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Agriculture and Veterinary

Highlights

- Hybrid Vigour Studies
- Stable Isotope Analysis
- Slovak National Breed
- Coturnix Coturnix Japonica

Discovering Thoughts, Inventing Future

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Roach in Lake Maggiore: A Peaceful Invasion Detected with C, N Stable Isotope Analysis

By Visconti Anna, Volta Pietro, Fadda Amedeo & Manca Marina

Abstract - Invasions by non-native species are increasingly detected all over the World, as a consequence of globalization. Successful establishment implies the presence of unexploited niches and/or competitive advantage of invader vs. native closely related species. As a consequence, invasion also impacts functional diversity and trophic relationships in ecosystems. Feeding niche is a relevant component of ecological niche; it can be investigated by means of C, N stable isotopes analyses (SIA). Here we present results of a study in which feeding niche of the invader *Rutius rutilus* is compared with those of *Coregone lavaretus* and Alosa agone. in a deep, subalpine lake (Lago Maggiore, Italy). By applying SIA we quantified seasonal shifts in pelagic vs. littoral diet sources and in their percentage contributions for the three species. Feeding plasticity, namely spatial and temporal displacement, allowed for a peaceful coexistence of the invader and the other two potential competitors.

Keywords : non-native species; competition; trophic niche; stable isotope analysis; freshwater fish.

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ROACH IN LAKE MAGGIORE A PEACEFUL INVASION DETECTED WITH C, N STABLE ISOTOPE ANALYSIS

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Roach in Lake Maggiore: A Peaceful Invasion Detected with C, N Stable Isotope Analysis

Visconti Anna [α], Volta Pietro [σ], Fadda Amedeo [ρ] & Manca Marina [ω]

Abstract - Invasions by non-native species are increasingly detected all over the World, as a consequence of globalization. Successful establishment implies the presence of unexploited niches and/or competitive advantage of invader vs. native closely related species. As a consequence, invasion also impacts functional diversity and trophic relationships in ecosystems. Feeding niche is a relevant component of ecological niche; it can be investigated by means of C, N stable isotopes analyses (SIA). Here we present results of a study in which feeding niche of the invader R*utius rutilus* is compared with those of *Coregone lavaretus* and *Alosa agone*. in a deep, subalpine lake (Lago Maggiore, Italy). By applying SIA we quantified seasonal shifts in pelagic vs. littoral diet sources and in their percentage contributions for the three species. Feeding plasticity, namely spatial and temporal displacement, allowed for a peaceful coexistence of the invader and the other two potential competitors.

Keywords : non-native species; competition; trophic niche; stable isotope analysis; freshwater fish.

I. Introduction

Invasions of non-native species usually cause negative perturbations on invaded environments and are often associated with environmental degradation (Wilcove *et al.* 1998; Byers 2002; Volta *et al.* 2013). One of the main impacts is the change in native communities with an imbalance of established trophic relationships between native species (Nillson *et al.*, 2012). Such imbalance in turn drives environmental consequences which can result into ecological and economical damages (Welcomme 1998; Rahel 2000; Richardson, 2011), hardly reversible.

Successful establishment of non-native species has been reported to deeply affect diversity of communities, driving changes in taxonomic composition and in functional diversity (Richardson, 2011; Strayer, 2012). Changes in functional diversity of the community in turn have strong impact on food webs and ecosystem functioning (Hooper *et al.* 2005; Britton *et al.* 2010; Richardson, 2011; Simberloff 2011; Volta *et al.* 2013). Species invasion largely depends on the degree of niche overlapping and competition among native and non-native species. Often, success of replacement of native by non-native species is linked to their taxonomical similarity, based on which the two are also ecologically similar. In other cases, however, also taxonomically distant species can be characterized by a similar morphology (e.g. body size), which makes them suitable for the same habitat/niche (Visconti *et al.* 2009; Ricciardi and Mottiar 2006).

Consequent to global changes and increasing environmental vulnerability, number of invasions are exponentially recorded all over the World (Moss *et al.* 2009). Such invasions are increasingly detected also in aquatic environments which were traditionally regarded as resilient to environmental impacts and characterized by stable taxonomic structure of their communities, and a high level of predictability in seasonality. Such is the case of deep lakes, increasingly reported as becoming vulnerable to invasions (e.g. Kamburska *et al.* 2013; Visconti *et al.* 2009; Volta *et al.* 2008, Volta *et al.* 2013a). Studying impact of successful establishment of alien taxa in this type of environments therefore allows for predicting new scenarios driven by global changes.

Environments such as Lake Maggiore, object of long term monitoring programs, are reasonably highly informative in detecting changes. Being their biotic communities investigated in detail over the years, they are certainly deputed to prompt detection of the appearance of non-native species. Increasing records of new taxa and of their successful establishment in the lake, are likely to be representative of increasing vulnerability of the lake to changes directly or indirectly driven by globalization, thus changing our perspective on highly stable and resilient environments (de Bernardi *et al* 1990).

Invasions in Lake Maggiore and in its catchment basin were detected at different levels of the biota from plankton (e.g. zooplankton copepods, Visconti *et al.* 2009), benthos (e.g. mussels: Kamburska *et al.* 2013; Piscia et al. 2011) and fish (Volta and Jepsen 2008; Volta *et al.* 2013a). Alteration in fish community resulting from invasion by aliens, is likely that having also major impacts on social and economical activities, being commercial fishing an important resource in the economy of deep lakes region.

A successful, and relatively fast invasion by the non-native roach, *Rutilus rutilus* (Linnaeus 1758), was recently recorded in Lake Maggiore (Volta and Jepsen 2008). Thanks to the prompt colonization of lake waters, roach is nowadays one of the most abundant fish species of the lake as registered by commercial catches (Volta et al 2013). The others being the autochthonous shad, *Alosa agone* (Scopoli 1786) and the alloch-thonous but naturalized coregonids (*C.lavaretus*

Authors α σ ρ ω : CNR ISE, Largo Tonolli 50, 28922 Verbania VB Italy. E-mail : annavisconti79@gmail.com

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Linnaeus 1758. and *C. macrophthalmus* Nusslin 1882 introduced since the end of 1800s). Depending on their life cycles, those species can be more related to pelagic or to littoral zones (Berg and Grimaldi 1966; Visconti *et al.*, 2013). However, due to the steep profile of the shore banks, fish can easily switch between littoral and pelagic zones, as detected by means of diet investigations. Being pelagic and littoral food sources characterized by peculiar carbon and nitrogen stable isotope signatures, tracing their contribution to fish diet, by means of detection of assimilated food, is allowed by Stable Isotope Analysis (SIA) of their tissues. This type of analysis also allows for quantifying relative contribution of the two potential food sources along the season, irrespective of catchment/sampling zone.

While interactions between roach and littoral fish were largely discussed (e.g. Volta and Jepsen 2008), relatively less information is available on interference of roach with pelagic fish species (Perrson and Greenberg 1990; Bergman and Greenberg 1994). Comparative studies on the biology of coregonids, shad (Berg and Grimaldi 1965,1966, Volta 2010) and roach (Volta and Jepsen 2008) allow for hypothesizing that the "genuine invasion" (as defined by Volta and Jepsen 2008) of the roach can lead to a peaceful coexistence.

In this respect, the aim of the present study is to define/quantify 1) the degree of trophic niche overlap along the season; 2) seasonal pelagic vs. littoral carbon sources exploitation; 3) seasonal changes in trophic level with respect to isotopic baselines for roach, shad and the European whitefish *C. lavaretus*. All these information will contribute to quantifying the degree of competition among these species.

II. Materials and Methods

a) Study Site

Lake Maggiore (45°58'30"N latitude; 8°39'09"E longitude; 194 m a.s.l. altitude) is the second-deepest (370 m maximum depth) and largest (212.5 km^2) subalpine lake in Italy. Long-term (LTER) limnological and paleolimnological studies have traced the impact of multiple stressors (*i.e.* changes in algal nutrients, climate warming and meteo-climatic inter-annual variability, introduction of non native fish) on the lake (*e.g.*, Guilizzoni *et al.* 2011; Jeppesen *et al.* 2012; Manca and DeMott 2009; Visconti *et al.* 2008; Visconti and Manca 2010; Volta and Jepsen 2008).

b) Sample collection and laboratory analyses

Stable isotopic signatures of primary consumers, i.e. the pelagic cladoceran *Daphnia galeata* and chironomid larvae and amphipod, to trace pelagic and littoral baselines, respectively.

Daphnia was collected monthly during 2008 at three Lake Maggiore pelagic stations (Visconti *et al.* 2011): a station located at the point of maximum depth of the lake (Ghiffa: 45°58'30"N; 8°39'09"E); a second station located near the inflow of the Toce River (Baveno: 45°54'28"N; 8°31'44"E); and a third station located in the southern, shallower part of the lake basin, known for being more influenced by littoral inputs (Lesa: 45°49'70"N; 8°34'70"E). The three stations were sampled on the same day and isotopic data from the three were integrated for the pelagic baseline signature. Live samples for isotopic analysis were collected with large (58-cm opening mouth diameter), 450-µm nylon net, to ensured that large phytoplankton colonies were avoided and small-bodied zooplankton taxa (such as rotifers, and early developmental stages of copepods) were excluded. Organisms were kept overnight in filtered (1.2 µm GF/C filters) lake water for gut clearance, then isolated from other zooplankters in a quantity suitable for isotopic analyses (about 700 individual, to reach 1 mg dw/sample).

Samples of benthic littoral organisms (chironomid larvae and amphipods) were seasonally collected with benthic nets at three littoral stations located at the shore along the major axis of the lake (integrating the samples of three stations: Cannero, Baveno, Meina) and at a station (Toce) near the mouth of the River Toce. Samples were processed as described for *Daphnia*. Approximately 15 organisms/sample were necessary to reach the weight requested for SIA.

European whitefish and shad were sampled monthly in the central zone of the lake (Ghiffa station), with a set of drifting nets of different mesh size (32-34-40-50 mm knot to knot). Roach was sampled in the littoral area of the same region using benthic multimesh survey gillnets (Nordic type). Nets were set at dusk and retrieved the following morning. On each sampling date, the dorsal muscle (located between the head and the dorsal fin and above the lateral line) of three individuals/species (≤ 3 years old, as determined by scales analyses) was dissected for SIA.

All samples (baselines and fish) were oven-dried at 60°C for 48 hours (3 days for fish) and finely powdered. Subsamples of about 1 mg dry weight each were transferred to 5x9 mm tin capsules for Carbon, Hydrogen, Nitrogen (CHN) and Continuous Flow-Isotope-Ratio Mass Spectrometry (CF-IRMS) Stable Isotope Analyses. Three replicates were performed for each sample.

Samples were sent to the G.G. Hatch Stable Isotope Laboratory (University of Ottawa, Canada) where the isotopic composition of organic carbon and nitrogen was determined by a DeltaPlus Advantage CF-IRMS. The standard deviation of the analyses (S.D.), based on the laboratory internal standards, was < 0.2‰ for both $\delta^{13}C$ and $\delta^{15}N$. Isotope ratios were expressed as parts per thousand (‰) differences from a standard reference (PeeDee Belemnite for carbon and atmospheric N_2 for nitrogen):

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$$\delta^{13}C, \delta^{15}N = [(R_{sample} / R_{standard}) - 1] \times 1{,}000$$

where R is the isotopic ratio: $^{13}C/^{12}C$ and $^{15}N/^{14}N$.

c) Integration of baseline fluctuations into DBMM

Sources exploited by fish were assessed by comparing their $\delta^{13}C$ signature to the signatures of the two potential baselines, *i.e.* pelagic and littoral. A consumer maximum fractionation ($F = \delta^{13}C_{fish} - \delta^{13}C_{baseline}$) was assumed at 0.8 ± 1.1‰ (De Niro and Epstein 1978). Nitrogen stable isotopes were used to define steps in the trophic web based on the general assumption of a gradual $\delta^{15}N$ enrichment of 3.4‰ ± 1.0 (Post 2002) from food to consumer ($E = \delta^{15}N_{fish} - \delta^{15}N_{baseline}$).

When a single food source was used, fish trophic position (T) relative to baseline was calculated applying the equation:

$$T = (E/3.4) + \lambda; \quad (1)$$

Where: $\lambda = 2$ is a constant value usually assigned to primary consumers (*e.g. Daphnia* for the pelagic and chironomids/amphipods for the littoral).

When fish $\delta^{13}C$ signature appeared linked to both baselines (littoral and pelagic), their contribution to fish diet was quantified using the Dynamic Baseline Mixing Model (DBMM; Woodland *et al.* 2012). The model assumes that carbon isotopic signature of a consumer tissue is the result of a linear mass balance average of elemental mass from each metabolized food source (Phillips 2001). DBMM takes into account both seasonal shifts in baseline signatures integrated in fish isotopic signature and the specific metabolic and growth rates of investigated fish. It was assumed that monthly carbon signatures of investigated fish integrated diet isotopic signatures over 60 days, *i.e.* the time delay necessary for fish dorsal muscle to reach equilibrium (Hesslein *et al.* 1993; Perga and Gerdeaux 2005; Phillips and Eldridge 2006). Percentage contributions of pelagic (p) and littoral (q) sources to the fish carbon signature result from the equation:

$$p = (\delta^{13}C_{fish(0)}\, e^{-(k+m)t} + h_{litt(t)}\, e^{-(k+m)t} - \delta^{13}C_{fish(t)}) / (h_{litt(t)}\, e^{-(k+m)t} - h_{pel(t)}\, e^{-(k+m)t}); \quad (2)$$

$$q = 1 - p;$$

Where: $\delta^{13}C_{fish(0)}$ is the initial isotopic value of fish in equilibrium with its diet at time t=0; $\delta^{13}C_{fish(t)}$ is the isotopic signature of fish in equilibrium with its diet at time t (where t=60 days); and k and m are fish growth rate (d^{-1}) and tissue turnover metabolic constant (d^{-1}), respectively.

The model is based on a system of linear equations (h) best fitting baseline data through time (h_p and h_l = functions associated with pelagic and littoral signatures, respectively). For fish dorsal muscle tissue, m was assumed to be 0.0018 d^{-1} for both $\delta^{13}C$ and $\delta^{15}N$ (Hesslein *et al.* 1993). Growth rates k assigned to each fish species were calculated according to Hesslein *et al.* (1993): k_{shad}=0.01 d^{-1}; $k_{whitefish}$=0.03 d^{-1}; k_{roach}=0.03 d^{-1}. Time-specific percentage contributions of pelagic (p) vs. littoral (q) carbon signature were used to calculate mean year contribution of each source, *i.e.* the number of months·year^{-1} during which each source was exploited.

