low production and productivity. In the light of the foregoing, it is recommended that rural women farmers be provided with improved varieties of crops they cultivate while efforts are made to introduce to them more valued crops that would enhance their production. Also, access to relevant agricultural productive resources and timely information as well as gender-sensitive technologies that would reduce drudgery in farming operations, processing and storage activities could free them time to participate in other income generating activities which could in turn improve their income and standard of living.

Keywords: rural women, involvement, agriculture, okpo district, nigeria.

I. INTRODUCTION

Hunger remains unacceptably widespread in the world while many systems of food production in use are unsuitable. The world's population is set to reach a billion by 2050; therefore, agricultural production will need to increase by 60% in order to meet demand (GIZ, 2013). Rural women farmers are

important for increasing agricultural production and productivity. Women produce 60 to 80% of food in most developing countries and half of the world's food supply (Momsen, 1991; Mehra & Rojas, 2008). They produce food and cash crops and manage mixed agricultural operations, involving crops, livestock and fish farming and are considered as part of the agricultural labour force (FAO, 2011). Rural women are also known to be fully involved in all farming operations such as planting, tinning, weeding, fertilizer application, harvesting, storing, processing and marketing (Mybada, 2000).

The role of women in Nigeria economic sector cannot be over emphasized. Women are the real driving force of the nation's economy and are therefore crucial to the sustainable development of the country. Majority of Nigerian rural poor are involved in agriculture, with rural women producing major food crops comprising cereals (sorghum, maize, rice); tubers (yams, cassava), legumes (groundnut, cowpea, bambara nut) as well as vegetables such as okra, leafy vegetables, etc., (Odurukwe, Matthew, Njoku & Ejiogu, 2006; Satyavathi, Bharadwaj & Brahmanand, 2010; Osho & Dashiell, 1997). World Bank (2003) and Mahmood (2001) reported that about 60% of food produced comes from rural women farmers who make up to 60 -80 % of the agricultural labour force in the country depending on the region. Rural women in Nigeria worked side by side with men in agricultural production with some marked division of labour among them. The men perform the tedious tasks of felling trees, gathering and burning of bush and making ridges, while women are involved in planting of seeds particularly food crops, harvesting, transportation, processing and selling of farm produce and products (Lawanson, 2008). The role that women play and their position in meeting the challenges of agricultural production and development are quite dominant and prominent. According to Bill and Melinda Gates Foundation (2012), women in sub-Saharan Africa do about 80% of the farm labour. Banji & Okuade (2005) attributed 60% of the farm labour force to women who produce 80% of food and earn 10% of the monetary income but own just 1% of the farm assets.

The Nigeria economy is predominantly agrarian and women are key players in this business of agriculture in the country, especially within rural communities. Damisa, Samndi & Yohanna, (2007)

*Author α: Department of Agricultural Extension and Communication
Federal University of Agriculture, Makurdi, Nigeria.
e-mail: maryagada59@gmail.com*

pointed out that various researches conducted on the contribution of women to agricultural development in the country suggest that women's contribution to farm work is as high as between 60-90% of the total farm tasks performed. The contribution of women ranges from such tasks as land clearing, land-tilling, planting, weeding, fertilizer/manure application to harvesting, food processing, threshing, winnowing, milling, transportation and marketing as well as the management of livestock. Obasi (2005) also noted that rural women farmers in Nigeria performed about 70% or more of all agricultural food processing and utilization activities and over 60% of storage and marketing operations.

The agricultural activities of women go beyond crop production to other agricultural aspects like fisheries, poultry and as well as sheep and goat rearing. In Nigeria, over 60% of families kept poultry with women being the major managers and owners controlling the limited cash income from sales (Dessie & Ogle, 2001). Also in Nigeria, 77, 73 and 25% of women were involved in chicken, goat, and sheep production respectively and their main activities were pen cleaning (89%) and feeding (83%) (Oji and Ekumankama, 2002). Ironkwe and Ekwe (2005) also noted that rural women farmers in Abia State were involved in fisheries, rabbitary, poultry as well as sheep and goat rearing. Furthermore, FAO (2007) reported that women were responsible for rearing poultry and small livestock and growing food crops and were responsible for some 60 to 80% of food production in developing countries.

Despite the important roles women play in agriculture in the country, they are hardly given any attention in the area of training and /or visitation by extension agents with improved technologies. Banks hardly grant women loans and are hardly reached with improved seeds, fertilizer and other farm inputs (Damisa *et al.*, 2007). Ogunlela & Mukhtar (2009) also reported that the critical factors that affect productivity at the farm level include but are not limited to the factors of production such as land and capital, agricultural research, technology, infrastructure and access to support services such as extension services and credit.

In order to reduce the problems facing poor rural women farmers, various studies have been conducted on possible solutions. For instance, Ani (2004) carried out a study on women in agriculture and rural development. Fabiyi (2007) studied the role of women in agricultural production. Lawanson (2008) conducted a study on female labour force participation in Nigeria: Determinants and trends, while Damisa & Yohanna (2007) focused on roles of rural women in farm management decision making process. However, none of these studies was conducted in Okpo Local Government Area of Kogi State. In view of the changing socioeconomic, political and environmental situations and the fact that these conditions vary from place to place, this study becomes imperative.

The objectives of this study were: (i) describe the socio-economic characteristics of women farmers in the study area; (ii) identify the crops produced by rural women farmers in the study area; (iii) determine the livestock reared by rural women farmers in the study area; (iv) ascertain respondents' participation in agricultural production activities; and (v) identify the major constraints militating against respondents' participation in agriculture.

II. METHODOLOGY

The study was carried out in Okpo District, Olamaboro Local Government Area of Kogi State, Nigeria. Okpo is situated in south-eastern part of Kogi State. It has a land area of about 1,132 km² and a population of 160,152 inhabitants consisting 80,076 men, 60,046 women and 40,030 children (National Population Commission, 2006). The climate of the area is variably hot, having November-April as dry season, March-April as hottest months, while May-October is the rainy season with August recording the highest amount of rainfall. The inhabitants of Okpo are predominantly small scale farmers cultivating such crops as groundnut, vegetables, maize, yam, cowpea, citrus, etc. The livestock raised include goats, poultry, sheep and pigs.

The population for the study comprised all rural women farmers in Okpo District. Okpo District has five council wards, namely; Ade, Etutekpe, Okpo, Igah and Inele. Simple random sampling technique was employed to select three council wards (Okpo, Igah and Etutekpe), two villages per council ward, giving a total of six (6) villages that were selected for the study. The villages included Ofawna and Alagalani from Okpo, Ojuwo-Igah and Igah-Ocheba from Igah, and Akpakpa and Alagalani from Etutekpe council wards respectively. Furthermore, twenty (20) rural women farmers were selected from each of the six (6) villages, giving the total sample size of 120 respondents for the study. Data were collected from primary sources using a well structured questionnaire. Data were analyzed using descriptive statistics such as frequencies, percentages, mean scores.

III. RESULTS AND DISCUSSION

a) Socio-economic Characteristics of Respondents

Age (years): Results in Table 1 show that about 36.7% of the respondents were within to the age bracket of 15-30 years, 30.8% were within the age bracket of 46-60 years, 19.2% belonged to the age bracket of 31-45 years while 13.3% were above 61years old with a mean age of 41.3%. The result suggests that majority (55%) of the respondents were in their active and productive years and would be able to participate actively in farming activities, thereby enhancing production and productivity.

Marital status: The study revealed that a little above thirty percent (31.7%) of the respondents were married, 30.0% were widowed, 17.5% were divorced, 10.8% were single while 10% were separated (Table 1). Marriage makes labour supply stable for farmers, but a reasonable number (69.3%) of the women were unmarried. As such, they may have to hire labour which can result to an increase in the cost of production, hence the smallness of land under cultivation in the study area.

Education: Entries in Table 1 show that 31.7% of the respondents had no formal education, 27.0%; 27.0% had primary and secondary education respectively while 13.3% had post secondary education. This implies that majority (68.3%) of the respondents were literate and this can help in the adoption of certain agricultural innovations that could assist them in their production and processing activities. The result corroborates that of Okwu, Kuku & Aba (2007) who reported that a farmer's level of education affect his level of access, comprehension and adoption of modern agricultural practices. Also, Okunade (2007) in a study on accessibility of agricultural credit and inputs to women farmers in Osun State reported that the multiple regression analysis in the study showed a positive and significant relationship between level of education and accessibility to credit and other inputs.

Farm size (ha): Majority (55.0%) of the respondents had farm sizes of between 1-3 hectares, 32.5% had between 3-5hectares while 12.5% had less than1hectare. The results revealed that majority of the respondents were small-scale and subsistence farmers, a situation that may not allow them to engage in large production, have access to credit facilities or procure farm inputs for increased agricultural production and productivity. The finding is corroborated by the Africa Fertilizer Summit (2006) which reported that smallholder farmers cultivate from 0.8 -4.5 hectares of farm land.

Access to extension services: Results on access to extension services by the respondents (Table 1) indicate that majority (91.7%) of farmers were visited by extension agents once a year, about 5.8% were visited monthly while 2.5% reported weekly visits. The implication of this finding is that the female farmers lack extension contact, making it difficult for them to access and use new technologies that are appropriate and timely for improved agricultural production and productivity. This could be due to limited number of female extension agents to cover the study area. The challenge for the agricultural extension organizations, therefore, is to design the most appropriate strategies for women. Similar finding was reported by FAO (2003) which noted that in spite of their role in food production, women in sub-Saharan Africa receive little from the agricultural extension services due to traditional prejudiced attitude towards women, lack of time on the part of women to attend meetings due to their

productive and reproductive roles and their limited decision making powers. Several studies have alluded to the need to develop suitable extension activities that target women farmers (Odurukwe *et al.*, 2006; Satyavathi *et al.*, 2010).

Access of farm credit: Access to credit could increase total output. Credit can also affect expenditure on the use of mechanical equipment, working capital as well as improved seed. Most of the respondents interviewed reported they could not secure loan from formal financial institutions. The source of farm credit for majority (50.8%) of the respondents was borrowing from traditional lenders and cooperative societies while personal savings constituted about 49.2% (Table 1). Generally, women have less access to credit markets than men partly because they command fewer resources and have no collateral security as well as the direct discrimination against them in such markets. The implication of this finding is that majority of the respondents accessed farm credit from informal sources, making it difficult for them to venture into long term production practices that could increase their income and improve their livelihoods. As noted by Ajani (2008), access to formal credit services is often an insurmountable barrier for women as lending is directed by male-dominated larger enterprises that make the minimum loan larger than what is needed by women. Women's inability to provide acceptable assets as collateral reduces the possibility of obtaining credit facilities for their primary activities. Without credit, it is impossible for women farmers to purchase vital inputs such as fertilizer, seeds, improved technology and hire labour for improved agricultural production and productivity.

Membership of social organizations: Rural organizations are channels for providing training, credit and agricultural inputs to farmers. Results in Table 1 show that a little above half (50.8%) of the respondents were members of a social organization while 49.2% did not belong to any social organization. However, Odurukwe *et al.* (2006) found that women's membership of groups enhanced their access to decision making powers and farm inputs. The implication of this finding is that many farmers would be unable to access credit facilities since lending agencies would prefer to give credit to cooperatives rather than individuals.

Annual farm income (₦): Table 2 shows farmers' annual farm income. The results indicate that about 30.8% of the respondents earned an annual farm income of about ₦51,000-₦80,000, a little below 30% (29.2%) earned between ₦21,000-₦50,000 while 20.8% earned less than ₦20,000 and 19.2% earned above ₦80,000. This implies that the income level of all the farmers is very low, about ₦6.67 per month. This is way below the national minimum wage of ₦18, 000 only for Nigeria. The low financial status has made it difficult for farmers to

expand their area of cultivation since they may not be able to invest in capital projects like modern farm technology and inputs as this normally attracts huge financial obligation.