When both food sources (littoral and pelagic) were exploited, the fractional carbon contribution from each source (p and q) was entered into the trophic level equation:

$$T = (\delta^{15}N_{fish} - (p * \delta^{15}N_{pelagic} + (1-p) * \delta^{15}N_{littoral})/\lambda) + 2; \quad (3)$$

III. Results

a) Seasonal fluctuations in baselines and fish carbon signatures

Seasonal changes in carbon isotopic values ($\delta^{13}C$)of the pelagic baseline were substantial, following a common trend of deep, subalpine lakes, with more ^{13}C-depleted values in winter (-35.78‰ ± 0.06 SE) and less depleted values in summer (-25.72‰ ± 0.72 SE). Overall, pattern of change in $\delta^{13}C$ signature of pelagic baseline was related to water temperature and thermal stratification (Caroni *et al.* 2012), with a gradual thermal de-stratification and increasing contribution of dissolved carbon from the hypolimnion, leading to a seasonal minimum during winter mixing (Zohary et al. 1994).

Seasonal changes in littoral baselines were very rarely investigated (e.g. in Lake Maggiore, 2008: Visconti and Manca, 2010). Indeed, littoral baseline was found to change seasonally, in a step-by step temporal pattern similarly to what observed for the pelagic baseline, although shifted towards less ^{13}C-depleted values in summer (-18.3‰± 0.14 SE) and more ^{13}C-depleted values in winter (-25.28‰ ± 0.6 SE) (Visconti *et al.,* 2013).

Owing to results showed in trophochemical plots of the three fish species analyzed (Fig. 1), is clear that both truly pelagic species, whitefish and shad, closely related to the pelagic food sources from June ($\delta^{13}C$ signatures: -28.6‰ ±0.5 and -29.1‰ ±0.6, respectively) to December ($\delta^{13}C$: -29.2‰ ±0.4 for shad and -28.5‰ ±0.2 for whitefish), are able to exploit also littoral food sources in winter and early spring ($\delta^{13}C$: -27.8‰ ±0.7 and -28‰ ±0.4, in February and -28.6‰ ±0.2 and -26.9‰ ± 0.4, in April, for shad and whitefish, respectively), *i.e.* when both pelagic and littoral carbon baselines reached their most ^{13}C-depleted values. Similarly, the truly littoral invader, related to littoral sources from December (-25.7‰±0.4) to June (-25.3‰±0.2), was found to incorporate pelagic isotopic signatures from August (-26.3±0.2‰) to October (-25.6±0.2‰). Seasonal pattern of change in isotopic signatures of the two mainly pelagic fish species allowed for tracing their moving into the littoral for feeding in winter. In Summer, however, when all three fish species fed in the pelagia, their C and N isotopic

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signatures did not overlap, therefore suggesting that they were consuming different preys.

The trophochemical graph also suggests that whitefish were, overall, on a higher trophic level ($\delta^{15}N$ signatures ranging from 9.65‰ ±0.7 in June to 11.79‰ ±0.3 in September) than the other two species ($\delta^{15}N$: between 8.58‰ ±0.3 in August and 11.74‰ ±0.2 in December for shad; between 8.59‰ ±0.3 in November and 10.41‰ ±0.8 in September, for roach). Thus suggesting that whitefish preferentially exploit, when available, zooplankton secondary consumers.

When relying on littoral sources, the trophic position of the three fish were of 4 or 5, indicating the presence of one or two intermediate preys between fish and organisms used to trace littoral baseline (T=2). In August-October, when roach fed entirely in the pelagic, T was always 3, *i.e.* one step above primary consumers (T=2) used as pelagic baseline (*Daphnia*). When relying on pelagic food sources (May-December), shad occupied level 3 from June to November, feeding directly on cladoceran (*Daphnia*) or copepod (diaptomids and the small-sized *Mesocyclops leukartii* (Visconti *et al.* 2013)) primary consumers. In November, whitefish trophic position T= 4 was due to the presence of intermediate secondary consumers (namely, *Bythotrephes* and *Leptodora* among cladocera; the large *Cyclops abyssorum* among copepods (Visconti *et al.* 2013)) among zooplankton potential preys.

When a mix of pelagic and littoral $\delta^{13}C$ isotopic signatures were integrated into fish tissues, DBMM allowed to calculate percentages of pelagic (*p*) vs. littoral (*q*) contributions (equation 2; Tab. 1). For roach, intermediate carbon isotopic values between pelagic and littoral were measured in July and November, suggesting simultaneous exploitation of the two carbon sources. A *p* contribution of 64% in July and of 46% in November were estimated (equation 2; Tab. 1). For both whitefish and shad, isotopic carbon signatures were intermediate between pelagic and littoral carbon sources in January and May. We estimated 78% of littoral sources (*q*) in January and 79% of pelagic (*p*) sources in May for shad. A *p*-contribution of 51% and of 53% were estimated for whitefish in January and May, respectively (equation 2; Tab. 1).

On an annual basis, mean contributions of pelagic sources exploited by the three fish species were of 33%, 75% and 67 %, for roach, whitefish and shad, respectively.

IV. Discussion and Conclusions

Being omnivorous and opportunist, roach is characterized by a wide trophic spectrum, directly influenced by seasonality. SIA results confirm previous studies (Volta and Jepsen 2008) indicating that roach switches towards a zooplanktonic diet in summer (Volta and Jepsen, 2008), while relying upon littoral food sources (such as algae, benthos, detritus and zoobenthos) in winter and spring, i.e. until the spawning period.

On the other hand, we found that whitefish and shad relied upon littoral food sources although for a short time, three and four months, respectively. Littoral feeding was restricted to the spawning periods (winter for whitefish and late spring for shad). During this period, whitefish preferentially eat on chironomid larvae and amphypods (Berg and Grimaldi 1965; Perga and Gerdeaux 2005), while shad mainly feed on ostracods, Tendipendidae, Turbellarii and detritus (Berg and Grimaldi 1966). Owing to results of the present study, when whitefish and shad exploited pelagic food sources, however, competition was not strong: based on isotopic signatures of zooplankton available preys (Visconti *et al.* 2013) and on their own isotopic signatures, in fact, they fed on different preys. Whitefish mainly fed on cladocera. When shad shifted towards cladoceran primary consumers (i.e. *Daphnia*), whitefish shifted towards cladoceran secondary consumers (i.e. *Bythotrephes* and *Leptodora*), by shifting to a higher trophic level thus releasing competion with shad.

During pelagic co-occurrence with the other two species (i.e. from July to October), roach tended to overlap with shad for 15N-enrichment, by sharing the same primary consumers (*Daphnia* and *Bosmina*). During pelagic feeding, however, less- and more- 13C-depleted isotopic signatures of roach and whitefish, respectively, indicate horizontal segregation in feeding zones of the two fish species: likely, roach was related to nearshore and shad the open water pelagic zones of the lake, thus not exploiting the same preys. Absence of competition was also suggested by a similar increase in abundance of these two species during the last ca. five years (Volta *et al.* 2013).

Despite a similar ability to shift between pelagic and littoral food sources, roach invasion did not result apparently into an heavy competition with to the two naturalized fish species. Their trophic niches were not only displaced in time, with only a 25 (with whitefish) and 33 (whit shad) % overlapping in foraging zones, but they were also displaced in space in periods of apparent overlap in diet (i.e. with shad, in summer).

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Legends to Figures

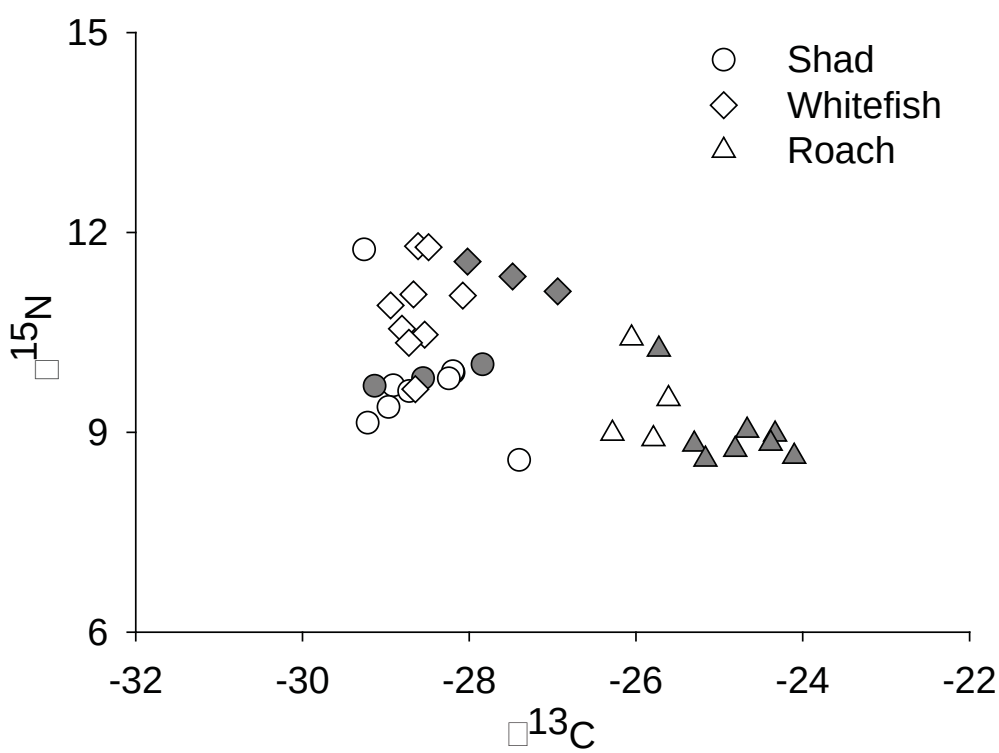

Figure 1 : Trophochemical graph of monthly $\delta^{13}C$ and $\delta^{15}N$ isotopic signatures of roach, whitefish and shad from Lake Maggiore, 2008. White and grey symbols identify pelagic and littoral sources, respectively. For further explanation refer to text

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Table 1 : Monthly values of *p*- (pelagic, white cells) and q- (littoral, grey) contributions (%) to carbon isotopic signature of the three Lake Maggiore's fish species. Numbers in bold refer to values calculated by applying a DBMM (Woodland *et al.* 2012). For further explanation see text

	Ja	Fe	Ma	Ap	My	Jn	Jl	Au	Se	Oc	No	De
Roach	88	95	83	86	96	76	**64**	96	80	66	**46**	58
Whitefish	**51**	63	84	89	**53**	60	96	61	98	94	86	71
Shad	**78**	65	76	71	**79**	65	88	80	82	96	92	79

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Hybrid Vigour Studies in Brinjal (*Solanum Melongena* L.)

By Leena Biswas, Nandan Mehta & Sabeena F. Ansari

Indira Gandhi Krishi Vishwavidyalaya, Raipur

Abstract - The seeds of sixty hybrids along with ten parents generated during *Rabi*, 2009 were evaluated for heat tolerance and earliness during Summer, 2010 in a Randomized Block Design along with national check PH-6 in three replications for C.G. plains. Heterosis analysis was carried out for days to 50% flowering, days to first picking, plant height, number of primary branches per plant, average fruit length (cm), average fruit girth (cm), average fruit weight (g), total number of fruits per plant, number of fruits per plant per picking, marketable fruit yield per plant, total fruit yield per plant and total soluble solids (%). Highest standard heterosis was shown by IBWL x PPC (46.86%) followed by GL x PPL (46.13%), MK x IBWL (42.44%), PPC x WBPF (41.62%) and WBPF x PR (40.96%) for total fruit yield per plant.

Keywords : brinjal, heterosis, yield, summer set/heat tolerance.

GJSFR-D Classification : FOR Code: 820602, 820215

HYBRID VIGOUR STUDIES IN BRINJAL SOLANUM MELONGENA L.

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Hybrid Vigour Studies in Brinjal (*Solanum Melongena* L.)

Leena Biswas [α], Nandan Mehta [σ] & Sabeena F. Ansari [ρ]

Abstract - The seeds of sixty hybrids along with ten parents generated during *Rabi*,2009 were evaluated for heat tolerance and earliness during Summer, 2010 in a Randomized Block Design along with national check PH-6 in three replications for C.G. plains. Heterosis analysis was carried out for days to 50% flowering, days to first picking, plant height, number of primary branches per plant, average fruit length (cm), average fruit girth (cm), average fruit weight (g), total number of fruits per plant, number of fruits per plant per picking, marketable fruit yield per plant, total fruit yield per plant and total soluble solids (%). Highest standard heterosis was shown by IBWL x PPC (46.86%) followed by GL x PPL (46.13%), MK x IBWL (42.44%), PPC x WBPF (41.62%) and WBPF x PR (40.96%) for total fruit yield per plant.

Keywords : brinjal, heterosis, yield, summer set/heat tolerance.

I. Introduction

Brinjal (*Solanum melongena* L. 2n = 24) also known as eggplant or aubergine, is an important solanaceous crop of sub-tropics and tropics. It is a member of the family *Solanaceae* (also known as the nightshades), which includes other vegetable crops such as tomatoes, potatoes and capsicums. Most of the local varieties which are grown by the cultivators of Chhattisgarh have not been fully utilized in any genetic improvement programs so far on scientific line, they are very well responding to the high temperature of summer in Chhattisgarh. For the development of an effective heterosis breeding programme in brinjal one needs to elucidate the genetic nature and magnitude of quantitatively inherited traits and estimate prepotency of parents in hybrid combinations. The information generated in the process is used to understand the magnitude of heterosis for earliness alongwith heat tolerance for Chhattisgarh State. Hence, the present research work was undertaken with a view to understand the genetic architecture of parents and cross combinations for earliness over hot/summer season. Thus, keeping in view the above facts, the present study entitled "Heterosis in Brinjal (*Solanum melongena* L.)" was carried out.

II. Material and Methods

The experimental material used in the present study was supplied by All India Coordinated Vegetable Improvement Project, Department of Plant Breeding and Genetics, IGKV, Raipur (C.G) which consisted of ten parents *viz.*, Green Long, Mukta Keshi, Pusa Purple Long, IBWL-2007-1, White Brinjal Purple Flower, Pusa Purple Cluster, Pant Rituraj, Pusa Purple Round, Safed Round, Punjab Sadabahar and their 60 F_1's with national check Pusa Hybrid-6. The parents were crossed during *Rabi*- 2009 and F_1's were evaluated in *Summer*- 2010 in Randomized Block Design with three replication at Horticulture Research Farm in AICVIP (All India Coordinated Vegetable Improvement Project), Department of Plant Breeding and Genetics, Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh), India. Observations were recorded for days to 50% flowering, days to first picking, plant height (cm), number of primary branches per plant, average fruit length (cm), average fruit girth (cm), average fruit weight (g), number of fruits per plant, number of fruits per picking, total fruit yield per plant (g), marketable fruit yield per plant (g) and total soluble solids (%) on five randomly selected plant from each replication.

III. Results and Discussion

Analysis of variance was carried out which revealed that variance due to lines was significant for all the traits studied. Based on mean performance of parents for fruit yield and its components in brief, the earliest days to 50% flowering was recorded in parents GL, MK, PPL and IBWL (each 42 days): days to first picking is noted earliest in PPL and PH-6 whereas, maximum plant height recorded in GL and SR; maximum number of primary branches counted in IBWL, PS and PH-6; maximum average fruit length observed in GL; whereas, fruit girth was maximum PPR and PPL; while average weight was maximum in MK, PH-6 and PPR; total number of fruits per plant recorded maximum in IBWL, PPC and SR; total number of fruits per plant per picking recorded maximum in PPL, GL and SR whereas, marketable fruit yield per plant recorded maximum in GL, IBWL, PH-6 and PPC; total fruit yield per plant recorded maximum in GL, IBWL and PH-6 check while total soluble solids was maximum in PH-6 and PPR. These parents can be further utilized for hybridization programmed in brinjal improvement for C.G. plains. In case of F_1's earliest flowering recorded in MK x IBWL, MK x IBWL, MK x WBPF, MK x PS, MK x SR, IBWL x NK, IBWL X PPL , IBWL X PPC, IBWL X PS , WBPF x GL and PPC X PR; earliest days to first picking recorded in IBWL

Authors α σ ρ : Department of Genetics & Plant Breeding, Indira Gandhi Krishi Vishwavidyalaya, Raipur, 492012 (C.G.).
E-mail : namitabiswa@rediffmail.com

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x PS MK x WBPF MK x SR and IBWL x PPR; maximum plant height was observed in GL x MK, GL x PPL and MK x PPL; whereas maximum number of primary branch recorded in GL x MK, IBWL x PPL, WBPF x PPR; while fruit length recorded maximum in PS x SR, SR x MK, PS x MK and WBPF x PPL; while maximum fruit girth was observed in IBWL x MK, GL x PR, GL x MK and MK x PR; average fruit weight was recorded maximum in MK x PPC, MK x WBPF and MK x PR; total number of fruits per plant counted in PPC x PR, PPC x SR; maximum number of fruits per plant per picking counted in MK x PPL, IBWL x PPL, PPL x PPC and PPL x GL; maximum marketable fruit yield per plant observed in GL x PPL, MK x IBWL , PPC x WBPF, GL x PS and PPL x PPC finally total fruit yield per plant was recorded in GL x PPL, MK x IBWL, GL x PPR, IBWL X PPC, IBWL x GL, IBWL x MK and PPL x WBPF; a quality trait total soluble solids was recorded maximum in GL x PS and PPC x SR. In these way this desirable hybrids can be repeated for their verification.

The range of mid-parent heterosis *i.e.* per cent deviation of hybrid value from its mid parental value for days to first picking varied from -22.41% (IBWL x PS) to 24.32 % (GL x PPL, PPL x PS). The top ranking hybrids for this trait were, IBWL x PS, WBPF x PPL, MK x WBPF, MK x SR, MK x PPC. The better parent heterosis ranged from -22.41 % (IBWL x PS) to 30.19 % (GL x PPL, PS x PPL). Out of sixty hybrids, forty eight hybrids showed significant heterosis, over their better parent. The range of standard heterosis *i.e.* per cent deviation of hybrid from the standard parent for this trait ranged from -16.67% (IBWL x PS) to –29.63% (WBPF x PS). In this out of sixty F_1's fifty two hybrids showed significant heterosis of which forty nine exhibited positive heterosis. Maximum negative standard heterosis were shown by IBWL x PS, MK x WBPF, MK x SR, IBWL x PPR. Early first picking is highly desirable trait for any local and distant market for vegetables in general and for brinjal in particular. Early summer hybrids of this study may be exploited for the same. These results are in agreement with the finding of Das and Barua (2001).

The range of the mid-parent heterosis for the trait plant height (cm) varied from -28.41 % (PS x GL) to 62.87 % (WBPF x PR). Thirty eight hybrids out of sixty showed significant negative mid-parent heterosis and twenty five F_1's revealed significant positive heterosis. The top ranking hybrids for this trait were PS x GL, WBPF x SR, GL x SR, WBPF x PPL and PPC x PPL. The better parent heterosis for plant height ranged from -18.64% (WBPF x PPL) to 86.05% (MK x PS). Out of sixty hybrids, forty four hybrids exhibited significant heterosis over better parent (better parent heterosis). Six hybrids showed significant negative better parent heterosis, some superior hybrids of them were PS x GL, WBPF x SR, GL X SR, WBPF X PPL and PPC x PPL. As far as standard heterosis is concerned plant height ranged from -26.15 % % (WBPF x PPL) to 69.74% (GL x MK) of thirty six significant hybrids only nine showed check and twenty seven F_1's showed significant positive standard heterosis. Top F_1's were WBPF x PPC, PPC x PPL, WBPF x SR, IBWL x PS, PS x GL. In general tall and dwarf plants both are desirable in brinjal which is coupled with the fruit and stalk length. Dwarf plants are being exploited particularly for small round group whereas, rest of the group i.e. long, oblong round etc. tall plant will be preferred. In this study heterosis is available for both the direction. Present findings are in agreement with the finding of Babu and Thirumurgan (2000).

Mid-parent heterosis for average fruit weight ranged from -69.06% (PR x MK) to 18.87% (IBWL x PPC). Fifty six out of sixty hybrids showed significant mid-parent heterosis for this trait. Two hybrids exhibited significant positive mid-parent heterosis. The top ranking hybrids were PPL x SR and PPC x IBWL. Better parent heterosis for average fruit weight ranged from -79.47% (SR x MK) to 4.26% (PPC x IBWL). Out of twenty one hybrids, only five hybrids showed significant positive better parent heterosis, top rankers were, SR X PPC, IBWL x PPL, PPC x PPL, PPC x GL, GL x PR and WBPF x SR. The standard heterosis for this character ranged from -84.81 % (PPC x SR) to -39.87% (MK x PPC) all hybrids showing significant negative standard heterosis. Present study showed most of the F_1's are with small are in accordance with findings of Singh *et al.* (2003).

The mid-parent heterosis for marketable fruit yield per plant ranged from -79.15% (WBPF x IBWL) to 81.18% (MK x PR). Out of sixty hybrids seventeen exhibited significant positive mid-parent heterosis for this trait. Highest mid-parent heterosis was recorded by MK x PR, WBPF x PR, MK x PS, PR x PS, MK x PPR. The better parent heterosis over better parent ranged from -79.15% (WBPF x IBWL) to 81.18% (MK x PR). Out of sixty hybrids seventeen exhibited significant positive better-parent heterosis for this trait. The extent of standard heterosis for this character was observed from -52.83% (PS x PPL) to 47.9% (GL x PPL). Forty seven hybrids reported significant standard heterosis and twenty two out of them had positive value for this trait. Highest standard heterosis was observed for GL x PPL, IBWL x PPC, MK X IBWL, PPC X WBPF, WBPF x PR the hybrid, whereas, other twenty five hybrids showed significant negative standard heterosis for marketable fruit yield per plant. Present findings are in accordance with the findings of Deep *et al* (2000), Choudhary (2006), Sunitha and Katharia (2006), Vadadoria *et al.* (2007), Prakash *et al.* (2008). Range of heterosis and top crosses showing significant heterosis for twelve characters in Brinjal given in table 1.

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Table 1 : Range of heterosis and top crosses showing significant heterosis for twelve characters in Brinjal

S. No.	Characters	Range of heterosis (%)		Top crosses showing significant heterosis
		BP	SV	
1	Days to 50% flowering	-9.52-38.64	-13.6-38.64	MKxIBWL, MK x WBPF, MK x PPR
2	Days to first picking	-22.41-30.19	-16.67-(–29.63)	IBWL x PS, MK X WBPF, IBWL x PPR
3	Plant height	-18.64-86.05	-26.15-69.74	WBPF x PPC, GL x PPL, MK x PPL
4	Number of primary branches	-37.78-33.75	–48.89-18.89	GL x MK, IBWL x PPL
5	Average fruit length	–69.94-27.55	-43.18-80.46	PPL x PPR, IBWL x GL, MK x PS, PPL x MK
6	Average fruit girth	-69.91-147.7	-64.95-71.13	IBWL x MK, GL x PPR, GL x MK, MK x PPR
7	Average fruit weight	-79.47-4.26	-84.81-(-39.87)	MK x PPC, MK x PR
8	Total number of fruits per plant	-63.33-471.43	-9.09-845.45	PPC x PR, PPC x SR
9	Total number of fruits per plant per picking	-84.62-266.67	-50.00-345.00	IBWL x PPL , MK x PPL, PPL x PPC, PPL x GL
10	Total fruit yield per plant	-50.24-88.18	-51.37-46.86	GL x PPL, PPC x WBPF, MK x IBWL, GL x PS, PPL x PPC
11	Marketable fruit yield	-79.15- 81.18	-52.83-47.9	GL x PPL, MK x IBWL, GL x PPR, IBWL x GL, IBWL x MK, PPL x WBPF
12	Total Soluble Solids	–32.00-15.22	-24.44-18.44	GL x PS, PPC x SR

BP = Better parent; SV = Standard variety

The estimates of mid-parent heterosis, better parent heterosis and standard heterosis were also obtained for fruit yield and its components. The mid-parent heterosis for this trait ranged from -67.53% (GL x SR) to 24.95% (MK x PPL). Four showed positive mid-parent heterosis and for this trait. The highest mid-parent heterosis was exhibited by MK x PPL, MK x PR, WBPF x PR, PPL x PPC. The better parent heterosis for this trait ranged from -50.24% (PPC x IBWL) to 88.18% (WBPF x PR). Out of sixty hybrids, twenty seven showed significant positive better parent heterosis for this trait. Highest better parent heterosis was reported in WBPF x PR, MK x PPL, MK x PR, PPL x PR, PPL x WBPF. The heterosis over check for total fruit yield per plant was observed from -51.37% (PS x PPL) to 46.86% (IBWL x PPC) (Table 1). Forty nine hybrids showed significant standard heterosis and twenty two out of them had positive value for this trait. Highest standard heterosis was shown by IBWL x PPC, GL x PPL (Table 1), MK x IBWL, IBWL x PPC, PPC x WBPF, WBPF x PR. Present findings are in accordance with the findings of Deep *et al* (2000), Choudhary (2006), Sunitha and Katharia (2006), Vadadoria *et al.* (2007), Prakash *et al.* (2008).

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Persistency of Common Fodder Grasses under *Melia azedarach* based Silvipastoral System

By S.R. Barsila, Naba R. Devkota & I. Barshila

Agriculture and Forestry University, Nepal

Abstract - An experiment was conducted from July 2004 to October 2005 at IAAS Livestock Farm, Rampur under 14 years old *Melia azedarach* tree (maintained 1200 stems/ha) shade to study the dried weight yield potentiality of common fodder grasses, grown with tropical legumes and their persistency. A split Plot Design (SPD) was employed with three replications with three different canopy levels (trees pruned at 3m, 4m and 5m from the ground and one open) as main plots and four forage mixtures as subplots. Shade level was maintained by pruning the trees throughout the experiment. The shade level at the initial phase was measured by LUX-101 Lux Meter (Model No.44147) at August, 2004 and was standardized for low (72%irradiance to open) medium (64%irradiance to open) and heavy (58 % irradiance to open). Number of tillers/plant in fodder grasses decreased as the shade level increased in all the harvests whereas blue panic always had the highest number of tillers/plant ($P<0.001$) in all shade levels. Likewise, cumulative dried weight yield of (2004 and 2005 harvests) fodder grasses also decreased as the shade level increased.

Keywords : fodder grasses, silvipastoral system, melia azedarach, shade level, canopy closure ratio.

GJSFR-D Classification : FOR Code: 070199

PERSISTENCY OF COMMON FODDER GRASSES UNDER MELIA AZEDARACH BASED SILVIPASTORAL SYSTEM

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Persistency of Common Fodder Grasses under *Melia azedarach* based Silvipastoral System

S.R. Barsila [α], Naba R. Devkota [σ] & I. Barshila [ρ]

Abstract - An experiment was conducted from July 2004 to October 2005 at IAAS Livestock Farm, Rampur under 14 years old *Melia azedarach* tree(maintained 1200 stems/ha) shade to study the dried weight yield potentiality of common fodder grasses, grown with tropical legumes and their persistency. A split Plot Design (SPD) was employed with three replications with three different canopy levels (trees pruned at 3m, 4m and 5m from the ground and one open) as main plots and four forage mixtures as subplots. Shade level was maintained by pruning the trees throughout the experiment. The shade level at the initial phase was measured by LUX-101 Lux Meter (Model No.44147) at August, 2004 and was standardized for low (72%irradiance to open) medium (64%irradiance to open) and heavy (58 % irradiance to open). Number of tillers/plant in fodder grasses decreased as the shade level increased in all the harvests whereas blue panic always had the highest number of tillers/plant ($P<0.001$) in all shade levels. Likewise, cumulative dried weight yield of (2004 and 2005 harvests) fodder grasses also decreased as the shade level increased. Nevertheless, the effect of shade was similar ($P>0.05$) Furthermore, highest cumulative dried weight yield was in open condition (63.29 t/ha) followed by low shade 26.50 t/ha (42% to that of open t/ha) whilst, the cumulative dried weight yield in medium shade remained 27% and it was only 21% in heavy shade to that of open. It can be concluded that *Panicum antidotale* can be grown in summer under high density plantations at least for two harvests. The the selection of forage species is more important criterion of silvipastoral work than the maintenance of shade level.

Keywords : fodder grasses, silvipastoral system, melia azedarach, shade level, canopy closure ratio.

I. Introduction

Nepal is one of the countries with the highest livestock density in the world (HMG/N, 2002/03), which shares 32% to Agriculture Gross Domestic Product (AGDP) and is expected to increase by 47% by 2015 AD (APP, 1995). However, the associated shortage of feedstuffs to livestock has been considered important reason for the low productivity, thereby causing the poor household income. The estimated feed deficit in the country is 34% on dry matter (DM) basis and 54.3% in terms of green roughages, annually, to feed the growing ruminants (Pande, 1997; Raut, 1998).The present feed deficit condition both in terms of quality and quantity has not only aggravated the poor household income, but also expected to reduce the trade deficit for livestock and livestock related products (Yadav and Devkota, 2005).