Table 1: Respondents' Socio-Economic Characteristics (n=120)

Characteristics	Frequency	Percentage
Age (years)		
15-30	44	36.7
31 – 45	23	19.2
46 – 60	37	30.8
61 – 75	16	13.3
Marital status		
Married	38	31.7
Single	13	10.8
Widowed	36	30.0
Divorced	21	17.5
Separated	12	10.0
Educational status		
Non formal Education	38	31.7
Primary	33	27.5
Secondary	33	27.5
Post secondary	16	13.3
Farm size (ha)		
<1	15	12.5
1 – 3	66	55.0
4 – 6	39	32.5
Extension contact		
Weekly	3	2.5
Monthly	7	5.8
Yearly	110	91.7
Sources of farm credit		
Informal Borrowing	61	50.8
Personal savings	59	49.2
Membership of social organization		
Yes	61	50.8
No	59	49.2
Annual farm income(₦)		
<20,000	25	20.8
21,000-50,000	35	29.2
51,000-80,000	37	30.8
Above 80,000	23	19.2

Source: Field survey, 2015

b) Crop Production of Respondents

Crop production of respondents is depicted in Table 2. The results revealed that the crops produced by majority of farmers were cassava (80%), groundnut (75.0%), vegetables (okra and spinach) (62.5%), cowpea (60.0%), maize (57.5%) and bambaranut (56.7%). Other crops grown by women included rice (42.5%), yam (41.7%), water yam (33.3%), pigeon pea (27.5%), cocoyam (26.7%), soybean (25.8%) and sorghum (22.5%). The finding of this study showed that rural women in the study area mainly grew subsistence food crops. The finding agrees with the report of Sahel Capital Field Research (SCFR) (2014) that women were

more involved in the production of food crops such as maize, cowpea, melon, pepper, cassava and vegetables. It is also corroborated by the works of Odurukwe, *et al.* (2006), Satyavathi, *et al.* (2010), and Osho & Dashiell (1997) who reported that rural women produced food crops comprising mainly cereals (sorghum, maize, rice), tubers (yam, cassava) and vegetables (okra, leafy vegetables). The production of low valued crops coupled with poor access to agricultural productive resources by women farmers could decrease their production and productivity, thereby diminishing their income and standard of living.

Table 2: Crop Production of Respondents (n=120)

Crops	Frequency*	Percentage
Cassava	96	80.0
Groundnut	90	75.0
Soybean	31	25.8
Rice	51	42.5
Maize	69	57.5
Sorghum	27	22.5
Vegetables	75	62.5
Yam	50	41.7
Cowpea	72	60.0
Cocoyam	32	26.7
Water yam	40	33.3
Pigeon pea	33	27.5
Bambara nut	68	56.7

* Multiple responses recorded
Source: Field survey, 2015

c) Livestock Production of Respondents

The livestock kept by the respondents in the study area are shown in Table 3. Majority of the rural women farmers reared goats (70.8%), poultry (63.3%) and sheep (41.7%) while a few (32.5%) kept pigs. This implies that goats, poultry and sheep are the major livestock produced by women farmers in the study area. The finding of this study is in agreement with the report of FAO (2007) that in developing countries, women are responsible for rearing poultry and small livestock, in addition to growing food crops. It also corroborates the

finding of Dessie & Ogle (2001) that in Nigeria, over 60% of families kept poultry with women being the major managers and owners controlling the limited cash income from sale. Although the finding on rural women's participation in goat rearing is similar to that of Oji & Ekumankama (2002) who reported 73% involvement, that of the sheep is lower (25%). Rural women in the study area keep poultry and small ruminants which they use as a buffer for generating funds to finance important and urgent needs such as children's school fees and health care.

Table 3: Livestock Production of Respondents (n=120)

Livestock	Frequency*	Percentage
Pigs	39	32.5
Goats	85	70.8
Sheep	50	41.7
Poultry	76	63.3

* Multiple responses recorded
Source: Field survey, 2015

d) Participation in Agricultural Activities by Respondents

Majority of the respondents reported high involvement in all the agricultural production activities (Table 4). These included land clearing (91.6%), weeding (90.9%), sowing/planting (88.4%), harvesting (87.5%), transportation of produce/products (85.8%). Involvement of women in processing, storage and marketing activities were 77.3%, 67.5% and 79.2% respectively. The results revealed that the labour contribution of rural women farmers in farm operations

in the study area was about 68-92% which is actually very high. This is higher than the findings of the World Bank (2003) and Mahmood (2001) that rural women farmers make up about 60-80% of agricultural labour force in Nigeria while Damisa *et al.* (2007) reported between 60 and 90% participation of women in farm tasks performed. The findings on processing, storage and marketing are higher than that of Obasi (2005) who reported that in Nigeria, rural women farmers do perform about 70% or more of all agricultural food processing

and utilization activities and 60% of storage and marketing operations. Rural women in the study area participated in all agricultural activities, therefore, gender

sensitive production, processing and storage facilities should be developed and disseminated to them in order to enhance their activities in the agricultural value chain.

Table 4: Respondents' Participation in Agricultural Activities

Activities	Frequency*	Percentage
Land clearing	110	91.6
Sowing/planting	106	88.4
Weeding	109	90.9
Harvesting	105	87.5
Transporting of produce/products	103	85.8
Processing	93	77.3
Marketing	95	79.2
Storage	81	67.5

* Multiple responses recorded

Source: field survey, 2015

e) *Perceived Constraints to Participation of Rural Women in Agricultural Activities*

The constraints militating against the respondents' participation in agriculture in the study area are presented in Table 5. Findings revealed that rural women farmers are faced with the problems of limited access to land (M = 2.26), lack of access to credit (M = 2.15), lack of time for agricultural production activities (M = 2.07), lack of access to inputs (improved seeds, fertilizers, agro-chemicals) (M= 2.05), lack of storage facilities (M = 2.03) and lack of appropriate agricultural technologies (M = 2.00).

The finding on limited access to land and land ownership by women farmers corroborates the report of FAO (2003) that access to land remains a major constraint for women farmers in Africa, Nigeria inclusive and land reform programmes have led almost exclusively to the transfer of land rights to male heads of households. According to Paarveen (2008), lack of access to land remains a major constraint for women in developing countries such as Nigeria.

One of the important support services for increased agricultural productivity is credit. Credit is important for securing fertilizer, improved varieties of seeds and other technologies on farms. However, lack of production credit has been reported as a major constraint to increased agricultural production among women farmers in the study area. This could be attributed to the fact that rural women farmers produce food crops and not crops for the market. They also do not have assets which could be used as collateral in case of default; as such formal lending organizations do not want to take risks.

Limited access to time by rural women farmers is a serious constraint in view of the fact that they are engaged in one activity or another throughout the day. When a rural woman is not on the farm, she is either

involved in crop processing, attending to livestock or carrying out reproductive and community activities.

The findings of this study showed that rural women farmers in the study area were constrained by poor access to farm equipment and farm inputs, implying that farmers would only be able to cultivate a small portion of land since agriculture is labour intensive and requires use of inputs for enhanced productivity. Doss (2002) noted that besides tools, inputs such as improved seeds, fertilizers and agro-chemicals are quite useful in increasing productivity. However, fertilizer use depends on availability and farmer's resources to purchase, but women farmers generally have less access to cash and credit, therefore, they are less likely to purchase and use fertilizers and other inputs that would increase productivity.

Farmers in the study area reported lack of access to modern storage facilities. Although, Obasi (2005) reported that over 60% of agricultural storage operations are performed by women in Nigeria, they do not have access to modern storage facilities. Rural women store their farm produce/products in traditional storage facilities such cribs, baskets, earthen pots, among others.

The respondents identified lack of appropriate agricultural technologies as a major constraint to agricultural production in the study area. Therefore, for consistent growth in agricultural production, it is important to equip rural women farmers with relevant and timely information and technology to improve their production techniques and increase their income (Salilaja & Reddy, 2003; Goldey *et al.*, 2001).

Table 5: Respondents' Constraints to Participation in Agricultural Activities (n=120)

Constraints	Mean	Standard Deviation
Limited access to land	2.26*	.794
Lack of access to credit	2.15*	.589
Poor access to agricultural extension services	1.78	.739
Limited time for agricultural activities	2.07*	.786
Lack of access to agricultural inputs (improved seeds, fertilizers, agro-chemicals)	2.05*	.776
Lack of appropriate agricultural technologies	2.00*	.789
Lack of education and skills	1.80	.705
Women producers not taken serious as men	1.86	.744
Lack of modern storage facilities	2.03*	.796
Lack of access to ready market	1.87	.766
Poor knowledge of improved production techniques	1.97	.721
Shortage of farm labour	1.95	.684
Weak or non existence women farmers' group	1.88	.795
Lack of access to labour-saving equipment for production and processing	1.98	.761

*Mean \geq 2.0

Source: Field survey, 2015

IV. CONCLUSION AND RECOMMENDATIONS

The study concluded that rural women farmers in the study area were small-scale producers who grew subsistence food crops, kept poultry and small ruminants and contributed about 68-92% of their labour in farming operations, and 77%, 68% and 79% in storage, processing and marketing activities respectively. However, they were constrained by lack/limited access to agricultural productive resources, poor processing and storage facilities as well as limited access to ready markets, hence low income and standard of living.

Based on the findings of the study, the following recommendations were made:

1. For consistent growth in agricultural production, it is important to equip rural women farmers with relevant and timely information and technology to improve their production techniques and increase their income and standard of living.
2. In view of the fact that rural women farmers contribute about 68-92% labour in all agricultural operations in the study area, gender-sensitive technologies should be developed by researchers and given to women at subsidized rates to minimize the drudgery in agricultural tasks and enable them have time for other income generation activities.
3. Extension agents should prioritize the dissemination of appropriate and timely information of women crops and livestock to enhance production which could in turn improve their household food security, income and standard of living.

4. Research institutions in Nigeria should consider working on women crops and come up with improved varieties for adoption which could enhance the production and productivity of such crops.

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Review on: Role of Legume Forage Meal Supplementation on Feed Intake, Weight Gain, Digestibility and Carcass Characteristics of Ruminant Livestock

By Denbela Hidosa

Jinka, Agricultural Research Center

Abstract- This paper recapitulates the role of legume forage meal supplementation on feed intake, weight gain, and digestibility and carcass characteristics of ruminant livestock. The different research works that had been carried out on ruminant livestock that fed on a basal diet of roughage based diets and supplemented with leaf meal(hay) of forage legumes demonstrated that supplementation of legume forages stimulated microorganism function in the rumen, reduced retention time and thus increased the intake of the feeds. Furthermore, different research output demonstrated the advantages of forage legume supplementation in process of digestibility which had depicted that supplementation of legume forages such as Lablab purpureus, Cowpea, pigeon pea, alfalfa and Sesbania sesba, Tagasaste, L. pallida, Desmodium leaf meal (hay) had played significant role in improvements in digestibility of DM, OM, CP, NDF and ADF.

Keywords: *legume forages, feed intake, digestibility weight gain and carcass characteristics.*

GJSFR-D Classification : *FOR Code: 079999*



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Review on: Role of Legume Forage Meal Supplementation on Feed Intake, Weight Gain, Digestibility and Carcass Characteristics of Ruminant Livestock

Denbela Hidosa

Abstract- This paper recapitulates the role of legume forage meal supplementation on feed intake, weight gain, and digestibility and carcass characteristics of ruminant livestock. The different research works that had been carried out on ruminant livestock that fed on a basal diet of roughage based diets and supplemented with leaf meal(hay) of forage legumes demonstrated that supplementation of legume forages stimulated microorganism function in the rumen, reduced retention time and thus increased the intake of the feeds. Furthermore, different research output demonstrated the advantages of forage legume supplementation in process of digestibility which had depicted that supplementation of legume forages such as Lablab purpureus, Cowpea, pigeon pea, alfalfa and Sesbania sesba, Tagasaste, L. pallida, Desmodium leaf meal (hay) had played significant role in improvements in digestibility of DM, OM, CP, NDF and ADF. Moreover, this review paper also had been demonstrated the positive effect of supplementation of legume forages leaf meals on weight gain and carcass characteristics in ruminant livestock as did concentrate supplements. Therefore, it is advisable to livestock producers to use legume forage leaf as protein supplements in order to improve the livestock production and boost the economic advantages. Despite the many research output on effect of supplementation on ruminant livestock, the availability of information to the livestock producers is very low. Future research be aimed to demonstrate many of research output on supplementation effect of legume forages wider scale in order to benefits the communities. This review paper also not reported supplementation effect of forage legumes on carcass quality characteristics such as carcass compositions and chilling losses which should be reviewed in the future in order to fill the gap.

Keywords: legume forages, feed intake, digestibility weight gain and carcass characteristics.

I. INTRODUCTION

The ruminant livestock production especially in developing country has been used as a pillar for food security, human nutrition and economic growth of the county (Shapiro *et al.*, 2015). However, despite of the huge potential in terms of ruminant livestock population and presence of diverse agro-

ecologies suitable for their production, the productivity obtained from the ruminant livestock is very low due to poor nutrition impediments (Berhanu *et al.*, 2007; FAO, 2010). In most developing countries the ruminant livestock production has depended on natural pastures and crop residues feed base (Adugna, 2007). It is apparent that feed resource base from the natural pasture and crop residues is insufficient to provide the minimum crude protein requirements to rumen microorganism and their host animal. Consequently, the digestibility and intake of these feeds are low which results in poor growth and reproductive performance in ruminant livestock (McDonald *et al.*, 2010; Adugna, 2008; Tessema and Ameha, 2003

Aregheore, 2001). The supplementing ruminant livestock with feed that affluent in protein and energy improves intake, digestibility and growth performance of ruminants that fed on low quality forages base diets. Among the supplements has been used as protein supplements in ruminant nutrition is the legume forages which has been used as protein supplements for ruminant livestock to improved sustainability of production (Savon, 2005). However, many of research works had demonstrated the importance of legume forages as supplements to the ruminant livestock. On the other hand, the availability of information on legume forages as supplementation for the readers and ruminant livestock producers are still limited. Therefore, review of the baseline information on research output available on the issue is so important to readers or livestock producers in order attain goals of high animal production (Crowder and Chheda, 1982) because the attainment of production goals depends upon the feeding value of feed resource (Humphreys, 1991). Therefore, the objective of this paper was reviewed role of forage legume meal supplementation on feed intake, weight gain, and digestibility and carcass characteristics of ruminant livestock.

II. EFFECT OF FORAGE LEGUME SUPPLEMENTATION ON FEED INTAKE

Feed intake is the weight of feed eaten by an animal or group of animals in a given period of time

Author: Southern Agricultural Research Institute, Jinka Agricultural Research Center, P.O.Box.96, Jinka, Ethiopia.
e-mail:denbelahidosa@gmail.com

during which they have free access to feed (Forbes, 2007). Feed intake is one of the most important factors that influence the performance of animal (Huhtanen *et al.*, 2011). If the feed intake is too low, the performance will be depressed (Forbes, 1995). The feed intake is affected by many factors like the density of energy in the diet, digestibility, succulence and amount of crude fiber and the physical nature of the feed (Rehrahie *et al.*, 2003). Conversely, the McDonald *et al.* (2002) report demonstrated that feed intake in ruminants consuming fibrous forages is primarily determined by the level of rumen fill, which in turn is directly related to the rate of digestion and passage of fibrous particles from the rumen. Furthermore, Adugna *et al.* (2002) reported that feed bases that have low in protein content and high in fiber constituents has been resulted in low voluntary feed intake in animal. Different research output demonstrated that supplementation of legume forages to poor quality roughages stimulated microorganism function in the rumen, reduced retention time and thus increased the intake of poor quality feeds. Hunegnaw and Berhan (2016) reported that the higher improvement in total DM intake in Wollo Lambs supplemented with Pigeon pea, Cowpea and Lablab hay meals over those Wollo sheep supplemented with wheat bran and fed natural grass hay as basal diet. The higher nutrient intakes particularly higher CP intakes helped the Lambs to acquire protein required for growth faster than the Lambs supplemented with wheat bran only which is indicating the advantages of legume forages as supplements to roughage feed has improved feed intake by the animals (Abraha, 2013). Likewise, the study made by Abule *et al.* (2004) reports demonstrated that cross bred calves fed on a basal diet of *Teff* straw which supplemented with *Lablab purpureus* and Cow pea hay meal had shown higher improvement in dry matter intake of *Teff* straw than none supplemented groups. Sultan Singh *et al.* (2010) found out that growing Bundel khandi kids which supplemented with 50% and 100% *Lablab purpureus* meal had exhibited higher daily roughage intake over none supplemented group of goats. Furthermore, the study made from Ethiopia highland area by the Dana *et al.* (2000) demonstrated that sheep Supplemented with graded levels of *Leucaena* leaf meal to a basal diet of chickpea haulm had resulted in increased DM intake of the basal feed with concomitant increase in total DM and CP intake. Similarly, Adugna and Sundstøl, (2000) observed the higher feed intake in Ethiopia highland sheep when sheep supplemented with graded levels of *Desmodium intortum* hay meal than sheep fed on basal diet of Maize Stover. According to Abule (1994) supplementation of graded level of cow pea and *Lablab meal* indicated that there was significantly increased microbial nitrogen supply in calves. Conversely, Bonsi *et al.* (1995) observed that sheep fed a basal diet of *Teff* straw and supplemented with 0, 175, 245 or 315 g of *Sesbania*

shown that the dry matter degradation and liquid passage rates increased with increasing level of *Sesbania* up to 245.

III. EFFECT OF FORAGE LEGUME SUPPLEMENTATION ON NUTRIENT DIGESTIBILITY

The digestibility of a feed is defined as the proportion that is not excreted in the feces and it is assumed to be absorbed by the animal body. On the other hand, it is simply a measure of the availability of nutrients to the animal. It is commonly expressed in terms of DM as a coefficient or percentages base. Supplementation of legume forages to the animal that fed on poor quality feed has been improved the digestibility of feed by the ruminant animals in large. Different research output demonstrated the advantages of legume forage supplementation in process of digestibility improvements. Mekonnen *et al.* (2016) report demonstrated that Horro sheep supplemented with *Lablab purpureus* leaf had 63% and 68% of DM and CP digestibility respectively than 58% and 56% of DM and CP respectively for Horro sheep supplemented with concentrate. Devendra (1982) and McDonald *et al.* (2002) had stated that supplementation with forage legumes increased the digestibility of poor-quality roughages by promote high microbial population in the rumen through facilitate rumen fermentation process. Moreover, Meron (2016) and Tolera and Sundstøl (2000) reports were demonstrated that there was a linear increase in CP digestibility with increasing levels of legume forages (*Tagasaste* and *Desmodium*) leaf meal supplementation in sheep fed a basal diet of Barley straw and Maize stover. Similarly, Adugna(2007) findings demonstrated that the digestibility of the DM, CP and NDF was improved when sheep fed on basal diet of *Napie* grass hay supplemented with *Sesbania sesba* and *Desmodium* or *Lucerne*. Conversely also, Bonsi and Osuji (1997) reported that supplementation of *Sesbania* or *Leucaena* leaf meal to *Teff* straw improved the digestibility of DM, OM and N. Furthermore, Belete *et al.* (2013) noted significantly higher DM and CP digestibility for Arsi Bale kids supplemented with air dried pigeon pea hay than kids supplemented with concentrate. Moreover, similarity in DM and OM digestibility has been reported by Ajebu *et al.* (2013) for Arsi Bale goats supplemented with pigeon pea leaves that fed as a supplement to replace the commercial concentrate which indicated that pigeon pea leaf had potential to replace commercial concentrate. Improvement in DM and OM digestibility noted in ruminant animal which supplemented with legume forage leaf meal to poor quality forage is due to increase the availability of nitrogen in the rumen, thereby improving the rate of degradation of the feed (Yohannes, 2011; Gebreslassie, 2012; Hagos 2014).

Abraham (2015) reported that similarity in DM and OM digestibility for Begait sheep fed pasture hay as basal diet and supplemented with Tsar and Pigeon pea leaves compared to the concentrate mixture. Moreover, Kaitheo *et al.* (1998) showed that DM, digestible organic matter (OM) and nitrogen (N) intakes as well as the digestibility of DM, OM and N were increased with increasing level of forage legume supplementation to a basal diet of tef straw fed to Ethiopian highland sheep. Similarly, Adu *et al.* (1990) also reported that lablab supplementation to sorghum stover significantly improved CP digestibility and generally improved rumen fermentation of the test diets and improved live weight gains of sheep. However, Solomon (2004) also reported that lablab had better digestibility of N, ADF and ADL than graded levels of *L. pallida*, while, it had lower digestibility of DM, OM and NDF than graded levels of *L. pallida*.

IV. EFFECT OF LEGUME FORAGE SUPPLEMENTATION ON WEIGHT GAIN

Generally supplementation of poor quality diets with good quality feed or leguminous sources can improve intake, digestibility and thereby weight gain. Different research output had been demonstrated the positive effect of supplementation of legume forages leaf meals on weight gain performance in ruminant livestock as concentrate supplements. Hunegnaw and Berehan (2016) reported higher ADG for Wollo sheep fed on basal diet of grass hay supplemented with *Lablab purpureus* meal than those Wollo sheep supplemented with wheat bran. Conversely, Denbela (2017) also had observed higher ADG performance for Woyto-Guji goats fed on basal diet of haricot bean haulms and supplemented with *Lablab purpureus* meal than those Woyto-Guji goats that supplemented with concentrate meal which had comprised wheat bran and noug cake. The reason why higher in ADG for goats supplemented with *Lablab purpureus* meal than goats supplemented with concentrate reported by Denbela (2017) is due to higher total DM intake and digestibility which made them efficiently converted feed in to flesh. Furthermore, Nsahlai and Umunna (1996) and Adu *et al.* (1990) reports also demonstrated that the nitrogen in *Lablab purpureus* leaf is rapidly degradable in the rumen which is useful to meet the requirements of rumen microorganisms for efficient degradation of low quality roughages. Moreover, Denbela (2017) also observed similarity in ADG between goats supplemented with pigeon pea leaf and Concentrate meal which had showed that pigeon pea leaf had potential to replace the commercial concentrate in goat feeding as CP supplements in area where commercial concentrate are not available. The ADG of the Spanish goat kids and Boer and Boer cross weathers fed on grass hay supplemented with Alfalfa hay meal were showed higher

daily body weight gain than those fed only grass-hay (Wildeus *et al.*, 2007). Turner *et al.* (2005) also reported that the average daily weight gain of goats supplemented with alfalfa-hay-fed were 80 % higher than those goats fed only on *Sericea lespedeza* hay. Similar investigation made by Wuliji *et al.* (2003) for Spanish goat kids fed a basal diet of prairie-grass hay and supplemented with alfalfa pellets which had 17.9 % CP demonstrated that there was notable improvement in average daily weight gain (82g/day vs. 0g/day). Manaye *et al.* (2009) and Gebregiorgis *et al.* (2012) reports also demonstrated that there was significance improvement in body weight changes of sheep supplemented with *Moringa stenopetala* leaf meals than non supplemented sheep. Dana *et al.* (2000) report also showed that supplementation of graded levels of *Leucaena leucocephala* leaf hay up to 300 g/head/day to Ethiopian highland sheep fed a basal diet of chickpea haulm improved body weight gain performance of sheep than the sheep supplemented with concentrate. Similarly, Adugna and Sundstøl (2000) and Adugna (2007) reports also demonstrated that sheep fed a sole diet of maize stover lost body weight while supplementation with different levels of *Desmodium intortum* and *Macrotyloma axillare* hays resulted in body weight gain. In addition, Miller *et al.* (2005) reported for the weaned goats that fed Pangola grass hay as a basal diet and supplemented with dried mulberry leaves had achieved similar ADG's (g/day) as compared to the commercial grain concentrate. The other study made by Singh *et al.* (2003) demonstrated that the higher weight gain performance was observed in rams supplemented with the cowpea haulms of variety IT90K-277-2 compared to concentrate meal.