The feed supply from the agricultural land is limited and it hardly further allows going for massive fodder/forage production due to small holdings in nature. Obviously, optimization of the forest related resources in order to satisfy the demand of growing livestock population would be one of the sound alternatives. Development of silvipastoral system is one of them as tree plantings have been common especially in the terai region. Benefits of integration of pastures with plantations have been well documented (Shelton et. al., 1987; Reynolds, 1988), which could be inferred as an alternative to the conventional forage production systems (Anderson, 1991) with many ecological benefits (Barsila, 2008) to reduce the competition between increasing ruminants and human population due to the increased demand of forage resources (Blair, 1991) from the same unit of agricultural land. Development of such agroforestry systems has also been aimed in order to produce both quality and quantity forages as envisaged in twenty years of Agriculture Perspective Plan (APP, 1995), and possibilities of growing some leguminous and non-leguminous forage species under different tree species has also addressed by LMP(1990).

Limited information are available on modality of silvipastoral system mainly in case of tree -fodder integration (Shreshtha et. al., 1996; Devkota, 2000), and scientific information with respect to the morphological adaptations and their persistency particularly to that for trees and associated understorey forage crops, are scanty. Among many multipurpose tree species found in southern plains of Nepal, *Melia azedarach* tree is gaining popularity. Hactares of *Melia azedarach* based plantations are established and the area under the trees is still neglected. The available radiation could also be better exploited for better forage production in the shaded barelands (Healy et. al., 1998), the swards of which not only adds the fresh green matter production but also to the nutritive quality of the forages. This paper aims to determine the effects of shade of mature stands of *Melia azedarach* L. mostly on persistency of tiller production and DM yield.

II. Materials and Methods

The experiment was carried out from July 2004 to October 2005at Institute of Agriculture and Animal

Authors α σ : Agriculture and Forestry University, Rampur, Chitwan, Nepal.
Author ρ : Ministry of Agricultural Development (MOAD), Kathmandu, Nepal. E-mail : ibarsila@gmail.com

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Science, Livestock Farm, Rampur using 14 yrs old *Melia azedarach* L. planted with 5 ×5 m^2 area. The number of stems (trees) in the field were maintained 1200/ha with an average height of 8.5 m, whereas average girth measured at breast height of trees was recorded 12 inches at the end of this experiment. The soil of the research site was sandy loam with organic matter content found 3.59%, whereas soil organic carbon and soil N were 2.1% and 0.1% respectively when employed with Walkey and Black (1934) method. The experiment was conducted using with Split Plot Design (SPD) with three replications. The main plot was tree shade created by pruning trees to the height upto 3, 4, and 5 m from the ground with one open condition, whereas forage mixture as subplots. Grasses were planted at 1X 0.75 m^2 while the legumes were planted in the inter-row of grasses at the rate of 2 kg seed/ha at 5 cm depth. The combination of grasses and legumes in each subplot were as follows:

$T_{1=}$ *Pennisetum purpureum* (Napier) + *Desmodium distortum* (Greenleaf Desmodium)

$T_{2=}$ *Pennisetum purpureum* (Napier)+ *Neonantia weightii* (Glycine)

$T_{3=}$ *Panicum antidotale* (Blue Panic)+*Desmodium distortum* (Greenleaf Desmodium)

$T_{4=}$ *Panicum antidotale* (Blue Panic)+ *Neonantia weightii* (Glycine)

General Agronomic practices were followed without irrigation and fertiization throughout the experiment. The understorey bushes and weeds were cleared once a month, while earthing up was done twice a year for fodder grasses. A fairly similar shade level was maintained in each main plot throughout the experiment by pruning the lowermost branches of *Melia* tree. The shade level at the initial phase was measured by LUX-101 Lux Meter (Model No.44147) at August, 2004 and was standardized for low (72%irradiance to open) medium (64%irradiance to open) and heavy (58 % irradiance to open). The experimental site was also analyzed with respect to canopy closure ratio in the previous year by (Timsina, 2005) and was having 0.64, 0.54 and 0.43 canopy closure ratio respectively for heavy, medium and low shade.

The first harvest of grssses herbage mass was taken above 20 mm separately at 60 days after plantation. Then, the subsequent harvests were taken in the interval of 45 days. The number of tillers/plant was analyzed separately at all harvests. Fresh herbage mass production was sampled on square meter basis, whereas only 100 gm of the fresh herbage from a plot was used to estimate the dry matter yield. The total dry matter production on hectare basis was calculated.

III. Results

The tables provided hereunder represent the average values across the different shade level. The figures for averages according to the forage mixtures have been given in the texts only.

a) Number of tillers/plant

Effect of shade was significant ($P<0.05$) to number of tillers / plant for grasses at 30th July 2004 harvest (Table 1). In general, the number of tillers per plant decreased as the shade level increased. Accordingly, highest number of tillers/plant was obtained for grasses under open condition (41/plant), while it was lowest for heavy shade (8/plant). Among the species, the number of tillers/plant for forage species at medium shade level was in between the open and heavy shade. Blue panic had 77 tillers /plant in open condition, the number was lowest for heavy shade (12 tillers /plant when grown with Desmodium. The trend of obtaining highest tillers/plant by blue panic continued in all shade levels in the order of more tillers in low shade followed by at medium and heavy shade.

At 15th Sept. 2004 harvest, the effect of shade was non-significant ($P>0.05$) to the number of tillers/plant for non-leguminous forages (Table 3). The number of tillers per plant was increased in all shade levels compared to the number of tillers per plant of 30th July harvest compared to the values of 30th July harvest. Accordingly, the number of tillers/plant was increased by 100 %in heavy shade, 73 % in medium shade, 59% in low shade and 85 % in open. The interactive effect of shade on forage mixture had similar effect ($P>0.05$) to the number of tillers/plant.

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Table 1 : Average number of tillers/plant in non-leguminous forages under different levels of *Melia* shade at IAAS Livestock Farm, Rampur, 2004/05

Shade Level	Average no. of tillers /plant			
	Herbage harvested at			
	30-Jul. 2004	15-Sept.2004	30-Jul. 2005	15-Sept. 2005
Heavy	8	16	16	24
Medium	11	19	19	32
Low	17	27	31	50
Open	41	76	48	81
Analysis of variance				
Shade level (df =2)	$P<0.05$	NS	$P<0.001$	$P<0.05$
SEM	3.23	4.39	1.35	3.53
LSD	11.18	15.18	4.68	12.23
Forage mixture (df =3)	$P<0.001$	$P<0.001$	$P<0.001$	$P<0.001$
SEM	4.89	9.12	2.76	6.19
LSD	14.18	26.47	8	17.95
Interaction (df=6)	NS	NS	NS	NS
SEM	8.01	14.37	4.35	9.93
LSD	23.05	41.43	12.54	28.59

Note: NS= No significance difference at P<0.05, SEM=Standard error of mean, LSD=Least significant difference of means at significance level α=0.05, Na=Napier, BP=Blue panic, Des=Desmodium, Gly=Glycine, df=Degrees of freedom, Cumulative* =Cumulative values of all months of 2004 and 2005 harvests

At 30th July 2005 harvest, as well, the effect of shade was highly significant (P<0.001) to number of tillers/plant for grasses. As in the case of previous harvest, highest number of tillers/plant was recorded for open condition (mean value 48 tillers/plant), which was decreased subsequently at low shade (31 tillers/plant), medium shade (19 tillers/plant) and heavy shade (16 tillers/plant) (Table 1). At this harvest also, blue panic always had the highest number of tillers/plant (87 tillers/plant) under open condition when grown with glycine compared to Napier. Napier had the lowest number of tillers /plant in all shade levels (Table 1).The detail of average tiller production and dried weight yield across the dates of harvest has been presented in figure 1.

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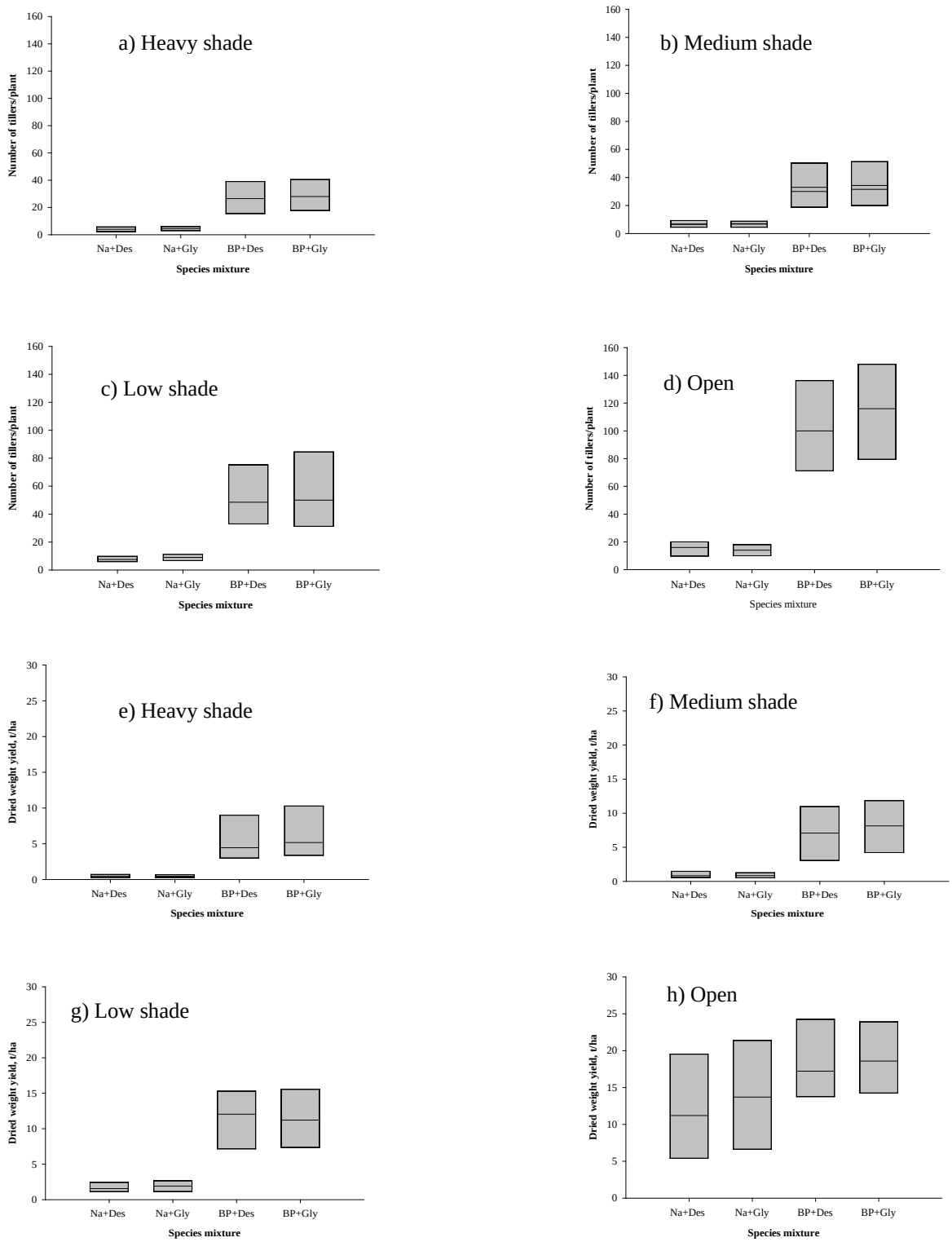

Figure 1 : Average number of tillers and dried weight yield (t/ha) of different grass-legume mixture herbage harvested at 30th July and 15th September in 2004 and 2005. Average values across all harvested displayed

Shade effect remained similar (P>0.05) to the number of tillers/plant for herbage harvested on different dates (Table 1). In general, number of tillers/plant in non-leguminous forages decreased as the shade level increased from low to heavy shade (Table 1). Highest number of tillers per plant was obtained in open (81 tillers/plant) and the lowest in heavy shade (24 tillers/plant).

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b) Dried Weight Yield

At 30th July 2004 harvest, 10.14 t/ha dried weight of non leguminous herbage harvested was obtained for open conditions, whereas in the case of low shade, the value was recorded as 3.92t/ha. Lowest dried weight yield of herbage harvested was 1.51 t/ha in medium shade. Dried weight harvested of blue panic was always highest in all shade levels, whereas the value was 13.98 t/ha in case of open conditions when grown with Glycine. Napier, similarly always had the lowest dried weight compared to the blue panic at all shade levels (Table 2).

The Dried weight yield of grasses at 15th September 2004 harvest was obtained highest for open condition (21.67 t/ha) and the lowest in heavy shade (3.14t/ha). The dried weight reduced ($P<0.05$) as the shade level increased from low to heavy shade Accordingly, dried weight yield of blue panic was always highest in all shade levels followed by napier. The highest dried weight yield in blue panic was found in open conditions (25.82 t/ha) when grown with Desmodium and remained the lowest in heavy shade (5.19 t/ha) (Table 2). At 30th July 2005 harvest, dried weight trend of non leguminous forages mixture and the effect of shade was similar to that of 2004 harvests. Accordingly, highest dried weight of regrowth was obtained for open which subsequently decreased in case of low, medium and heavy shade. However, the dried weight at all shade levels and also the dried weight value of forage mixture decreased for 30th July harvests to that of 2004 harvests (Table 2). Accordingly, the highest dried weight value was limited to 10.45 t/ha for open and 2.16 t/ha for heavy shade (Table 2).

The trend of dried weight yield for grasses at 15th September 2005 harvest was similar to that of previous harvests (Table 2), as well. Highest dried weight yield in open condition was 21.03 t/ha, whereas the lowest value for low shade was 5.78 t/ha. Nevertheless, the effect of shade was similar ($P>0.05$) to all levels of shade. However, the species difference was highly significant ($P<0.001$).The trend of dried weight attained by blue panic remained highest in the order of low shade followed by at medium shade and at low shade respectively (Table 2).