V. EFFECT OF FORAGE LEGUME SUPPLEMENTATION ON CARCASS CHARACTERISTICS

A carcass is composed of muscle, bone, fat and its' compositions which influenced by the slaughter weight, age at slaughter, sex, breed and nutrition (Amha, 2008). A lot of studies reported the positive effect of supplementation of animal with forage legumes with great improvements on the carcass performance (Hirut, 2008; Gebretnsae, 2011; Gebreslassie, 2012). Hunegnaw and Brehan (2016) report demonstrated that the significantly higher carcass characteristics merits such as hot carcass weight (HCW), empty body weight (EBW), slaughter weight (SW), dressing percentage (DP) and rib eye muscle area (REMA) had obtained when the lambs fed grass hay as basal diet and supplemented with legume forage leaf meal as compared to lambs that supplemented with concentrate. Moreover, Meron (2016) and Kumer *et al.* (1991) reports showed that the weights of total non-carcass of the rams supplemented with Tagasaste leaf was significantly ($p < 0.01$) higher

than rams kept only on barley straw. Conversely, Wildeus *et al.* (2007) and Wuliji *et al.* (2003) findings also showed that Spanish kids and Boer-cross goats supplemented with Alfalfa hay had higher hot carcass weight (HCW) and dressing percentage (DP) compared to those group of goats fed on only grass hay. Shahjalal *et al.* (1992) observed that increasing CP concentrations of diets resulted in increments in DP in wether goats. Similarly, also Mahgoub *et al.* (2005) and Solomon *et al.* (2008) showed an increased slaughter weight, carcass weight, empty body weight and DP with increasing level of metabolisable energy intake in the diets of Omani and Sidama goats. Furthermore, Denbela (2017) reported that DP values for yearling male Woyto-Guji goats supplemented with legume forages (*Lablab purpureus* and pigeon pea) leaf meal were higher than those Woyto-Guji goats supplemented with concentrate-based diets. Similarly, also Denbela (2017) supplementation of goats with *Lablab purpureus* and pigeon pea leaf meals had been resulted in better improvement in total edible components than goats supplemented with concentrate meal. The higher in carcass characteristics such as HCW, EBW, DP total edible offal and total none edible offal for the ruminant animal supplemented with forage legumes than animals supplemented with concentrate based diets is due to fact that higher intake of total DM and digestibility of nutrients. According to Pralomokarn *et al.* (1995) carcass characteristics of animals increased as total DM and nutrient intake increased.

VI. SUMMARY

In most developing countries the ruminant livestock production has been depended on natural pastures which are insufficient to provide the minimum crude protein requirements to rumen microorganism and their host animal. Consequently, the digestibility and intake of these feeds are low which results in poor growth and reproductive performances. The supplementing ruminant livestock with feed that affluent in protein and energy is one of appealing strategies that has been carried out in developing country in order to improve production performance and boost economic benefits of livestock producers. Legume forages has a significant role in improving ruminant nutrition due to legume forages are rapidly degradable in the rumen which is useful to meet the requirements of rumen microorganisms for efficient degradation of low quality roughages. The feed intake, digestibility of nutrients, growth performances and carcass characteristics of ruminants' livestock that fed on low quality forages base diets and supplemented with legume forages had been improved. It was apparent that this indicated that the legume forages be used as protein supplements for ruminant livestock to improved sustainability of production in area where commercial concentrate is not available due to its high cost and distance.

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GLOBAL JOURNAL OF SCIENCE FRONTIER RESEARCH: D
AGRICULTURE AND VETERINARY

Volume 17 Issue 4 Version 1.0 Year 2017

Type : Double Blind Peer Reviewed International Research Journal

Publisher: Global Journals Inc. (USA)

Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Repeatability of Boldness and Aggression in the Zebrafish and the Guppy

By T. O. Ariyomo, T. Jegede & P. J. Watt

Federal University Oye-Ekiti

Abstract- Recent studies suggest that personality traits that were previously thought to be plastic may be repeatable within individuals in a population. Repeatability measures how consistent personality traits are. In this study we tested whether boldness and aggression were repeatable in both sexes of three strains of zebrafish (London Wild Type (LWT), Tupfel Long fin (TL) and Nacre) and one population of guppies. Boldness and aggression were highly repeatable in both sexes of the three zebrafish strains, and boldness (not aggression) was repeatable in the population of guppies. The high repeatability estimates in the zebrafish trials suggested that the traits were potentially heritable.

Keywords: *personality traits, boldness, aggression, repeatability, zebrafish, guppies.*

GJSFR-D Classification : FOR Code: 070799



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Repeatability of Boldness and Aggression in the Zebrafish and the Guppy

T. O. Ariyomo ^α, T. Jegede ^σ & P. J. Watt ^ρ

Abstract- Recent studies suggest that personality traits that were previously thought to be plastic may be repeatable within individuals in a population. Repeatability measures how consistent personality traits are. In this study we tested whether boldness and aggression were repeatable in both sexes of three strains of zebrafish (London Wild Type (LWT), Tupfel Long fin (TL) and Nacre) and one population of guppies. Boldness and aggression were highly repeatable in both sexes of the three zebrafish strains, and boldness (not aggression) was repeatable in the population of guppies. The high repeatability estimates in the zebrafish trials suggested that the traits were potentially heritable.

Keywords: personality traits, boldness, aggression, repeatability, zebrafish, guppies.

I. INTRODUCTION

Conventional ecological theory assumes that individuals should show behavioural plasticity in relation to the situations they encounter in their environment and the behavior be reversible (Sih et al. 2004a; Bell, 2007a; Edward & Jon, 2013; Tibblin et al., 2016). However, recent findings have shown that individuals show distinct behaviours that are consistent over time and across contexts and these behaviours are often referred to as personality traits, coping styles or temperaments (Koolhaas et al., 1999; Réale et al., 2007; Wolf & Weissing, 2012). Personality traits have been observed in many groups of animals and these traits have been shown to be linked to fitness because they can influence foraging, reproduction and survival (Dingemanse & Réale, 2005; Ariyomo & Watt, 2012). The implication of such consistency in behaviour over time is that it would impose a constraint on behavioural plasticity and prevent individuals from optimally adjusting their behaviour to the prevailing conditions in the environments they encounter (Dingemanse et al., 2002; Sih et al., 2003; Sih et al., 2004a, b; Bell, 2007b).

Two personality traits under focus in this study are boldness and aggression. Boldness is the propensity of an individual to take risks in an unfamiliar situation (Brown et al., 2007), while aggression is any sequence of behaviour that is deemed confrontational

(Olivier & Young, 2002). Aggression can be used to gain access to food or mates, protect offspring or to establish dominance (Davies & Houston, 1981; Stamps, 1994; Larson et al., 2006; Spence & Smith, 2006; Spence et al., 2008; Paull et al., 2010; Nephew et al., 2010; Davis et al., 2011).

This study was aimed at determining whether boldness and aggression were repeatable in three strains of zebrafish, *Danio rerio* (London Wild Type (LWT), Tupfel Long fin (TL) and Nacre), and the guppy, *Poeciliareticulata*, two species that have been used extensively as comparative and experimental model species in biology. If individuals show consistency in behaviour and there is a wide range of variations among them, this would indicate that the variations in behaviour among individuals may have a genetic basis (Edward & Jon, 2013). Under normal conditions selection would act upon this that of variation. However, if there is inconsistency in the display of behaviour by individual within a population, then factors (such as hormonal changes) other than genetic factor may be responsible (Edward & Jon, 2013; Trillmich et al., 2015).

II. MATERIAL AND METHODS

All the fish used in these experiments came from stock maintained in the Department of Animal and Plant Sciences at the University of Sheffield. Fish were sexed and the females were separated from the males. Each fish was housed separately before the trials. Zebrafish were housed in 10 litre tanks (30 cm x 15 cm x 24 cm) in a recirculatory system kept at $26 \pm 1^\circ\text{C}$, whereas the guppies were placed in aerated tanks (18 cm x 11.5 cm x 11.8 cm) and the water changed daily. All fish were fed twice daily with brine shrimp and dry fish food. To ensure uniformity in hunger level, feeding took place after the experimental trials. Behavioural testing for boldness and aggression was similar to that described in Ariyomo and Watt (2012, 2013a, b, 2015) and Ariyomo et al., (2013).

a) Test of Boldness

The open field test (Ariyomo & Watt, 2012; Ariyomo & Watt, 2013a, b; Ariyomo et al., 2013; Ariyomo & Watt, 2015; Burns, 2008; Walsh & Cummins, 1976) was used to determine boldness in the three strains of zebrafish (London Wild Type (LWT), Tupfel Long fin (TL) and Nacre) and in one population of guppies. A tank (48 cm x 23 cm x 26 cm) with a gridded base, marked into

Author α : Department of Fisheries and Aquaculture, Federal University Oye-Ekiti, Ekiti State, Nigeria

Author σ : Department Fisheries and Aquaculture Management, Ekiti State University, Ado-Ekiti, Ekiti State, Nigeria.

e-mail: temitopejegede@yahoo.com

Author ρ : Department of Animal and Plant Sciences, University of Sheffield, Western Bank, S10 2TN, UK.

24 rectangles (8 cm x 5.5 cm; Fig. 1), was filled with three litres of dechlorinated water heated to 26°C. The tank was covered with green cardboard. A fish was placed into the tank and allowed 60 s to acclimatise. The number of lines crossed and how well the fish utilised the inner and outer portions of the tank in 180 s after the acclimatisation period were used as a measure of boldness. Fish that crossed the highest number of lines while effectively utilising the tank were deemed bold. Fish that crossed the least number of lines and did not utilise the tank were deemed shy. The time each fish spent freezing over a period of 180 s was also recorded. Freezing time was excluded from the analysis because the majority of the fish tested did not freeze.

Lighting during the experiments consisted of two 18 W daylight fluorescent tubes placed approximately 34 cm above the tank. Twenty five males and 25 females of each of the zebrafish strains (LWT, TL and Nacre) and 25 male and 25 female guppies were tested for boldness in this way. After each trial, the water in the test tank was replaced. Each fish was tested twice over two consecutive days. After these tests, the green cardboard was replaced with brown cardboard and each fish was retested (alternate form test) twice over two consecutive days.

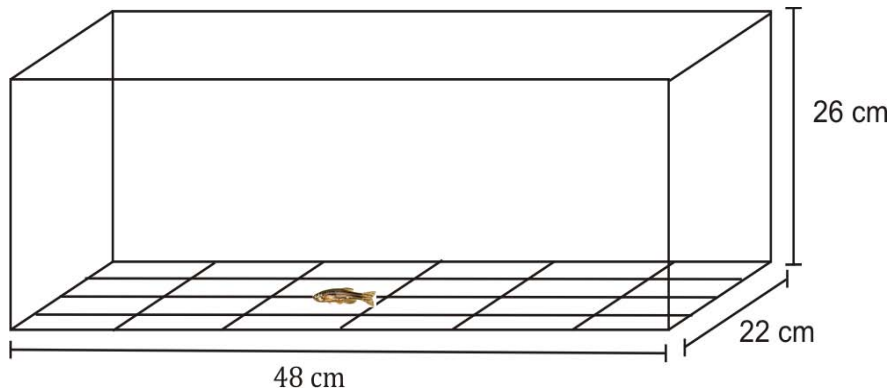


Fig.1: Diagrammatic representation of the open field test (Ariyomo & Watt, 2012; Ariyomo et al., 2013)

b) Test of aggression

The mirror test was used to test for aggression (Ariyomo & Watt, 2012; Ariyomo & Watt, 2013a, b; Ariyomo et al., 2013; Ariyomo & Watt, 2015; Gerlai et al.,2000; Moretz et al.,2007a, b). All individuals were tested on two consecutive days. A test tank (36 cm x 25 cm) was filled with six litres of water and a mirror (45 cm x 38 cm) was placed at the side of the tank at an

angle of 22.5° (Fig. 2). Lighting was the same as that used in the open field test. The same batch of zebrafish and guppies that were used in the open field test were tested for aggression. Prior to the introduction of a fish into the test tank, the mirror was covered with dark Perspex and the fish was allowed to acclimatise for 60 s. After this period, the dark Perspex was removed and the behaviour of the fish was monitored for 300 s.

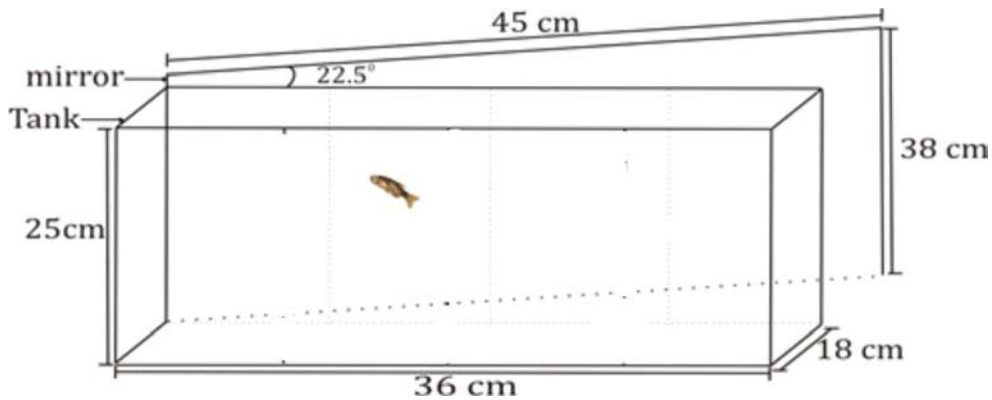


Fig.2: Diagrammatic representation of the mirror test (Ariyomo & Watt, 2012; Ariyomo et al., 2013 adapted from Gerlai et al.,2000)

The number of bites, displays and fast bouts of swimming the fish made towards its mirror image were

counted and recorded. The total number of aggressive interactions was used as a measure of aggression.