Table 2 : Herbage harvested (above 20 mm regrowth dried weight (t /ha) average of common fodder grasses under *Melia* shade at IAAS, Livestock Farm, Rampur, 2004/05

Shade Level	Dried weight yield of non-leguminous forages , t/ha						
	Herbage harvested at						
	30-Jul 2004	15- Sept. 2004	Total of 2004	30-Jul 2005	15 –Sept. 2005	Total of 2005	Cumulative*
Heavy	1.63	3.14	4.77	2.14	5.78	7.95	12.71
Medium	1.51	4.77	6.28	3.85	6.8	10.65	16.93
Low	3.92	8.32	12.23	5.05	9.21	14.27	26.5
Open	10.14	21.67	31.81	10.45	21.03	31.48	63.29
Analysis of variance							
Shade level (df=2)	*P*<0.05	*P*<0.05	*P*<0.05	*P*<0.05	NS	NS	NS
SEM	0.57	0.81	1.5	0.51	1.36	1.669	2.6
LSD	1.96	2.81	3.67	1.77	4.7	5.776	9.01
Forage Mixture (df =3)	*P*<0.001	*P*<0.001	*P*<0.001	*P*<0.001	*P*<0.001	*P*<0.001	*P*<0.001
SEM	0.53	0.62	1.22	0.57	1.2	1.2	1.4
LSD	1.52	1.81	2.51	1.66	3.48	3.47	4.06
Interaction (df=6)	NS	*P*<0.01	*P*<0.01	NS	NS	NS	P<0.01
SEM	0.97	1.24	2.37	1	2.26	2.45	3.34
LSD	2.81	3.62	4.88	2.88	6.55	7.2	10.08

Note: NS= No significance difference at $P<0.05$, SEM= Standard error of mean, LSD= Least significant difference of means at significance level $\alpha=0.05$, Na =Napier, BP= Blue panic, Des= Desmodium, Gly = Glycine, df =Degrees of freedom, Cumulative* =Cumulative values of all months of 2004 and 2005 harvests

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The dried weight yield total in 2004 was differed according to the shade level ($P<0.05$) which was further dependent on species ($P<0.001$). In overall, the highest dried weight yield attained by blue panic remained in the order of highest in open (31.81 t/ha) followed by low (12.23 t/ha) and medium shade (6.28 t/ha), while it was the lowest for heavy shade (4.77 t/ha). Likewise, the trend of dried weight total of 2005 was similar in trend to that of dried weight total of 2004 harvests. Nevertheless, shade effect was similar ($P>0.05$) in 2005 harvests.

The cumulative dried weight of all months (harvests of 2004 and 2005 total) harvests of non-leguminous forages remained in trend similar to that of 2005 harvests. Accordingly, shade effect remained similar ($P>0.05$) across the shade levels, but the species difference was highly significant ($P<0.001$). Cumulative dried weight yield was 63.29 t/ha in open condition and the lowest was obtained for low shade (12.71 t/ha).The dried yield cumulative for non leguminous forages decreased as the shade level increased (Table 2).The detail of the interactive effect of shade and forages in mixture to the dried weight yield of grasses component in all the harvests has been presented in table (2).

IV. Discussion

Research results based in this study showed that numbers of tillers/plant in grasses was highest ($P<0.001$) in the order for open, followed by low shade. The available results have also well demonstrated that the number of tillers/plant increased for second cut (15th September. harvests) in all shade levels as well as to the open condition. Various environmental factors might influence the vegetative growth of forages under shade. The low temperature at shaded condition could slow down the morphological development. The decrease in number of tillers/ plant in grasses is possibly due to due to the slower rate of photosynthesis (Bahamani *et al.,* 2000; Gautier *et al.,* 1999). Low light intensity could render negative effect to the number of tillers per plant (Auda *et al*., 1966; Devkota, 2000).The differences in the shade condition, forage species grown and the time forages species grown are the likely sources of variation in number of tillers / plant in non-leguminous forages. The increase in number of tillers per plant for non leguminous forages in second cut (15th Sept.) might be due to the defoliation effect (Watt and Haggar, 1980; Krans and Beard, 1985). Paez *et al*. (1997) reported the beneficial effect of defoliation to the number of tillers per plant for *Panicum maximum* under *Eucalyptus grandis* shade which was similar to the condition of harvests of this experiment. Result of this experiment also matches to the findings of Timsina (2005).

Generally, forage availability reduces under tree plantations (Robinson, 1991), especially when trees grow older (Mohd.-Najib 2003). In contrast to the findings of this experiment to the dried weight, Wong and Wilson (1980) on the other hand found increased herbage yields for green panic (*Panicum trichoglume*). Research result showed that dried weight yield, as indicated by dry matter content of non leguminous forages, reduced as the level of shade increased for all the harvests. The main reason for such result could be due to the reduction of photosynthetic rate in shade (Peri *et al.,* 2002). When plants experience a change from high to low irradiance, photosynthesis deactivation process occurs due to a reduction in stomatal conductance (Amundson et. al., 1995) related to an increase in biochemical limitations (Tinoco-Ojanguren and Pearcy, 1993). However, the rate of photosynthesis and stomatal conductance of shade grown forages are not quantified with respect to the dried weight yield in this experiment.

The result of this experiment confirmed the results reported by Timsina (2005) for same species under the same canopy level as dried weight reduced in shade due to reduction in light level (Henderson and Robinson, 1982), would be caused by reduced rate of photosynthesis. The shaded plants attained shorter plant height, tiller number/ plant and number of leaves/plant, which ultimately reduced the dried weight yield. The dried weight yield increased at 15th September harvests in both years could be related to the residual tillers in the field that might have added effect indeed. In terms of species, blue panic, had the highest number of tillers/plant, highest plant height and highest number of leaves per plant which could well contribute to the highest dried weight yield to that of Napier.

V. Conclusion

Results of this experiment revealed the possibilities of growing common perennial fodder grassesunder *Melia azedarach* tree. Blue panic (*Panicum antidotale*) in low shade gave the highest dried weight yield when grown in combination with Greenleaf Desmodium. Summer sowing of blue panic for deciduous based silvipastoral system under high density plantation (heavy shade) at least for two harvests can be recommended. Based on the findings of this experiment it can be concluded that selection of forage species is more important part of silvipastoral study than maintenance of shade as reflected by the changes in tiller density (number of tillers/plant) and dried weight yield.

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Utilization of Some Selected Wood Species in Relation to their Anatomical Features

By Adeniyi, I.M., Adebagbo, C.A., Oladapo, F.M. & Ayetan G.

Forestry Research Institute of Nigeria, Ibadan

Abstract - Anatomical features of some selected wood species were investigated in this study. The microscopic properties such as rays, vessels and fibre dimensions were related to the other properties such as the mechanical properties. This study reflected the implication of large pores in *Ceiba pentandra*, Bombax and some other wood species in printing papers which may require some fillers before they are finished to a smooth surface. The effects of density, small lumen, thick cell wall and some deposits are also presented. Wood micrographs showing microscopic features unique to *Ceiba pentandra, Bombax bounopozense* and *Ricinodendron heudelotii* were included as these anatomical properties could explain the reason why some wood are used for different categories construction purposes, furniture, particle boards, matches, boxes, crates, cabinet making and paper. Small-vessel wood species such as *Nesogordomia papaverifera, Diospyros mespiliformis* and *Mansonia altissima* were also discussed to possess characteristics that have bestowed fine texture and are often heavy and therefore are often used for flooring, tool handles, sculpture (as in *Diospyros mespiliformis*) and other heavy constructional purposes.

Keywords : fibres, vessels, microscopic, moe, and mor.

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UTILIZATION OF SOME SELECTED WOOD SPECIES IN RELATION TO THEIR ANATOMICAL FEATURES

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Utilization of Some Selected Wood Species in Relation to their Anatomical Features

Adeniyi, I.M. [α], Adebagbo, C.A. [σ], Oladapo, F.M. [ρ] & Ayetan G. [ω]

Abstract - Anatomical features of some selected wood species were investigated in this study. The microscopic properties such as rays, vessels and fibre dimensions were related to the other properties such as the mechanical properties. This study reflected the implication of large pores in *Ceiba pentandra*, Bombax and some other wood species in printing papers which may require some fillers before they are finished to a smooth surface. The effects of density, small lumen, thick cell wall and some deposits are also presented. Wood micrographs showing microscopic features unique to *Ceiba pentandra, Bombax bounopozense* and *Ricinodendron heudelotii* were included as these anatomical properties could explain the reason why some wood are used for different categories construction purposes, furniture, particle boards, matches, boxes, crates, cabinet making and paper. Small-vessel wood species such as *Nesogordonia papaverifera, Diospyros mespiliformis* and *Mansonia altissima* were also discussed to possess characteristics that have bestowed fine texture and are often heavy and therefore are often used for flooring, tool handles, sculpture (as in *Diospyros mespiliformis*) and other heavy constructional purposes. An attempt was made to correlate anatomical properties with mechanical properties such as modulus of rupture (MOR) and modulus of elasticity (MOE) while variability in end uses as a result of different microscopic features was also presented.

Keywords : fibres, vessels, microscopic, moe, and mor.

I. Introduction

The thickness of the fibre cell wall is the major factor governing density and strength in wood. Species with thin-walled fibers such as cottonwood (Populus deltoides), basswood (*Tilia americana*), *Ceiba pentandra,* and balsa (*Ochroma pyramidale*) have a low density and strength and are therefore preferred for light construction purposes, whereas species with thick-walled fibers such as *Diospyros spp,* hard maple (*Acer saccharum* and *Acer nigrum*), black locust (*Robinia seudoacacia*), Ipe (*Tabebuia serratifolia*), and bullet-wood (*Manilkara bidentata*) have a high density and strength which have made them useful in heavy construction work. The patterns of rays also account for variations in wood processing and wood utilization. For instance, the rays in hardwoods are much more diverse than those found in softwood, and usually more than one cell wide (though in some species, e.g. *Brachystegia kennedyi* and cottonwood, the rays are exclusively uniseriate and are much like the softwood rays). Variation in anatomical properties is not only observed from one species to the other but also within the same species; within a tree, there are differences in wood properties between the core wood of the tree and the outer wood (Albert *et al.*, 2004). This variability reflects in wood utilization. There is a particular pattern of axial parenchyma uniquely present in each wood species, which is more or less consistent from specimen to specimen, and these cell patterns are very important in both wood identification and utilization (Alex and Regis, 2000), yet histological features of wood, the wood chemical components and its mechanical properties vary from pith to bark, from tree base to the top, from the stem to the branches and roots (Rupert, 2002).

Authors α σ ρ ω : Department of Forest Products Development and Utilization, Forestry Research Institute of Nigeria P.M.B 5054, Forest Hill, Jericho Estate, Ibadan, Oyo-State of Nigeria, Ibadan.
E-mail : micifad@gmail.com

II. Variability of End Uses

Woods of different species from the same genus often have different properties and perform differently under various conditions. Serious problems can develop if species or genera are mixed during the manufacturing process and in use. In order to understand the behaviour of wood in service it is essential to begin with an understanding of the structure and variability of the cells that different wood species are made of. The arrangement, distribution and sizes of wood cells are not the same for every wood. Wood deposits (such as gum and resin), cell wall thickness and pore size are not the same in all wood species. While gum veins is often a natural protective response to injury in most Eucalyptus, gum deposits in some wood species have been found useful in the production of adhesives by the appropriate industries. The dense fibres of *Xylia dolabridormis* are plugged with gum and this makes the wood resistant to wear and thus it is excellent for flooring. The gum resins in *Lignum vitae* is also believed to make the wood self lubricating so that it can be useful for pulley blocks and for pushing the propeller shafts of ships, while gum deposits in the wood of Indian rosewood (*Dalbergia spp*) have been found to pose problems. Kaiser (2003) stated that logs with calcerous deposits are more prone to checking. Wood deposits can shorten the life span of cutting surfaces, and at the finish stage, although coloured deposits in the pores dissolve when solvents containing alcohol are used, and as a result, this can lead to stains. Some wood species glue and finish well but can create

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stain as a result of gum deposits which Balakrisman (2010) mentioned as being promoted by poor soils, drought and other hostile situations. The differences in wood structure and properties allow for the manufacture of wood-based products with many different appearances and uses. For example, a barrel manufacturer tells the difference between red oak, which does not hold liquids, and white oak, which does. Each species has unique cellular structure that creates differences in wood properties and ultimately determines the suitability for a particular use. Therefore, it is necessary to study wood features because specific features in some wood species have suggested them for certain end uses as indicated earlier. Other hardwood species like *Gmelina arborea* was found appropriate for pulp and paper making after investigation into its fibre characteritics.

III. Microscopic Features

The mean tangential diameters (MTDs) of *Ceiba pentandra, Bombax bounopozense, Terminalia superba, Terminalia ivorensis, Milicia excelsa, Tectona grandis, Gmelina arborea, Triplochiton scleroxylon, Ricinodendron heudeolotii, Lophira alata, Afzelia africana* and *Nauclea diderrichii* are over 200 μm, in fact, those of *Ricinodendron heudeolotii*, *Bombax bounopozense* and *Ceiba pentandra* are well over 300 μm. The implication of this is that such wood species have large pores; while the pore sizes of *Nesogordomia papaverifera, Mansonia altissima* and *Diospyros mespiliformis* are small to medium (Table 1). The vessel diameter for *Ceiba pentandra* and *Bombax bounopozense* are 387.75μ and 318.56μ respectively; *Nesogordomia papaverifera* is less than 100μ, while *Diospyros mespiliformis* and *Mansonia altissima* both have 119.04μ and 127.72μ respectively. The mean tangential diameter and cell wall thickness of the wood species are also presented in table 2, while Figures 1-6 show the wood micrographs of some wood species.

Table 1 : Anatomical features and strength properties of selected wood species

Wood Species	MTD (μ)	Fibre diameter (μ)	Cell wall (μ)	Lumen Width (μ)	Runkel ratio	Density at 18% (kg/m^3)	MOR (N/mm^2)	MOE (N/mm^2)	Strength group
Diospyros mespiliformis	119.04	17.41	5.41	6.59	1.64	864	28.00	12,500	N2
Nauclea diderrichii	215.08	29.34	7.29	14.76	0.98	800	35.50	15,000	N1
Tectona grandis	241.24	33.40	8.50	16.40	1.04	640	22.4	10,600	N3
Triplochiton scleroxylon	234.47	18.00	4.00	10.00	0.80	384	11.20	6,300	N6
Terminalia superba	262.00	32.00	8.00	16.00	1.00	464	11.2	6,300	N6
Afzelia Africana	206.20	23.60	5.73	12.30	0.93	864	28.00	12,500	N2
Ceiba pentandra	387.75	37.51	3.54	30.43	0.23	378	11.20	6,300	N6
Mansonia altissima	127.72	28.16	6.24	15.68	0.80	672	22.4	10,600	N3
Gmelina arborea	212.00	38.60	5.10	28.40	0.36	512	14.00	7,500	N5

MTD = mean tangential diameter
Density, MOR and MOE values are dry basic stresses from Nigeria Code of Practice (NCP 2), 1973.

Table 2 : Correlation between Anatomical features and strength properties of timber species

	MTD	*Fibre diameter*	*Cell wall*	*Lumen*	*Rr*	*Density at 18%*	*MOR*	*MOE*	*Strength group*
MTD	1								
Fibre diameter	0.563838	1							
Cell wall	-0.24424	0.169884	1						
Lumen	0.657487	0.904569	-0.26641	1					
Rr	-0.65295	-0.69774	0.451107	-0.87826	1				
Density at 18%	-0.67544	-0.41527	0.352079	-0.55594	0.671688	1			
MOR	-0.54833	-0.3293	0.381926	-0.48565	0.571193	0.932862	1		
MOE	-0.56447	-0.3245	0.388154	-0.48363	0.572581	0.939295	0.999302	1	
Strength group	0.609365	0.320711	-0.39696	0.483606	-0.58132	-0.95581	-0.98889	-0.99369	1

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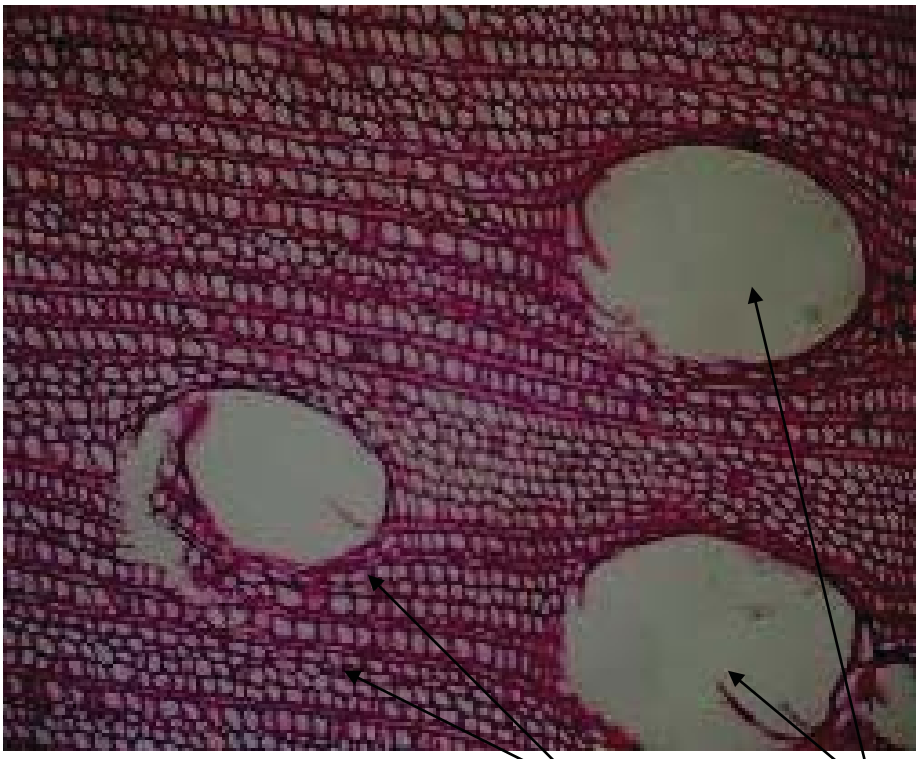

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Figure 1 : Ricinodendron heudelotii (Tr. Sec.) Thin fibre wa Large pores

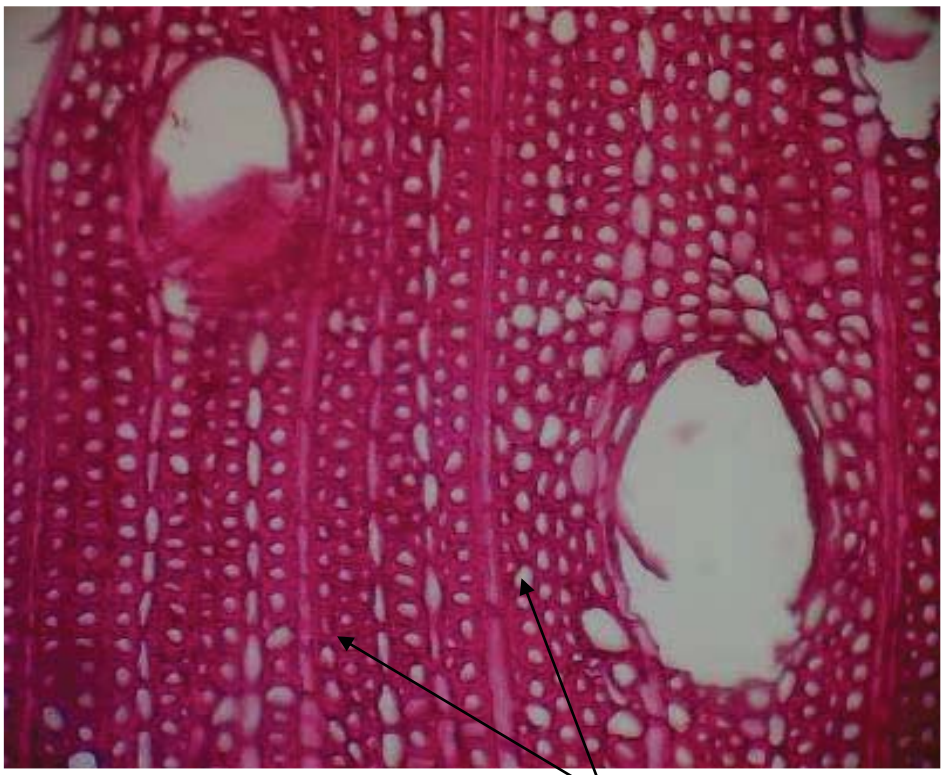

Figure 2 : Nauclea diderrichii (Tr. Sec.) Thicker fibre walls

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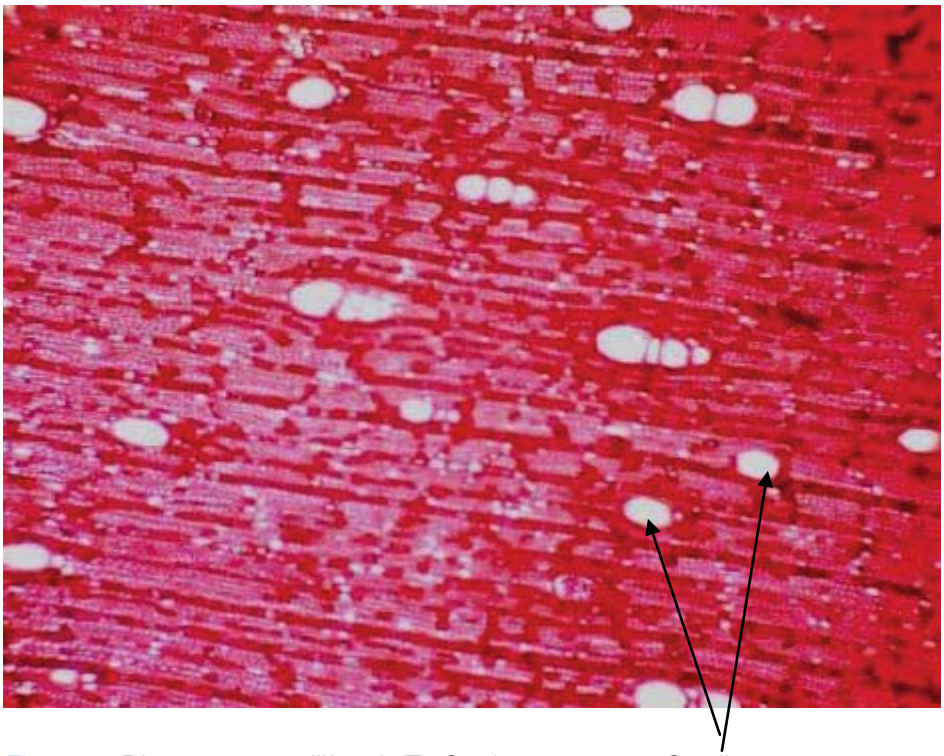

Figure 3 : Diospyros mespiliformis (Tr. Sec.)

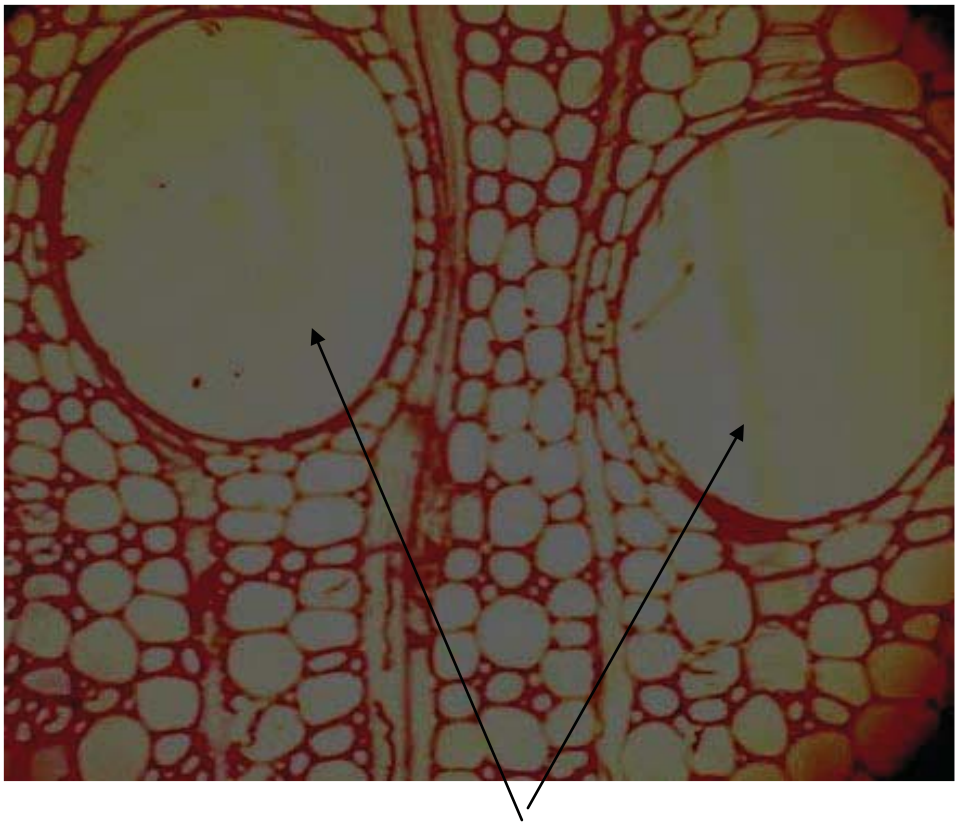

Figure 4 : Ceiba pentandra (Tr. Sec.)

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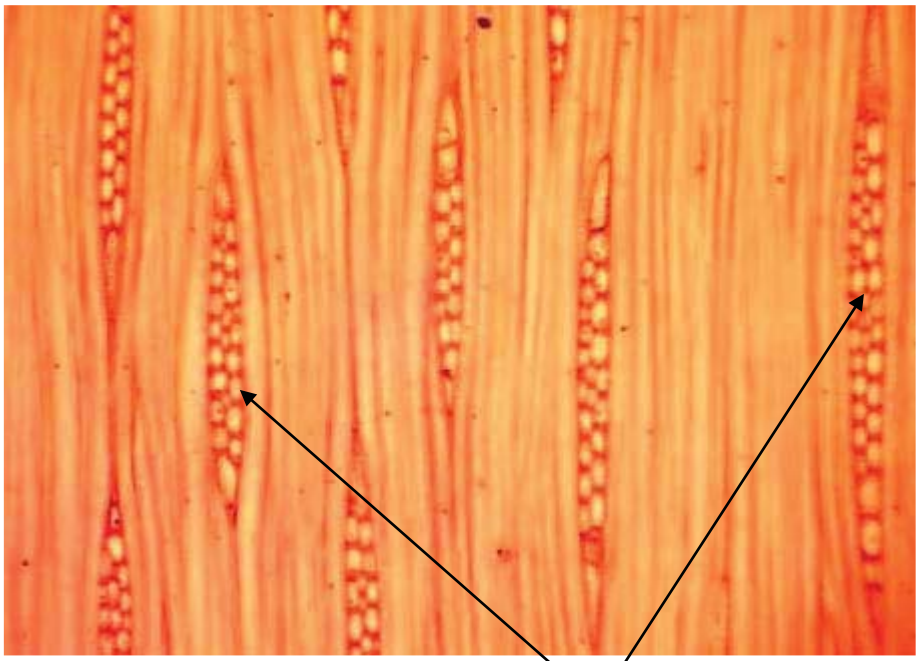

Figure 5 : Terminalia ivorensis (TLS) Multi-seriate rays

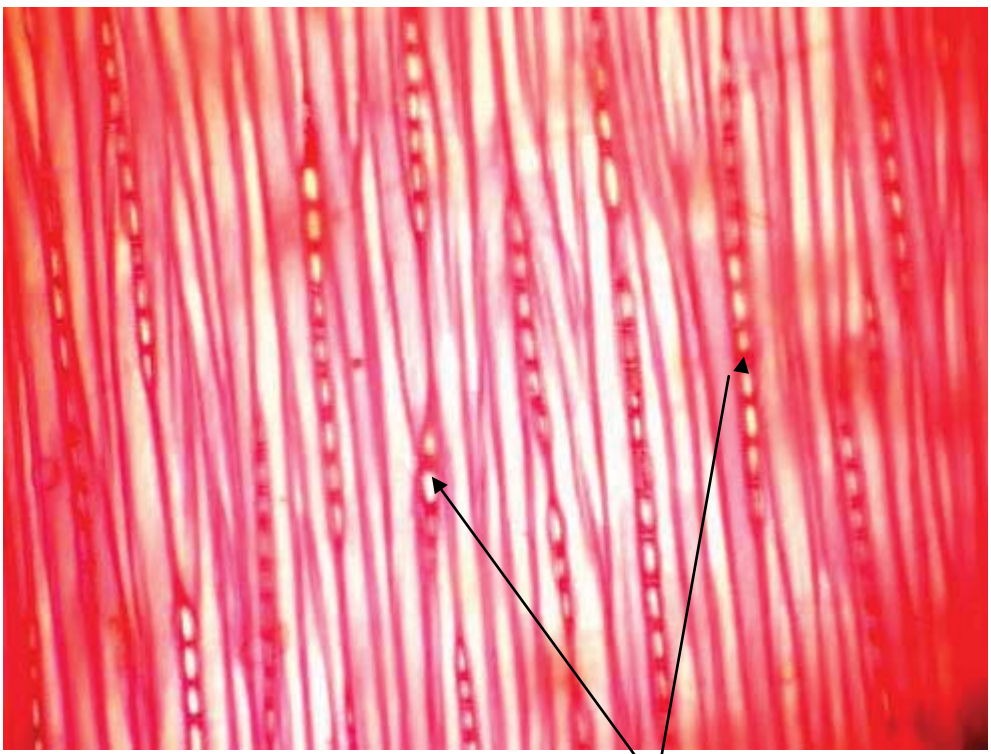

Figure 6 : Terminalia superba (TLS) Uniseriate rays

IV. Implications of Wood Features to Wood Utilization

Karl (1984) reported that wood species with large vessels, such as *Ceiba pentandra* and Bombax for instance, may not be good for printing papers. Such wood species with large pores also require some fillers before it is finished to a smooth surface; moreover, species with large pores (e.g. *Ceiba pentandra*) are usually easily attacked by beetles because their eggs are usually laid in the pores after feeding on the starchy contents of the sapwood. Generally, wood with large pores are light, and of coarse texture e.g. *Triplochyton scleroxylon, Ceiba pentandra, Bombax bounopozense*