III. DATA ANALYSIS

The variance components of boldness and aggression were estimated using a one-way analysis of variance (ANOVA). Repeatability (r) was calculated as an intraclass correlation coefficient (Sokal & Rohlf, 1981), using $r = S^2_A / (S^2 + S^2_A)$. Where S^2_A is the among-group variance component and S^2 is the within-group variance component, calculated from the mean squares in the ANOVA and given as $S^2_A = (MS_A - MS_W) / n_o$ and $S^2 = MS_W$. Where MS_A is the between-individual mean square, MS_W within-individual mean square and n_o is a coefficient related to the sample size per group in the

analysis of variance (Lessels & Boag, 1987). The standard error for repeatability based on F ratios was calculated according to Becker (1992).

IV. RESULTS

a) Repeatability of boldness in the zebrafish

Boldness was repeatable in both males and females of all the strains of zebrafish in both the first test and the alternate form of the test. Repeatability estimates for boldness ($r \pm SE$) ranged from 0.34 ± 0.27 to 0.88 ± 0.03 (Tables 1, 2 and 3 for details).

Table 1: Repeatability of the number of lines crossed (boldness) by the female and the male Nacre zebrafish strain, their F ratio, degrees of freedom (df) and their corresponding p values

Source of Variation	F ratio (df)	$r \pm SE$	P
Number of lines crossed			
Open field first test			
All individuals (irrespective of sex)	15.74 (49,50)	0.88 ± 0.03	<0.001
Females	12.14 (24,25)	0.85 ± 0.06	<0.001
Males	6.577 (24,25)	0.74 ± 0.09	<0.001
Alternate form test			
All individuals (irrespective of sex)	5.10 (49,50)	0.67 ± 0.08	<0.001
Females	12.14 (24,25)	0.85 ± 0.06	<0.001
Males	3.62 (24,25)	0.40 ± 0.17	>0.001
Across tests			
All individuals (irrespective of sex)	13.31(49,150)	0.75 ± 0.03	<0.001
Females	9.57(24,75)	0.68 ± 0.05	<0.001
Males	5.96(24,75)	0.55 ± 0.06	<0.001

Table 2: Repeatability of the number of lines crossed (boldness) by the female and the male LWT zebrafish strain, their F ratio, degrees of freedom (df) and their corresponding p values

Source of Variation	F ratio (df)	$r \pm SE$	P
Number of lines crossed			
Open field first test			
All individuals (irrespective of sex)	5.02 (49,50)	0.67 ± 0.08	<0.001
Females	6.30 (24,25)	0.73 ± 0.09	<0.001
Males	2.21 (24,25)	0.38 ± 0.17	0.027
Alternate form test			
All individuals (irrespective of sex)	6.64(49,50)	0.74 ± 0.06	<0.001
Females	14.11 (24,25)	0.85 ± 0.06	<0.001
Males	2.03 (24,25)	0.34 ± 0.27	0.043
Across tests			
All individuals (irrespective of sex)	11.89(49,150)	0.73 ± 0.03	<0.001
Female	15.54 (24,75)	0.78 ± 0.03	<0.001
Male	4.47(24,75)	0.48 ± 0.06	<0.001

Table 3: Repeatability of the number of lines crossed (boldness) by the female and the male TL zebrafish strain, their F ratio, degrees of freedom (df) and their corresponding p values

Source of Variation	F ratio (df)	r ± SE	P
Number of lines crossed			
Open field first test			
All individuals (irrespective of sex)	5.75(49,50)	0.70 ± 0.07	<0.001
Females	2.56 (24,25)	0.44 ± 0.16	0.011
Males	10.30 (24,25)	0.82 ± 0.07	<0.001
Alternate form test			
All individuals (irrespective of sex)	8.08(49,50)	0.78 ± 0.56	<0.001
Females	21.32 (24,25)	0.91 ± 0.04	<0.001
Males	4.58 (24,25)	0.64 ± 0.12	>0.001
Across tests			
All individuals (irrespective of sex)	8.27(49,150)	0.64 ± 0.03	<0.001
Females	5.90(24,75)	0.55 ± 0.06	<0.001
Males	10.11(24,75)	0.69 ± 0.04	<0.001

b) Repeatability of aggression in the zebrafish

Aggression was repeatable in both sexes in all strains tested and ranged from 0.60 ± 0.13 to 0.88 ± 0.03 (see Tables 4, 5 and 6 in the appendix for details).

Table 4: Repeatability of the mean number of aggressive interactions made towards the mirror image by the Nacre zebrafish strain, their F ratio, degrees of freedom (df) and their corresponding p values

Source of Variation	F ratio (df)	r ± SE	P
Aggressive interactions in Nacre strain			
All individuals (irrespective of sex)	6.69(49,50)	0.76 ± 0.06	<0.001
Females	4.02 (24,25)	0.60 ± 0.13	<0.001
Males	4.49 (24,25)	0.79 ± 0.08	<0.001

Table 5: Repeatability of the mean number of aggressive interactions made towards the mirror image by the LWT zebrafish strain, their F ratio, degrees of freedom (df) and their corresponding p values.

Source of Variation	F ratio (df)	r ± SE	P
Aggressive interactions in LWT strain			
All individuals (irrespective of sex)	16.06 (49,50)	0.88 ± 0.03	<0.001
Females	13.95 (24,25)	0.87 ± 0.05	<0.001
Males	19.19 (24,25)	0.79 ± 0.08	<0.001

Table 6: Repeatability of the mean number of aggressive interactions made towards the mirror image by the TL zebrafish strain, their F ratio, degrees of freedom (df) and their corresponding p values.

Source of Variation	F ratio (df)	r ± SE	P
Aggressive interactions in TL strain			
All individuals (irrespective of sex)	5.35(49,50)	0.69 ± 0.07	<0.001
Females	5.72 (24,25)	0.70 ± 0.10	<0.001
Males	5.17 (24,25)	0.68 ± 0.11	<0.001

c) *Repeatability of boldness in the guppy*

Boldness was repeatable in male guppies in both the first test ($r \pm SE = 0.47 \pm 0.16, p < 0.001$) and the alternate form of the test ($r \pm SE = 0.52 \pm 0.15, p =$

0.037). In the female guppies, boldness was not repeatable in the first test but was repeatable in the alternate form of the test ($-0.26 \pm 0.19, p = 0.902$ and $0.66 \pm 0.11, p < 0.001$ respectively: Table 8).

Table 8: Repeatability of number of lines crossed by the female and the male guppies, their F ratio, degrees of freedom (df) and their corresponding *p* values.

Source of Variation	F ratio (df)	r ± SE	P
Number of lines crossed			
Openfield first test			
All individuals (irrespective of sex)	1.67 (49,50)	0.14 ± 0.14	0.037
Females	0.59 (24,25)	-0.26 ± 0.19	0.902
Males	2.76 (24,25)	0.47 ± 0.16	<0.001
Alternate form test			
All individuals (irrespective of sex)	5.10 (49,50)	0.67 ± 0.08	<0.001
Females	4.9 (24,25)	0.66 ± 0.11	<0.001
Males	3.18 (24,25)	0.52 ± 0.15	>0.001
Across tests			
All individuals (irrespective of sex)	4.08(49,150)	0.44 ± 0.05	<0.001
Females	1.95(24,75)	0.19 ± 0.08	0.018
Males	4.03(24,75)	0.43 ± 0.07	<0.001

d) *Repeatability of aggression in the guppy*

Aggression was not repeatable for either sexes (female: $r \pm SE: 0.13 \pm 0.20, p = 0.263$ and male: $r \pm SE: 0.14 \pm 0.20, p = 0.247$: Table 9).

Table 9: Repeatability of aggression in the guppies, their F ratio, degrees of freedom (df) and their corresponding *p* values.

Source of Variation	F ratio (df)	r ± SE	P
Aggressive interactions in the guppies			
All individuals (irrespective of sex)	1.43 (49,50)	0.18 ± 0.14	0.107
Females	1.29 (24,25)	0.13 ± 0.20	0.263
Males	1.32 (24,25)	0.14 ± 0.20	0.247

V. DISCUSSION

Boldness and aggression were highly repeatable in both males and females of all three strains of zebrafish regardless of when the test was conducted and the colour of the test tank. This consistency in the behavioural pattern suggests that multiple measures of these personality traits may not be necessary (Dohm, 2002; Falconer & Mackay 1996; Bell et al., 2009). Boldness and aggression varied among individuals within the strains but the variations were consistent, indicating that the observed variation may be genetic (Falconer & Mackay, 1996). Alternatively, high repeatability estimates reported here could have been due to the short interval between the test and retest period (Bell et al., 2009). It has been found that repeatability estimates can decrease as the time

between testing increases, possibly because of changes in developmental stage or age leading to differences in the traits (Bell et al., 2009; Norin & Malte, 2011). The implication of such consistency in behaviour over time is that it would impose a constraint on behavioural plasticity and prevent individuals from optimally adjusting their behaviour to the prevailing conditions in the environments they encounter (Dingemanse et al., 2002; Sih et al. 2003; Sih et al., 2004a, b; Bell, 2007b).

Boldness was repeatable in the males guppies in the first open field test and in the alternate form of the test. However, boldness was not repeatable in the first test for the female guppies, but it was repeatable in the alternate form of the test. The fact that male guppies expressed more consistent behaviour in the open field

than females has been shown previously (Griffiths & Magurran, 1998), and it is possible that behavioural variation seen in the females is linked to their ovarian cycle (Warren & Callaghan, 1975). Variation in the optimal behavioural strategies of the males and females may also account for differences in the repeatability (Bell et al., 2009) such that males may take more risks while females are more interested in foraging (Brown & Warburton, 1997; Magurran & Macías García, 2000).

Aggression was not repeatable in both the male and the female guppies. The implication is that the animals did not respond to the mirror in the same way during the trials, which may be due to the fact that guppies are not overly aggressive (Kodric-Brown, 1992). Moreover, behavioural variation in female guppies has been linked to their ovarian cycle (Warren & Callaghan, 1975), but it is not known why aggression in the males was not consistent.

In conclusion, overall, boldness was repeatable in the three strains of zebrafish and to some extent in the guppies, while aggression was repeatable in the three strains of zebrafish but not in the guppies. Bell et al. (2009) argued that differences in repeatability of behaviour between male and females may occur but the degree to which this occurs may depend on the behaviour tested, the test interval, the age and the species tested. The high repeatability in the zebrafish trials suggested that the traits were potentially heritable (Ariyomo et al., 2013).

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Energy use Efficiency, Agronomic Efficiency, Economic Analysis, Residue Deposit, Nutrient Tolerance and Yield of Tomatoes under Limited and Optimal Fertilizer

By Afolayan, S.O., Habu, H, Yaduma, J.J., Shuaib S.M., Muazu, Y.G., Idris B.A.,
Hudu, A.H. & Adams, I.

National Horticultural Research Institute

Abstract- Nine tomato cultivars comprising Tropimech (T₁), Carl J (T₂), Peto 86 (T₃), Roma (T₄), UC82B (T₅), Chibli (T₆), Heinz (T₇), NI (T₈) and RIO (T₉) were evaluated for energy use efficiency, economic analysis, residue deposits, agronomic efficiency, nutrient tolerance and yield performance under four fertilizer rates. The trial was conducted at the Kadawa irrigation site of Kano State altitude 476.2m, Lat.11.55°N and Long. 8.38°E. Nursery sowing and transplanting were carried out on 10 November, 2015 at a minimum temperature of 16°C and on 22 December 2015 at a minimum temperature of 13.4°C. Fertilizer treatment was applied at 0, 170, 200,230 and 260 kgha⁻¹(20-10-10) respectively under the basin size of 25m² and 0.5m x 0.5m spacing. Irrigation water was supplied evenly at the flow rate of 11 m³hr⁻¹ using 3" diameter pressurized rubber tube at an average discharge rate of 10.87 m³-hr.

GJSFR-D Classification : FOR Code: 079999



Strictly as per the compliance and regulations of :



Energy use Efficiency, Agronomic Efficiency, Economic Analysis, Residue Deposit, Nutrient Tolerance and Yield of Tomatoes under Limited and Optimal Fertilizer

Afolayan, S.O. ^α, Habu, H ^σ, Yaduma, J.J. ^ρ, Shuaib S. M. ^ω, Muazu, Y.G. [¥], Idris B. A. [§], Hudu, A. H. ^x & Adams, I. ^v

Abstract- Nine tomato cultivars comprising Tropimech (T₁), Carl J (T₂), Peto 86 (T₃), Roma (T₄), UC82B (T₅), Chibli (T₆), Heinz (T₇), NI (T₈) and RIO (T₉) were evaluated for energy use efficiency, economic analysis, residue deposits, agronomic efficiency, nutrient tolerance and yield performance under four fertilizer rates. The trial was conducted at the Kadawa irrigation site of Kano State altitude 476.2m, Lat.11.55°N and Long. 8.38°E. Nursery sowing and transplanting were carried out on 10 November, 2015 at a minimum temperature of 16°C and on 22 December 2015 at a minimum temperature of 13.4°C. Fertilizer treatment was applied at 0, 170, 200,230 and 260 kg ha⁻¹(20-10-10) respectively under the basin size of 25m² and 0.5m x 0.5m spacing. Irrigation water was supplied evenly at the flow rate of 11 m³hr⁻¹ using 3" diameter pressurized rubber tube at an average discharge rate of 10.87 m³hr⁻¹. Results obtained indicated that the total energy budget for the production of the nine cultivars was 112,180.55 MJha⁻¹ with fertilizer accounting for about 41.2% of the energy input. Energy use efficiency was however low showing inefficient use of energy in tomato production typical of Nigerian system. T₂, T₄, T₅, T₆ and T₇ recorded agronomic efficiency of 8.05, 14.10, 2.38, 4.53, and 13.96 with a corresponding yield performance of 20.6, 24.8, 19.4, 20.1 and 24. 4 tha⁻¹ respectively. Residue deposits were significantly more pronounced with T₄, T₇, T₉, T₈, and T₂ possibly suggesting cultivars with higher concentration of ethanol than others at 7.88 tha⁻¹, 5.99 tha⁻¹, 4.85 tha⁻¹, 4.75 tha⁻¹, and 4.62 tha⁻¹ respectively. The highest nutrient limited tolerance index (TOLN) was observed in T₄ followed by T₇, T₆ and T₅, revealing the cultivars with the possibility of early segregation, although displaying the characteristics of initial better yield performance in contrast to T₂ with more stable traits as observed in low TOLN with higher yield at both optimal and limited fertilizer rates. However, due to low yield performance associated with T₅ under limited fertilizer rates, T₂,T₄, T₈ and T₇ were found to be more desirable for production and further improvement. Economics, a very strong agricultural business decision tool as indicated in the value of Benefit-Cost ratio, was found to be 2.09 with corresponding returns of ₦1,503,168.00 per ha. This outcome was highly desirable despite the massive invasion of tomato leaf-miner (*Tuta Absoluta*) towards the maturity stage of the crop.

Author ^α: National Horticultural Research Institute, Ibadan.
e-mail: afolestev@gmail.com

Author ^σ ^ρ ^ω [¥] [§] ^x ^v: National Horticultural Research Institute, Bagauda, Kano.

I. INTRODOUCTION

Plants generally exhibit unique growth traits even within a similar genotype despite uniform accessibility to nutrient factors, weather interactions and ecological balance. David (2011) reported that plants were the first complex organisms that evolve with the power of making the atmosphere hospitable for animal and humans, while displaying specific features as distinguishing factors of agriculture that guarantees animal, aquatic and human survival (Genesis 1: 1). In the next fifty years, it is certain agriculture will be struggling with the need for more food than in the previous 10,000 years combined therefore necessitating the need for efficient use of energy compatible with optimum economic returns especially in anti-oxidant crops like tomatoes. AVRDC (1996) classified tomatoes as one of the world's most important vegetables with global production capacity of 2.6 million ha at fresh tomato fruit production capacity of 100 million metric tons distributed across fifteen leading countries with Nigeria ranking as the 13th best producing country that accounts for about 1.7% of the global production index (FAO, 2010) compared with China (33.9%), Egypt (6.8%), despite the country's (Nigeria) diverse weather that accommodate and supports multiple vegetable production throughout the year. Notwithstanding, Nigeria's ranking as the 13th best producing country, the out-put per ha. suggests one of the lowest in global index with 7t/ha in contrast to Egypt (35t/ha), USA (65t/ha) Brazil (58t/ha), Iran (29t/ha) and Turkey (40t/ha) (Janice,2004).

In the recent times, Nigeria has been plunged into tomato production crisis. Unpredicted invasive insects of about 5-7mm in size with egg production capacity of between 250-300 per insect and life cycle of 24 to 76 days spanning 10-12 generations. The insect thrives favourably between 24°C and 25°C temperature (IRAC, 2011) and thus makes the insect difficult to be eradicated without holistic approach involving water management, energy implications, agronomic dynamics, economic analysis, integrated pest

management, environmental management and climate scenario. This study therefore attempted to determine the energy use efficiency, agronomic efficiency, economic analysis, residue deposits, nutrient tolerance and yield performance of nine cultivar of tomatoes under five fertilizer application rates in Sudan Savannah Ecology of Nigeria.

II. METHODOLOGY

This study was carried out in the Sudan Savannah Ecological Zone of Nigeria located on more than 2,000ha of rice, tomato and wheat cultivated area of Kano. The land was characterized with extensive deposition of mineral fertilizers, herbicides and insecticides due to the nature of soil fertility with resultant chemical residue accumulation of high alkalinity and salinity as observed in the red colorations of the surface soil. Seeds of nine cultivars of tomatoes were sown into the nursery on 10th November 2015 after the necessary land preparation, with each cultivar occupying one square meter of land. These include Tropimech (T₁), Carl J (T₂), Peto 86 (T₃), Roma (T₄), UC82B (T₅), Chibli (T₆), Heinz (T₇), NI (T₈) and RIO (T₉). The cultivars were transplanted six weeks after nursery

activities (6WAS) into 25m² basin constructed with a conventional MF Tractor and cut out manually to conform to farmers' practice at 50cm by 50cm spacing in line with treatment combinations in Table 1. Ten (10) plants were isolated from each of the basin as replicates. The temperature range for sowing and transplanting was 16°C and 13.4°C respectively. Fertilizer application at 0, 170, 200, 230, and 260 kg/ha⁻¹ (20-10-10) was imposed in split dozes 8WAS, 11WAS and 14WAS respectively (Table 1). Irrigation water was supplied evenly to the basins at the flow rate of 11m³/hr. through a pressurized 3" discharged tube that discharges water volumetrically at 1.73m³ per basin at an average of 9.5 minutes taking into consideration the distance between the downstream and the upstream of about 100m. Energy, agronomic and economic inputs involved during production comprising chemical fertilizer, herbicides, fungicides, insecticides, irrigation water, human labour, diesel and petrol were closely monitored and recorded as appropriate. Similarly, established procedure was used to convert each input and output into energy equivalent (Moosavi et al., (2012).

Table 1: Treatment Combinations of Nine Tomato Cultivars

Treatment Code	Plot Number	Tomato Cultivar	Fertilizer rate (kg/ha)
T ₁ F ₁	112	Tropimech	Control
T ₂ F ₁	113	Carl J	Control
T ₃ F ₁	114	Peto 86	Control
T ₄ F ₁	421	ROMA	Control
T ₅ F ₁	303	UC82B	Control
T ₆ F ₁	302	Chibli	Control
T ₇ F ₁	308	Heinz	Control
T ₈ F ₁	305	NI	Control
T ₉ F ₁	202	Rio	Control
T ₁ F ₂	405	Tropimech	170
T ₂ F ₂	401	Carl J.	170
T ₃ F ₂	408	Peto 86	170
T ₄ F ₂	417	ROMA	170
T ₅ F ₂	416	UC82B	170
T ₆ F ₂	419	Chibli	170
T ₇ F ₂	406	Heinz	170
T ₈ F ₂	410	NI	170
T ₉ F ₂	402	Rio	170
T ₁ F ₃	411	Tropimech	200
T ₂ F ₃	401	Carl J.	200
T ₃ F ₃	423	Peto 86	200
T ₄ F ₃	420	ROMA	200
T ₅ F ₃	418	UC82B	200
T ₆ F ₃	409	Chibli	200
T ₇ F ₃	412	Heinz	200
T ₈ F ₃	414	NI	200

T ₉ F ₃	403	Rio	200
T ₁ F ₄	413	Tropimech	230
T ₂ F ₄	422	Carl J.	230
T ₃ F ₄	424	Peto 86	230
T ₄ F ₄	115	ROMA	230
T ₅ F ₄	407	UC82B	230
T ₆ F ₄	426	Chibli	230
T ₇ F ₄	427	Heinz	230
T ₈ F ₄	111	NI	230
T ₉ F ₄	425	Rio	230
T ₁ F ₅	101	Tropimech	260
T ₂ F ₅	102	Carl J	260
T ₃ F ₅	103	Peto 86	260
T ₄ F ₅	104	ROMA	260
T ₅ F ₅	106	UC82B	260
T ₆ F ₅	107	Chibli	260
T ₇ F _r	108	Heinz	260
T ₈ F ₅	428	NI	260
T ₉ F ₅	105	Rio	260

Output- input ratio, specific energy, energy productivity; energy use efficiency and energy intensity in the tomato cultivars production were calculated using

the equations listed below following the quantity per unit of production (Table 2):

Table 2: Energy Consumption and Energy Input –Output Relationship of Irrigated Tomato Cultivation

Input	Quantity per unit area (ha)	Energy Equivalent (MJ/unit)	Reference
Land clearing (ha)	3,333.66	1.96	Singh et al., 2002
Watering in the nursery	555.56		
Nursery planting	2,222.22		
Post-planting Watering	555.56		
Nursery Watering	3,333.33		
Basin Construction	160		
Post-transplanting Watering	29.3		
Transplanting	80		
Harrowing (hr.)	13.33		
Pre-watering transplanting	29.3		
Application of Ash	13.3		
Fertilizer application	333.3		
Harrowing (hr.)	8.9		
Field Layout (hr.)	1773		
Weeding (hr.)	106.67		
Weeding (hr.)	97.19		
Weeding (hr.)	188		
Weeding (hr.)	188		
Fertilizer application	39.9		
Insecticide application	75.56		

Watering (major – 1s-16 th wk.)	63.02		
Harvesting (w)	445		
Transportation (kg/km)	25	13.6	Yin, 1996
Irrigation water (m ³ /ha)	1,700.6	1.02	Rafiee et al., 2010
Tomato seedlings (ha)	40,000	0.2	Pellizi., 1992
Tools			
Hoes (kg)	6.2	0.1	Wen., 1987
Rice straws (it)	50		
Knapsack (kg)	15	6.5	Chem, 2002
Fertilizers (kg)			
Nitrogen	1093.4	60.6	Singh et al., 2002
Phosphorus	322.2	11.1	Singh et al., 2002
Potassium	322.2	6.7	Singh et al., 2002
Chemical(L)			
Herbicides (L)	5	238	Helzel, 1992
Insecticides (L)	47.5	199	Helzel, 1992
Fungicides (L)	7.5	92	Helzel, 2002
Irrigation water (M ³ /ha)	1,700.6	1.02	Rafiee et al 2010
Tomato seedlings (ha)		0.2	Pellizi, 1992
Hoes (Kg)	666.6	0.1	Wen, 1987
Rice straw (t)	2,000	14	Zalman, 2015
Knapsack (Kg)	15	6.5	Chem, 2002
Gasoline	931.26	42.33	Cervinka, 1980
Diesel (L)		47.9	
Outputs			
Tomato fruits (kg)	7,792	1.2	Mihov and
Tomato fruits Residue (kg)	1,844.8	1.2	Tringosvska, 2010

$$\text{Energy Ratio:} = \frac{\text{Energy Output}}{\text{Energy Input}} \quad \text{----- (i)} \quad \text{(Baihya and Sharma 1990)}$$

$$\text{Specific Energy} = \frac{\text{Energy Input}}{\text{Yield}} \quad \text{----- (ii)} \quad \text{(Burnett, 1982)}$$

$$\text{Energy Productivity} = \frac{\text{Yield}}{\text{Energy Input}} \quad \text{----- (iii)} \quad \text{(Mittal, and Dhawan, 1988)}$$

$$\text{Energy Use Efficiency} = \frac{\text{Energy Output}}{\text{Energy Input}} \quad \text{----- (IV)} \quad \text{(Acaroglu, (1998)}$$

Economic indices in terms of Gross return, Net return, Benefit cost and productivity were determined as indicated in the equations below:

$$\text{Gross return} = \text{Total production value} - \text{Variable cost of production} \quad \text{----- (v)} \quad \text{(Banaeian et al., 2011)}$$

$$\text{Net return} = \text{Total Production value} - \text{Total Production cost} \quad \text{----- (viii)} \quad \text{(Mohammadi et al., 2010)}$$

$$\text{Benefit cost} = \frac{\text{Total production value}}{\text{Total production cost}} \quad \text{----- (ix)} \quad \text{(Salami and Ahmadi, 2010)}$$

$$\text{Productivity} = \frac{\text{Yield}}{\text{Total Production cost}} \text{ (x) (Ozkan et al; 2010)}$$

Agonomic efficiency was obtained using the model of Jagdish et al., (2005) $\frac{Y_T - Y_o}{FN}$ (xi)

Where Y_T = Fruit yield of tomatoes with optimum fertilizer rate.