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and *Ricinodendron heudelotii.* This could explain the reason why they are used for light construction purposes, lightweight furniture, particle boards, matches, boxes, crates and cabinet making. Small-vessel wood species include *Nesogordomia papaverifera, Diospyros mespiliformis* and *Mansonia altissima*. This characteristic has bestowed fine texture upon the wood species which are often heavy and are often used for flooring, tool handles, sculpture (as in *Diospyros mespiliformis*) and other heavy constructional purposes. *Terminalia superba* can be easily worked but has a tendency to split when nailed or screwed (Lamprecht,1989); this attribute could be explained on the basis of large rays possessed by the wood species. Wood with large rays are not easily nailed at their ends without splitting; in most cases, they are pre-bored before nailing as also witnessed in *Sterculia rhinopetala* (Okeke, 1975), though such wood species often season easily but split along their rays, and if quarter-sawn, they serve as figure and add a lot of beauty to the wood. Some wood species like *Lophira alata*, *Nauclea diderrichii* and *Diospyros mespiliformis* are thick-walled to medium wall. Such timber are very heavy (e.g *Lophira alata*) in weight and often have high specific gravity. Hence, if the cell wall is thick and the fibres have little lumen, the wood species are often used for heavy constructional purposes like *Lophira alata* is being used for railway sleepers and wood flooring. Thick-walled fibres are able to transmit more stress, but are difficult for adhesive to penetrate; the small lumens, thick walls , and narrow pit openings between fibres, all restrict adhesive flow into the wood and usually result in adhesive penetration only one or two fibres deep. Such shallow penetration may be inadequate. High specific gravity may result in poor gluability and low dimensional stability (Choong et al, 2000). On the other hand, wood with very thin fibre wall and wide lumen (e.g. *Ceiba pentandra, Bombax bounopozense* and *Ricinodendron heudeloti*) usually have their specific gravity about 0.25-0.5 and are very light. The wood micrographs showing some features related to wood utilization are presented from figures 1 to 6. Wood with gum deposits include *Afzelia africana, Termilania ivorensis, Nauclea diderrichii* and *Milicia excelsa* that may not be useful in the plywood industry owing to the presence of gum deposit as gum deposits interfere with wood gluability; Dillip (1963) stated that timber for plywood industry should be free from gum. The differences in the anatomical structures of *Terminalia superba* and *Terminalia ivorensis* affect their utilization. *Terminalia superba* had more of uniseriate rays, more abundance of thin-walled axial parenchyma cells that surrounded the vessels than that of *Terminalia ivorensis*. Past work in Forestry Research Institute of Nigeria, Ibadan revealed that these features of *Terminalia superba* accounted partly for the better longitudinal penetration in the wood species (*Terminalia superba*) as copper-chrome-arsenate (CCA) preservative penetrated deeper than in *Terminalia ivorensis* that possessed multiseriate rays, and more of gum deposit in the vessels which blocked the pathway against longitudinal penetration of preservative. Correlation between the anatomical structures (viz pores and cell wall) and strength properties such as density, modulus of rupture (MOR) and modulus of elasticity (MOE) shows that there is a positive correlation between vessel sizes and strength groups (Table 2); which suggests that strong wood species have less size of pores. A positive correlation is also observed between the cell wall thickness and density, MOE and MOR, while a negative correlation is recorded between the cell wall and strength groups.

Among the wood species indicated in table 1, *Triplochiton scleroxylon*, *Ceiba pentandra* and *Bombax* are thin-walled; this feature influences their strength properties (density, MOR and MOE); they also possess large pore size. Table 3 shows that there is a negative correlation between pore size (MTD) and other features like cell wall, density, MOR and MOE. This suggests that the larger the pore size the lower the strength properties of the wood. This negative correlation between MTD and strength properties was in agreement with the findings of Jacobsen et al.(2007) and Hugo et al, (2009) that stated that variation in wood density is mainly driven by variation in fibre lumen diameter which is directly related to cell size and to cell wall thickness.

V. Conclusion

Wood anatomical properties, when studied and put into consideration, are good indices that may guide owners of various wood species for their respective objectives. Vessel diameter, cell wall thickness, density and other indices such as the wood deposits are important areas of consideration before wood utilization. Some hardwood species are thin-walled, some are of medium size, while others are thick-walled, with or without abundance of tyloses, crystals, gum and resins. In any case, different features exhibited by various wood species have made the Nigerian wood species useful in different areas of application.

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Limitations to the Adoption of Recommended Aquaculture Production Technologies by small Scale Fish Farmers in Oyo State Nigeria

By Ashley-Dejo S. S, Olaoye, O. J, Fakoye, E. O, Ikeweinwe, N. B, Idowu, A. I, Bolarinwa K. K & Adelaja O. A

Federal University of Agriculture, Abeokuta

Abstract - The study was designed to identify the limitations to the adoption of recommended aquaculture production technologies by small-scale fish farmers Oyo State. A structured interview schedule was utilized in obtaining information from two hundred and twenty two respondents. Data were analysed descriptive and inferential statistics. The study revealed majority (49.1%) of the respondents were with the economic active age and mostly males (84.2%). Constraints perceived by most of the farmers include high cost of fish feed and market price fluctuation (100%), high cost/lack of construction equipment (96.0%), non-availability/high cost of quality fish seed (90.1%) and preservation and storage facilities (75.2%). Chi square analyses showed that there is a significant association between adoption of innovation and sex ($\chi^2 = 2.16$, $p < 0.05$), educational level ($\chi^2 = 9.30$, $p < 0.05$), occupation ($\chi^2 = 4.81$, $p < 0.05$) and marital status ($\chi^2 = 5.32$, $p < 0.05$).

Keywords : limitations, oyo state, small scale farmers, technologies.

GJSFR-D Classification : FOR Code: 300703, 300799

LIMITATIONS TO THE ADOPTION OF RECOMMENDED AQUACULTURE PRODUCTION TECHNOLOGIES BY SMALL SCALE FISH FARMERS IN OYO STATE NIGERIA

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Limitations to the Adoption of Recommended Aquaculture Production Technologies by small Scale Fish Farmers in Oyo State Nigeria

Ashley-Dejo S. S [α], Olaoye, O. J [σ], Fakoye, E. O [ρ], Ikeweinwe, N. B [ω], Idowu, A. I [¥], Bolarinwa K. K [§] & Adelaja O. A [χ]

Abstract - The study was designed to identify the limitations to the adoption of recommended aquaculture production technologies by small- scale fish farmers Oyo State. A structured interview schedule was utilized in obtaining information from two hundred and twenty two respondents. Data were analysed descriptive and inferential statistics. The study revealed majority (49.1%) of the respondents were with the economic active age and mostly males (84.2%). Constraints perceived by most of the farmers include high cost of fish feed and market price fluctuation (100%), high cost/lack of construction equipment (96.0%), non-availability/high cost of quality fish seed (90.1%) and preservation and storage facilities (75.2%). Chi square analyses showed that there is a significant association between adoption of innovation and sex ($\chi^2 = 2.16$, $p < 0.05$), educational level ($\chi^2 = 9.30$, $p < 0.05$), occupation ($\chi^2 = 4.81$, $p < 0.05$) and marital status ($\chi^2 = 5.32$, $p < 0.05$). It was concluded that efforts should be made by extension agents to design programmes aimed at co-opting small scale fish farmers towards achieving a mass adoption of recommended aquaculture production technologies.

Keywords : limitations, oyo state, small scale farmers, technologies.

I. Introduction

Aquaculture has been contributing to food supply and improving health and income levels for centuries through commercial operations that supply urban markets, households, and rural communities. The farming of fish in ponds is an ancient practice, as the earliest known as pond fish culture are from China, some 4,000 years ago (Messrs *et al.,* 2000). Aquaculture is a relatively new industry in most developing countries, being between 20 and 50 years old, but has developed significantly in the last 20 years. Edwards and Demaine (1997) argue that this recent growth in aquaculture is due to the growing human populations and the diminishing supply of products caught from the wild. This diminishing supply is caused by over fishing of some species and environmental degradation.

Authors α ω ¥ χ : Department of Aquaculture and Fisheries Management, Federal University of Agriculture, Abeokuta.
E-mail : adeolu247@yahoo.com
Author σ : Agricultural Media Resources and Extension Centre, Federal University of Agriculture, Abeokuta.
Authors ρ § : Departmnet of Agricultural Extension and Rural Development, Federal University of Agriculture, Abeokuta.

Aquaculture presents many opportunities for development initiatives its objectives range from food production, income generation, and wild stock enhancement to recreational uses (Haylor and Bland, 2001). Beside aquaculture's contribution to food production, it creates employment in the rural areas. The employment generated by fish farming in the world has increased over the years; from 3.8 million in 1990 to 7.5 million workers in 2000 (New, 2003).

In 2002, the world's total fishery production was put at 133 million tonns (Vannuccini, 2004) while production from world capture fisheries amounted to 93.2 million tonns. This represents a slight increase of 0.4 percent compared with 2001, but a decline of 2.4 percent from 95.5 million tonns produced in 2002. However, evidence indicates that in many areas of the globe, fishery management is falling (Cichrame, 2000). The management of the fishery industry has not achieved its goal of employment and social peace. This is because the system is not operating in a sustainable and efficient manner (FAO, 2005). Over the years, however, efforts have been made to develop new technologies, which have been introduced to the industry. This has led to more fish being caught, but adversely this resulted in the overexploitation of fisheries (MacLennan, 1995). The global fisheries production data is not a true reflection of the development in some of the regions of the world. The Less Developing Countries (LDCs) have been experiencing serious decline in production in recent years. Per capita fish supply in the LDCs is still relatively low at an estimated 8.5kg in 2001 where as in, industrialized countries it is 13.2 kg (Greenfacts, 2004).

Animal protein is very essential for the growth, development and maintenance of human life especially because it contains all the essential amino acids needed for this purpose. Shortage of protein, particularly those of animal origin is prevalent in most parts of Africa where it is estimated that on the average, 10g of animal protein is consumed per day compared to a recommended daily intake of 35g (FAO, 1986). Obioha (1992) observed that the level of consumption of meat and animal protein in Nigeria is estimated at about 8g per caput per day, about 20g less than the minimum requirement by the National Research Council of the United States of

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America. In order to ensure adequate supply of protein to the rapidly growing population of Nigeria, the output of animal products has to be increased especially by short cycle animals such as rabbits, poultry and pigs (Ozor and Madukwe, 2001).

Nigeria with a population of approximately 140.7 million and 3.2% annual growth rate (2006 census) is multi-ethnic. Despite the abundance fisheries resources and the relatively high consumption of fish in Nigeria that is the largest simple consumer of fish products in Africa (FDF, 2005; 2008), its domestic output of 0.62 million metric tonns still falls short of demand of 2.66 million metric tonns (FDF, 2008). A supply of deficit of 2.04 million metric tonnes is required to meet the ever increasing demand for fish in Nigeria. This large deficit between the demand and supply of fish is augmented by massive importation of frozen fish and consequently effect on the exchange earnings of the national economy as well as caput consumption 9.68kg/ head/year (FDF, 2008). The species imported are mainly herring, mackerel and stock-fish to offset the deficit of 2.04 million metric tonns. Quantity of fish imported rose from 557,884.00 tonns to 739, 666.12 tonns between 2000 and 2007. The amount of foreign exchange on fish importation also rose from US$ 241,066.54 million in 2000 to US$ 594,373.69 million in 2007. Nigeria is a large importer of fish with official records indicating 681,000 metric tonnes while export in 2008 was 0.065 million metric tonns and valued at US$40.5 million. The local supply consists of productions from the artisanal (89.5% - 85.5%), industrial (5% - 2.5%), and aquaculture (5.5% - 12.0%) sub-sectors (FDF, 2009). However, it has been shown that Nigeria can substitutes fish importation with domestic production to create jobs, reduce poverty in rural and peri-urban areas where 70% of the population live and ease the balance of payment deficits (Areola, 2007; FDF, 2005, 2009).

The study was therefore designed to find out in detail, the major limitations to the adoption of recommended aquaculture production technologies by small scale fish farmers in Oyo State. Specifically, the study was designed to:

1. identify the socio-economic characteristics of the respondents;
2. determine the level of awareness and rate of adoption of recommended aquaculture production technologies;
3. identify the major limitations confronting adoption of recommended aquaculture production techno-logies;

a) Hypothesis of the Study

Ho_1: There is no significant relationship between the socio-economic characteristics of the fish farmers and adoption of recommended aquaculture production technologies.

II. Methodology

a) The Study Area

The study was conducted in Oyo State South - West Nigeria. Oyo State is one of the thirty-six states of the Federal Republic of Nigeria. It came into existence with the break-up of the old Western State of Nigeria during the state creation exercise of 1976. Ibadan, the capital which is reputed to be the largest indigenous city in Africa, South of the Shara, had been the centre of administration of the old Western Region since the days of the British colonial rule in Nigeria.

The state has an estimated population of over 5,591,589 million people (N.P.C, 2006). The state is located in the rainforest vegetation belt of Nigeria within longitude $7^0 23' 47''$N and $3^0 55' 0''$. It is bounded in the south by Ogun State and in the north by Kwara State, in the west by the Republic of Benin while in the east it is bounded by Osun State (Figure 1). Oyo state exhibits the typical tropical climate of averagely high temperatures, high relative humidity and generally two rainfall maxima regimes during the rainfall period of March to October. Oyo State now consists of thirty three Local Governments and the capital of the state is Ibadan. The main occupations of the people in the state are: Agriculture which is the mainstay of the economy of the State. The tropical nature of the climate favours the growth of variety of food and cash crops are yam, maize, cassava, millet, plantain, banana, rice and fishing.