Y_o = Fruit yield of tomatoes with limited fertilizer rate.

FN = Optimum fertilizer rate.

Eleven drought tolerance indices consisting of nutrient limited susceptibility index (SSI), geometric mean productivity (GMP), nutrient limited tolerance (TOLN), mean productivity (MP), nutrient limited index (DIN), yield stability index (YSI), nutrient limited susceptibility percentage index (SNPI), modified nutrient limited tolerance index (KNST1, KNST2), relative nutrient limited index (RDI), and stress tolerance index (STI) were calculated from the modified models generated by

various researchers (Tables 3 & 4). Growth parameters such as number of flower per plant (NOFL), leaf area (LA), number of fruit per plant (NOFP⁻¹) were determined appropriately. Harvesting of fruit and residue was carried out on 5th and 6th April, 2016 followed by sorting into marketable and non-marketable grades. Pooled data were analyzed using SAS developed by SAS Company.

Table 3: Modified Indices used for nutrient limited tolerance and optimal tolerance

S/o.	Code	Explanation	Formula	Reference
1	SS1	Nutrient limited Susceptibility Index	$(1 - (Y_s/Y_p)) / (1 - (\bar{Y}_s/\bar{Y}_p))$	Bousslama et al., (1984)
2	GMP	Geometric mean productivity	$\sqrt{Y_s * Y_p}$	Eddaie and Sutka, (2002)
3	TOLN	Nutrient Limited tolerance index	$Y_p - Y_s$	Farshadfar and Sutka, (2002)
4	MP	Mean productivity	$\frac{Y_p + Y_s}{2}$	Farshadfar et al., (2001)
5	DIN	Nutrient limited index	$(Y_s * (Y_s/Y_p)) / \bar{Y}_s$	Fernandez (1992)
6	YSI	Yield stability index	$\frac{Y_s}{Y_p}$	Bousslama and Schapaugh (1984)
7	SNPI	Limited non-limited production index	$((Y_p * Y_s) / Y_p - Y_s)^{1/3} (Y_p * Y_s^2)^{1/3}$	Moosavi (2008)
8	KNST1, KNST2	Modified nutrient limited tolerance index	$KNST1 = Y_p^2 / \sqrt{\bar{Y}_p^2}, KNST2 = y_s^2 / \sqrt{\bar{y}_s^2}$	Fashadfan and Sutka (2002)
9	RDI	Relative Nutrient limited tolerances	$\frac{(Y_s/Y_p)}{(\bar{Y}_s/\bar{Y}_p)}$	Clarke et al., (1992)
10	STI	Nutrient limited tolerance index	$(Y_s * Y_p) / (\bar{Y}_p^2)$	Dehghani et al., (29009)

Table 4: Energy Equivalent for Input –Output in Irrigated Tomato Production under Fertilizer Application Rates

Input	Energy Equivalent (MJ/unit)	Percentage (%)
Land Clearing	6714.92	3.92
Watering	12,0359	7.13
Basin Construction	313.6	0.18
Transplanting	156.8	0.09
Harrowing	43.57	0.03
Harvesting	872.2	0.22
Application of Ash	26.07	0.12
Fertilizer	731.47	0.43

Field layout	3475.10	2.03
Weeding	1136.53	0.66
Insecticides	148.10	6.09
.Transportation	340	0.2
Irrigation water	1734.61	1.01
Tomato seedlings (ha)	8000	4.67
Rice straw	98	0.06
Knapsack	97.5	0.06
Fertilizer(kg)		
Nitrogen	66,260.0	38.7
Phosphorus	3576.42	2.09
Potassium	631.51	0.37
Chemicals(L)		
Herbicides	1190	0.70
Insecticides	9452.5	5.52
Fungicides	690	0.40
Hoes	66.66	0.3
Gasoline	39,420.24	23.0
Diesel	2874.0	1.68

III. RESULTS AND DISCUSSIONS

The previous year rainfall data was 1,107.36mm covering the months of June (124mm), July (213.9mm), August (505.7mm), September (235.8mm) and October (28mm) thus suggesting UNIFORMITY of distribution and sufficiency of rainfall for horticultural crop production with little or no supplemental irrigation within the production cycle. Six treatment combinations which include 102 (T₂F₅), 104 (T₄F₅), 106 (T₅F₅), 107 (T₆F₅), 108 (T₇F₅), 111 (T₈F₄) and 115(T₄F₄) appeared the treatment with most promising yield at 20.6, 24.8, 19.4, 20.1, 24.1 20.5t/ha and 19.3t/ha respectively (Table: 5). However, in terms of marketable yields, 102, 104, 106, 107, 111 and 115 recorded mean weights above 8.5t/ha with corresponding percentage of marketable yield to total yield at 63.9%, 59.3%, 47.3%,42.5%, 46% and 40% possibly revealing 102 and 104 exhibiting less susceptibility to pest damage. Similarly, residue yield followed this trend, 102(4.62t/ha) <104(7.88t/ha) > 106 (2.78t/ha) <107(3.64t/ha) <08(5.99t/ha) > 111(3.02t/ha), and >115(1.60t/ha) presenting 104 and 102 as Possessing highest potentials for ethanol production in agreement with the work of Ercolano et al., (2014). Tomato cultivars require multi-dimensional approach comprising energy requirements, economic analysis, residue deposits, agronomic efficiency, nutrients limited susceptibility and potential marketable yield to facilitate sustainable security of production with optimum resistance to pests, diseases, and minimal fertilizer application. Consequently, Nutrient limited tolerance indices are presented in Table 6. However, due to multiple indices, ranking was introduced to determine the cultivar that is most compatible with the ecological

system of Sudan Savanna of Nigeria. Four rankings were identified which grouped T₁, T₃, T₄, T₈ and T₉ together at 70 and above, T₂, T₅, T₆ (60-70) and T₇ (40-45). T₇ appeared the best with the highest total yield under optimum (24.4t/ha) and limited fertilizer application (5.96t/ha) compared with T₄ (24.8t/ha) under optimum and (1.41t/ha) under limited fertilizer application thereby suggesting that T₄ can only perform under optimum fertilizer application. T₂, T₅, T₆ equally displayed some measure of adaptability as observed in the total yield at 20.6t/ha, 19.4t/ha and 20.1t/ha with corresponding yields under limited condition at 13.6t/ha, 3.73t/ha and 3.21t/ha respectively. Generally, T₂, T₄, T₅, T₆ and T₇ displaced highly promising traits in addition to agronomic efficiency of 8.05 (T₂), 2.38(T₅), 4.53(T₆), and 13.96(T₂) which implies cultivars desirable for Sudan Savannah ecology of Nigeria under optimum or limited fertilizer application. Selection of the best cultivar in comparism with energy demand and economics is also essential. Yield under optimum and limited fertilizer application (Y_p, Y_s) as influenced by nutrient tolerance indices are presented in Table 6. T₂, T₄, T₅, T₆ and T₇, recorded Y_p mean yield values of 20.6t/ha, 24.8t/ha, 19.4t/ha, 20.1t/ha and 24.4t/ha with corresponding Y_s at 13.6t/ha, 1.41t/ha, 3.73t/ha, 3.21t/ha, and 5.96t/ha respectively. However, SS1 was highest under T₇ (1.04) with close range among T₄ (0.98), T₅ (0.96), and T₆ (0.96) thus reflecting T₇ as the most yield stable cultivar under diverse conditions with above-coverage susceptibility to nutrient stress in accordance with the work of Farshadfar et al., (2013). Similarly, MP, Y1, RD1, did not differ in most prominent cultivars identified at 17.1MP (T₂), 13.1MP(T₄), 11.6MP (T₅), 11.7MP (T₆), and 15.2MP (T₇) showing T₂ and T₇ most desirable under

both optimum and limited fertilizer application rate in agreement with Farshadfar et al., (2013). Y1 was highest under T₆ (3.12) although within similar range with T₇ (2.97), T₅ (2.63), T₄ (2.61) and T₂ (2.5) possibly indicating cultivars with stable physiological traits in both optimum and limited fertilizer conditions. RD1 mean values associated with T₂ (1.59), T₄ (1.54), T₅ (1.24), T₆ (1.32) and T₇ (0.89) revealed the consistency of the

cultivar to nutrient tolerance especially under nutrient limited condition in agreement with the work of Farshadfar et al., (1998). Generally, based on these nutrients tolerance interactions with Y_p and Y_s; T₂, T₄, T₅, T₆, and T₇, appeared the cultivars that could be selected for further works, although in terms of Y_p and Y_s, T₇ and T₂ would be preferred followed by T₄, T₆, and T₅.

Table 5: Growth response of nine cultivars of tomatoes (*Lycopersicon lycopersicum*) to Fertilizer rates

TRT	MTYLD	REDYLD	TOTYLD	MT ¹	RT ¹	NOFL	LA	NOFP ⁻¹
101	5.84	1.51	9.30	3.87	0.16	5.3	322.2	18.0
102	13.1	4.62	20.6	2.84	0.22	5.1	385.8	18.2
103	5.76	4.85	11.5	1.19	0.42	6.3	157.6	40.7
104	14.70	7.88	24.8	1.86	0.32	6.3	321.6	13.8
105	5.09	4.75	9.09	1.07	0.52	12.5	169.9	18.1
106	9.18	2.78	19.4	3.30	0.14	4.4	218.6	21.5
107	8.54	3.64	20.1	2.35	0.18	3.0	159.0	17.1
108	7.32	5.99	24.4	1.22	0.25	5.8	283.2	19.9
111	4.42	3.02	20.5	1.04	0.44	7.3	286.1	13.7
112	5.98	4.64	8.26	1.29	0.56	2.0	191.2	6.60
113	2.86	0.87	6.76	3.29	0.13	8.9	127.4	10.0
114	1.36	0.72	2.74	1.88	0.26	7.8	119.8	8.2
115	8.89	1.60	19.3	5.62	0.08	1.7	152.5	29.4
202	2.57	2.30	7.45	1.18	0.31	9.5	199.1	11.0
302	8.50	2.67	12.3	3.18	0.22	6.3	220.1	13.1
303	6.91	2.00	15.3	3.46	0.13	9.8	162.4	14.6
305	5.90	3.40	16.4	1.74	0.21	9.7	92.0	13.2
308	0.26	0.36	0.39	0.72	0.92	8.4	159.6	0.9
401	5.45	2.02	13.6	2.70	0.15	4.5	163.8	14.5
402	0.02	0.27	0.26	0.07	1.04	4.7	108.0	2.4
403	2.81	1.72	5.64	1.63	0.37	9.6	70.0	11.3
404	3.52	0.93	8.63	3.78	0.11	7.00	34.3	16.1
405	0.76	0.81	1.74	0.94	0.47	4.00	162.0	10.2
406	2.01	1.55	5.96	1.30	0.26	6.00	143.0	7.7
407	2.35	1.26	6.23	1.87	0.20	7.70	66.0	12.8
408	0.26	0.64	1.72	0.41	0.37	15.6	88.0	8.1
409	0.07	0.16	0.30	0.44	0.53	9.3	227.5	1.7
410	3.73	1.89	8.97	1.97	0.21	5.3	240.3	10.9
411	3.34	2.59	11.9	1.29	0.22	6.2	214.3	17.5
412	4.43	1.88	14.0	2.36	0.13	12.6	120.0	13.2
413	0.26	0.29	1.66	0.86	0.17	5.9	80.0	7.0
414	2.32	1.85	8.12	1.25	0.23	4.0	179.4	9.7
416	1.42	1.04	3.73	1.07	0.28	3.8	60.0	8.4
417	0.54	0.27	1.41	2.00	0.19	7.8	108.0	19.3
418	0.00	0.22	0.63	0.14	0.35	15.6	820.0	4.2
419	1.00	0.62	3.21	1.66	0.19	4.4	120.0	6.2
420	0.48	0.50	0.83	0.84	0.69	3.4	99.0	5.2
421	0.56	0.40	0.71	1.40	0.56	7.5	249.0	4.8
422	7.08	3.37	10.8	2.10	0.31	16.0	92.1	15.1

423	1.88	1.35	3.24	1.09	0.42	7.3	152.0	12.3
424	2.43	3.31	5.33	0.73	0.62	4.6	82.6	21.7
425	0.03	0.59	0.08	0.05	7.38	4.9	283.3	0.6
426	0.47	0.76	3.15	0.53	0.24	9.10	200.0	9.6
427	0.58	0.80	0.24	0.73	3.33	9.5	129.2	2.0
428	0.02	0.54	0.09	0.04	6.00	2.4	68.8	0.2
LSD (5%)	3.7*	2.02*	0.86*	1.2*	1.4*	3.5*	88.6*	7.8*

MTL/LD = marketable yield (t/ha); REDYLD = Residue deposits (t/ha); TOTYLD= Total yield (t/ha); MT 1 =ratio of marketable yield to total yield; RT-1 =ratio of residue deposit to total yield; NOFL= No of flowers; LA= leaf area per plant (cm²); NOFT – Number of fruits per plant

Table 6: Agronomic Efficiency & Nutrients/Tolerance indices of tomato cultivars under limited and optimal Fertilizer rates

TLN	SD 1	Y1	Y _p	Y _s	Y _{PM}	Y _{SM}	SS1	GMP	TOLN	MP	DIN	YS1	SNP1	KNST ₁	KNST ₂	RD1	ST1	AGE
T1	0.81	2.29	9.3	1.74	5.84	0.76	0.93	0.43	7.56	5.52	0.43	0.19	64.7	2.54	5.24	1.44	0.47	8.26
T2	0.34	2.5	20.6	13.6	13.1	5.45	0.58	0.81	7.00	17.1	1.65	0.66	26.7	2.47	6.23	1.59	1.63	6.76
T3	0.85	6.62	11.5	1.72	5.76	0.26	0.89	0.39	9.78	6.61	0.99	0.15	84.9	3.99	43.8	3.31	0.6	2.74
T4	0.94	2.61	24.8	1.41	14.7	0.54	0.98	0.24	23.4	13.1	0.15	0.06	79.7	2.86	6.82	1.54	0.16	0.71
T5	0.81	2.63	19.4	3.73	9.18	1.42	0.96	0.44	15.7	11.6	0.51	0.19	85.3	4.47	6.90	1.24	0.86	15.3
T6	0.84	3.12	20.1	3.21	8.54	1.03	0.96	0.40	16.9	11.7	0.5	0.16	98.9	5.54	9.71	1.32	0.88	12.3
T7	0.76	2.97	24.4	5.96	7.32	2.01	1.04	0.49	18.4	15.2	6.72	0.24	126	11.1	8.79	0.89	2.71	0.39
T8	0.99	4.50	8.97	0.09	3.73	0.2	1.00	0.10	8.88	4.53	0.05	0.01	119	5.78	20.3	1.87	0.06	8.97
T9	0.97	13.0	9.09	0.26	5.09	0.02	0.98	0.17	8.83	4.68	0.34	0.03	86.7	3.19	169	7.28	0.09	7.45

Holistically, in other to determine the most desirable nutrient limited tolerant criteria, correlation coefficients between Y_p and Y_s in relationship with other indices were evaluated (Farshadfar et al., 2013). Y_p was more highly and positively correlated with MP at 0.93 but negatively correlated with SS1 (-0.90) while Y_s was significantly and positively correlated with YSI (0.96), MP (0.80) and negatively correlated with SS1 (-0.81). Similar trends were observed under other tolerance indices (Table 7). This trend possibly suggested MP,

YS1 and SS1 as the most desirable tolerance indices required for tomato cultivar selection in both optimum and limited fertilizer conditions. AGE followed this trend, T₅ (15.3) > T₆ (12.3) > T₉ (9.46) > T₈ (8.97) > T₁ (8.26) > T₂ (6.76) and T₇ (0.39) the least. There however, appears little or no interaction between Y_p and Y_s considering the fact that the cultivar with the least AGE recorded the highest Y_p and second highest Y_s. This therefore calls for further studies to establish sustainable positive correlation between AGE, Y_p and Y_s.

Table 7: Ranking of Tomato Cultivars based on Nutrient Tolerance generated from Table 6

TRT	YLD	YI	MP	Y _{Pm}	Y _{Sm}	SSI	GMP	TOLN	DIN	YSI	SNPI	KNST ₁	KNST ₂	RDI	STI	Total
T ₁	7	9	7	6	5	7	4	8	6	3	8	8	9	6	6	92
T ₂	3	8	1	7	1	9	1	9	1	1	9	9	8	4	2	68
T ₃	6	2	6	7	7	8	6	5	2	6	6	5	1	2	5	74
T ₄	1	7	3	1	6	3	7	1	8	7	7	7	7	5	7	77
T ₅	5	6	5	3	3	5	3	4	4	3	5	5	6	8	4	68
T ₆	4	4	4	4	4	5	5	3	5	5	3	3	4	7	3	63
T ₇	2	5	2	5	2	1	2	2	3	2	1	1	5	9	1	43
T ₈	9	3	9	9	8	2	9	6	9	1	2	2	2	3	9	85
T ₉	8	1	8	8	9	3	8	7	7	8	4	6	3	1	8	89

Table 7: Simple correlation co-efficient for Yp, Ys, and other tolerance indices in 2015/2016 nine cultivars of tomatoes

	YP	Y _s	SSI	GMP	TOLN	MP	DIN	YSI	SNPI	KNST1	KNST2	RDI	STI
YP	1												
Y _s	0.51	1											
SS1	-0.90	-0.81	1										
GMP	0.45	-0.15	-.077										
TOLN	0.78	-0.14	0.48	-0.15	1								
MP	0.93	0.80	-0.42	0.72	0.49	1							
DIN	0.48	0.41	0.11	0.39	0.25	0.52	1						
YSI	0.37	0.96	-0.88	0.96	-0.28	0.69	0.31	1					
SNPI	-0.19	0.58	0.87	-0.63	0.93	-0.27	0.35	-0.69	1				
KNSTI	0.35	0.03	0.49	-0.02	0.38	0.26	0.83	-0.11	0.78	1			
KNST2	-0.51	-0.36	0.16	-0.44	-0.32	-0.51	-0.19	-0.36	0.06	-0.20	1		
RDI	-0.56	-0.36	0.08	-0.42	-0.38	-0.55	-0.27	-0.33	-0.03	-0.31	0.99	1	
STI	0.60	0.70	-0.20	0.70	0.19	0.73	0.91	0.61	0.07	0.68	-0.37	-0.44	1

Tables 2 & 4 show input and output quantities with their corresponding energy equivalents and percentages in nine tomato cultivars production. The total energy budget was 112,180.55 MJ/ha of which fertilizer alone accounted for 41.2% followed by the use of gasoline and human labour at 23.0% and 15.7% respectively in agreement with works of Sara et al., (2011), and Yuexician et al., (2014), showing the use of mineral fertilizer as the input in tomato production. However, in view of health implication of chemical fertilizer to humans and environmental respect to cancerous diseases as a result of fresh consumption of tomato or other agricultural products, there is need for alternative source for boosting production with fewer hazards to human nutrition and the environments (Scott, 2003). Human labour has long remained a major factor in Nigerian agricultural business which remains unsustainable in food security thereby calling for concerted effort to migrate from the present use of crude farm implements (cutlasses, hoes) to mechanized farming capable of eliminating all forms of drudgery associated with farming while attracting the reactive youths to agriculture and improve the national economy. Energy use efficiency still remained low in Nigerian agricultural production. This study showed energy use

efficiency of 0.1 (Table 8) in contrast to 4.94 reported by Sara et al., (2011) for grape; 0.96 for cherry (Kizilaslan, 2009) in 0.69 for cucumber, 1.48 for tomato (Heidari and Omid, 2011). This development poses a grave danger to the Nigerian agricultural development in view of crisis experienced by energy sector in the country and its implication on sustainable production. Table 9 shows the distribution of direct and indirect renewable and non-renewable energy components in nine tomato cultivars. Non-renewable energy accounted for 37.1% followed by indirect energy at 29.6% and renewable energy the least at 11% showing the national challenge to develop the natural renewable energy to the level of sustainability. The total expenditure for the cultivation of the nine tomato cultivars was ₦3, 116,800.00 with corresponding net return of ₦1, 641,292.00 at 2.09 benefit-cost-ratios (BCR). The BCR value revealed preferential performance of tomato cultivation over wheat (1.43) (Shahan et al., 2008), cotton (0.86) (Yilmaz et al., 2005), sugar beet (1.17) (Erdal et al., 2007), and stake tomato (1.03) Esengum et al., 2007). Succinctly speaking, Evaluation of energy use components of crop production is essential to determine the actual returns achievable in a project.

Table 8: Energy Input – Output Ratio of Tomato Production

Item	Unit	Value
Energy Input	MJha ⁻¹	112,180.55
Energy output (fruits +straw)	MJha ⁻¹	1,562.6
Tomato Yield	Kgha ⁻¹	9,636
Energy Use efficiency		0.1
Energy Productivity	KgMJ ⁻¹	0.1
Specific Energy	MJkg ⁻¹	11.64

Table 9: Total Energy Input in the form of direct, direct renewable and non-renewable for tomato production under Optimal and limited fertilizer application

Energy forms (MJ ^{ha})	Total Energy Input(MJ ^{ha})	%
Direct Energy	67,788.83	22.3
Indirect Energy	90,062.59	29.6
Renewable Energy	33,494.3	11
Non-Renewable Energy	112,926.33	37.1

Table 10: Economic Analysis of Tomato Production

Cost and Return Component	Value
Fruit Yield(kgha ⁻¹)	7,792
Sale price(Nkg ⁻¹)	400
Residue yield (kgha ⁻¹)	1,844
Sale price (minor)(N kg ⁻¹)	15.0
Gross value of production (N/ha)(fruits)	3,116,800
Gross value of production (N/ha) residue	27,660
Total gross value of production	3,140,460
Total cost of production	1,503,168
Net return (S/ha ⁻¹)	1,641,292
Benefit cost ratio	2.09

IV. CONCLUSION

Energy Use Efficiency, Agronomic Efficiency, Economic Analysis, and Nutrient tolerance indices are necessary budgets that require intensive and multi-disciplinary attention especially in the content of Nigerian agricultural production that often yield far below world standard. The situation becomes more frightening in view of dwindling energy sources in Nigeria that plummet the economy. The nine tomato cultivars investigated in this study were subjected to diverse conditions on the field. Results obtained suggested that T₂, T₇ were most adaptable to Sudan ecology of Nigeria, although T₆, T₄ and T₅ are potential alternatives.

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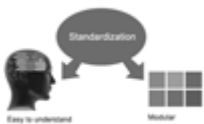
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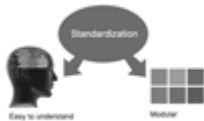
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- Abstract Font size of 9 Bold, "Abstract" word in Italic Bold.
- Main Text: Font size 10 with justified two columns section
- Two Column with Equal Column with of 3.38 and Gaping of .2
- First Character must be three lines Drop capped.
- Paragraph before Spacing of 1 pt and After of 0 pt.
- Line Spacing of 1 pt
- Large Images must be in One Column
- Numbering of First Main Headings (Heading 1) must be in Roman Letters, Capital Letter, and Font Size of 10.
- Numbering of Second Main Headings (Heading 2) must be in Alphabets, Italic, and Font Size of 10.

You can use your own standard format also.

Author Guidelines:

1. General,
2. Ethical Guidelines,
3. Submission of Manuscripts,
4. Manuscript's Category,
5. Structure and Format of Manuscript,
6. After Acceptance.

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- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently. You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.



Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.



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<i>References</i>	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring



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