It is concerted efforts to revitalize agriculture in the state and thereby boost food production, the State Government has established the sate-wide Oyo State Agricultural Development Programme (OYSADEP), which is an offshoot of the defunct Oyo North Agricultural Development Project (ONADEP). According to OYSADEP, Oyo State was divided into four Agricultural extension zones namely: Ibadan/Ibarapa, Ogbomoso, Oyo and Saki.

b) Sampling Procedure and Sample Size

Multi-stage random sampling technique was used for the selection of two hundred and twenty two (222) fish farmers throughout the four extensional zones. In stage 1, 60% extensional blocks from each of the four zones to give a total of 16 blocks were purposively selected for the study. In stage 2, from each of the selected extensional blocks 60% were also randomly selected to give a total of 79 circles in all the selected blocks. In stage 3, from each circle, 60% fish farmers were selected using simple randomly sampling techniques to give a total of 222 fish farmers. Thus a total number of two hundred and twenty (222) fish farmers were selected throughout the four extensional zones.

A structured interview schedule was used in obtaining relevant information from the respondents.

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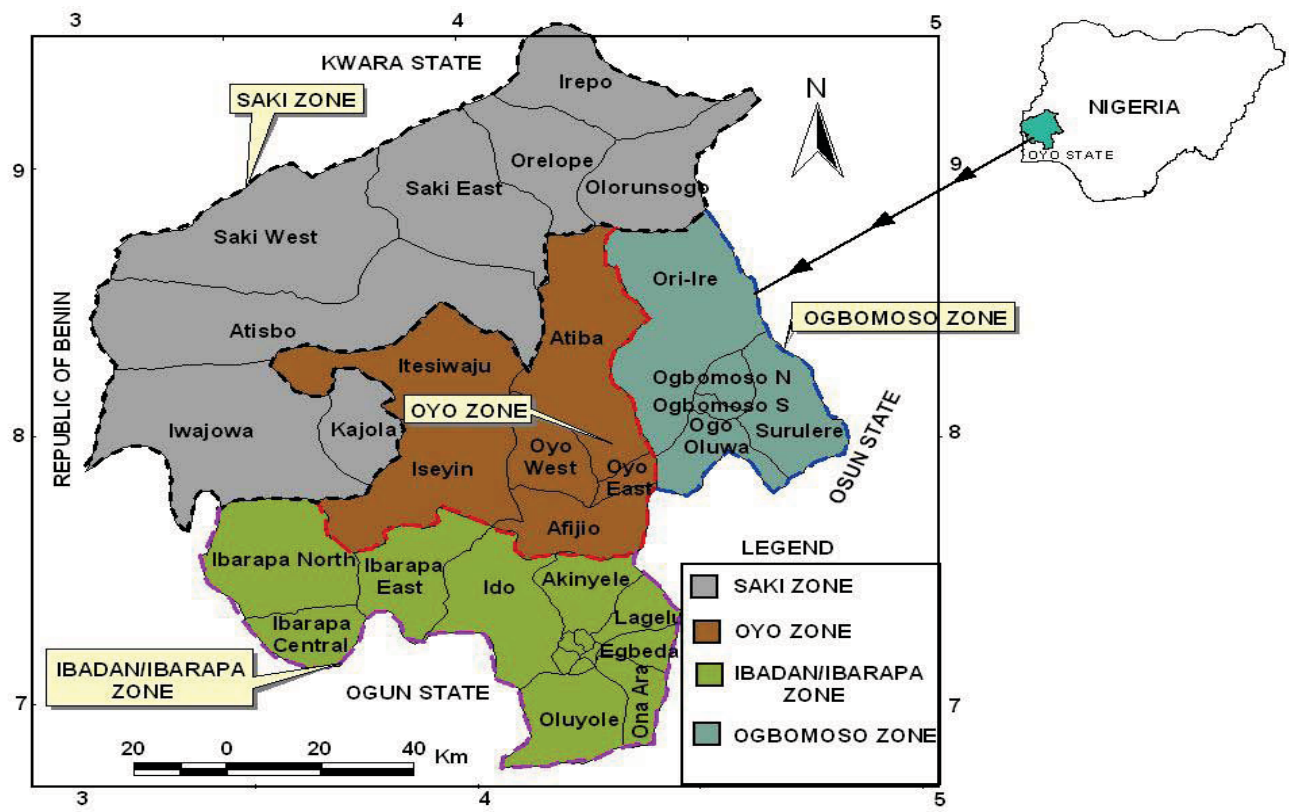
The Variables considered under the personal characteristics of the respondents included: age, sex, marital status, educational level, years spend in school, religion, household size, other occupation, and fish farming experience. A four (4) point Likert type scale was developed and used to determine the extent to which the constraint factors listed posed a hindrance or limitation to the adoption of recommended aquaculture production technologies. The response options and values assigned were as follows: very serious = 0; serious = 1; not a problem = 2; I don't know = 3.In order to ascertain the level of adoption by the respondents, technologies from the production recommendations on aquaculture production practices from Oyo State Agricultural Development Programme (OYSADEP) were adapted. Adoption scores were calculated by using seven stages of adoption that were rated as follows: aware (yes) = 0, aware (no) = 1, adopted (yes) = 2, adopted (no) = 3, full adoption = 4, partial adoption = 5 and discontinuance = 0.Data obtained from the field was subjected to descriptive (Frequency counts, Percentage and Mean).



(Source: Field Survey, 2011).

Figure 1 : Oyo State ADP Zones & Blocks showing study location

III. Results and Discussion

a) Socio-economic characteristics of small scale fish farmers from Oyo State

Table 1 shows the distribution of fish farmers with respect to their socio economic characteristic. Most (49.1%) of the fish farmers fall within the age bracket of 41 – 50 years, 37.8 percent fall within 31 – 40 years, 8.1 percent were above 50 years of age while 2.0 percent fell within the age range of 21 – 30 years. This age bracket is a productive age which portends better future for catfish production also it is considered as economically active age (Olowosegun*et al.*, 2004). This indicates that very few young and old people are involved in fish farming. This is because fish farming requires adequate attention and a lot of sense of responsibility.

Sex plays a very important role in fish farming and agriculture, in terms of property acquisition, for example, fixed assets like land and machines. Majority (84.2%) of the fish farmers were male while 15.8 percent were female. This result can be justified by the assertion of Brummett*et al.*, (2010) that fisheries activities are mostly dominated by men. Ekong, 2003 pointed out that marriage in our society is highly cherished. This ascertain was further confirmed by the report of Fakoya (2000) and Oladoja*et al.,* (2008) who assert that marriage confer some level of responsibility and commitment on individual who are married. In this study, it was discovered that majority of the farmers were

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married (46.1%) while very few were single, widowed and separated. Respondents without formal education were 3.2 percent while 87.3 percent had tertiary education. This means that fish farming is dominated by the educated class and mostly by those armed with high level of education. This is so because fish farming requires a lot of technical and scientific knowledge to be successfully undertake. Majority (58.1%) spent above 15 years in school, 23.0 percent spent between 11 – 15 years while 14.4 percent spent. It was found that, majority (53.2%) of the fish farmers were Christians, 43.2 percent of them practiced Islam while 3.6 percent were traditional worshippers. The mean household size was found to be 9 people per household. This was an indication that the more educated and urban-based an individual is, the less family-size that individual will keep (Yarhere, 2004). Based on farmer's response during field survey, it was discovered that some of the respondents engaged in other occupation apart from fish farming. Occupation remains valid in our society as people have one or two things they engaged in which gives them sense of satisfaction and belonging in the society. Assessing the occupational status of the respondent, majority (63.1%) of the fish farmers engaged more in other farming actives part from fish farming than any other occupation. It revealed that 40.5 percent had fish farming experience ranging between 11 – 15 years, 35.6 percent had between 5 – 10 years, and 15.8 percent had less than 5 years while 8.1 percent had above 15 years experience in fish farming. As a result, the respondents with the highest number of years of experience should have good skill and better approaches to fish farming business. The respondents with longer years of experience were also able to forecast market situation in which they sell their products at higher prices. Those with less years of experience, especially with less than 5 years faced many risks in the early days of their fish farming business. Majority (67.6%) of the respondents purchased the land they are using for fish farming, 23.0% rented the land, while 7.7% and 1.8% got the land through inheritance and gift respectively.

Table 1 : Percentage distribution of the socio-economic characteristics of small scale fish farmers in Oyo states (N = 222)

VARIABLES	FISH FARMERS Frequency	Percentage (%)	Mean($\overline{X}$) / Mode	Std
Age (years)				
Bellow 20	0.0	0.0		
21-30	11	5.0		
31-40	84	37.8		
41-50	109	49.1		
Above 50	18	8.1		
Total	**222**	**100.0**	**46**	**0.709**
Sex				
Male	187	84.2		
Female	35	15.8		
Total	**222**	**100.0**	**Male**	**0.365**
Marital Status				
Single	25	11.3		
Married	169	76.1		
Widowed	20	9.0		
Separated	8	3.6		
Total	**222**	**100.0**	**Married**	**0.588**
Educational status				
No formal Education	7	3.2		
Adult Education	0	0.0		
Primary Education	44	19.8		
Secondary Education	62	27.9		
Tertiary Education	88	39.6		
Others	21	9.5		
Total	**222**	**100.0**	**Tertiary**	**0.670**
Number of years spend in school				
1 – 5	10	4.5		
6 – 10	32	14.4		
11 – 15	51	23.0		
Above 15	129	58.1		

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Total	222	100.0	16	0.866
Religion				
Christianity	118	53.2		
Islam	96	43.2		
Traditional	8	3.6		
Total	222	100.0	Christianity	0.569
House Hold Size (Persons)				
1 – 3	35	15.8		
4 – 7	152	68.5		
8 – 11	35	15.8		
Total	222	100.0	6	0.563
Other Occupation that Generate Income apart from Fish Farming				
Farming	140	63.1		
Civil service	40	18.0		
Trading	20	9.0		
Vocational job	22	9.9		
Total	222	100.0	Farming	0.670
Fish Farming Experience (Years)				
Less than 5	35	15.8		
5 – 10	79	35.6		
11 – 15	90	40.5		
Above 15	18	8.1		
Total	222	100.0	9.3	0.850

Source: Field Survey, 2011.

b) Awareness, adoption and level of adoption of recommended aquaculture production technologies by fish farmers

The technologies examined in this study were as follows:

i. *Culture System*

Entries in table 2 shows that majority (87.4%) of the respondents was aware of culture system, 78.8 percent adopted the practice, 51.8 percent fully adopted the practice and 17.1 percent partially adopted the practice while 9.9% discontinue the use of culture system.

ii. *Pond Site Selection*

It was found that 95.0 percent of the respondents were aware of pond site selection, 94.1percent adopted the practice, 45.5 percent fully adopted the practice, and 33.3 percent partially adopted the practice while 15.3 percent discontinue the use of pond site selection.

iii. *Pond Construction*

The result shows that majority (97.7%) of the respondents was aware of pond construction system, 91.4 percent adopted the practice, 64.9 percent fully adopted the practice and 22.1 percent partially adopted the practice while 4.5 percent discontinue the use of pond construction system.

iv. *Pond Installation System*

Majority (89.2%) of the respondents was aware of pond installation system, 77.9 percent adopted the practice, most (45.5%) of the respondents fully adopted the practice, 26.6 percent partially adopted the practice while about (5.9%) discontinue the use of pond installation system.

v. *Fish Pond Netting to Control Pest*

Out of 222 fish farmers interviewed, all of the respondents (100%) were aware and adopted the use of fish pond netting, 80.6 percent fully adopted the practice, 19.4 percent partially adopted the practice.

vi. *Application of Lime*

Result from table 2 revealed that majority (100%) of the respondents was aware of lime application, about 80.6 percent adopted the use of lime, 24.3 percent fully adopted the practice, and 31.1 percent partially adopted the practice while only (25.2%) discontinue the use of lime.

vii. *Fertilizer Application*

From the table below, it was revealed that majority (100%) of the respondents was aware of fertilizer application, 90.5 percent adopted the use of fertilizer, 44.6 percent fully adopted the practice and 27.5 percent partially adopted the practice while 18.5% discontinue the use fertilizer.

viii. *Stocking Density/Rate*

Table 2 shows that 96.8% were aware of stocking density/rate, out of which 90.5% adopted the practice, 64.4% fully adopted the practice and 18.5% partially adopted the practice while 7.7% discontinue the practice.

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ix. *Feeding Method*

The result revealed that almost (99.1%) all the respondents were aware and thus adopted feeding method practice, 78.8 percent fully adopted the practice while 21.2% percent partially adopted the practice.

x. *Fish Feed Formulation (Compounded feed)*

It was shown in the table below that almost (96.4%) all the respondents were aware of fish feed formulation method,out of which 88.7 percent adopted the practice, 81.5 percent fully adopted the practice and 7.2 percent partially adopted the practice.

xi. *Use Maggot to Feed Fish*

Table 2 revealed that all (100%) the respondents interviewed were all aware about the use of maggot as feed supplement, out of which 90.5 percent adopted the practice, 50.0 percent fully adopted the practice, and 31.5 percent partially adopted the practice while about (9.0%) discontinue the practice.

xii. *Water Quality*

Majority of (100%) the respondents in the study area were aware and adopted water quality monitoring practice, 95.5percent fully adopted the practice while 4.5 percent partially adopted the practice.

xiii. *Artificial Production of fry/fingerlings*

The result shows that majority of (100%) the respondents were aware of artificial production of fry/fingerlings, 77.9 percent adopted the practice, and 34.7 percent fully adopted the practice while 43.2 percent partially adopted the practice.

xiv. *Culture of Hybrid*

From the table below, it was revealed that most (77.0%) of the respondents were aware of the culture of hybrid, 36.5 percent adopted the practice (culture of hybrid species), 4.5 percent fully adopted the practice, and 14.0 percent partially adopted the practice while 22.5 percent discontinue the practice.

xv. *Live Fish Transportation*

Result shows that, most (85.1%) of the respondents were aware of the live fish transportation, 57.2 percent adopted the practice, 31.5 percent fully adopted the practice, and 20.3 percent partially adopted the practice while 5.4 percent discontinue the practice.

xvi. *Stock Management (Fish Sorting)*

It was found that out of 222 fish farmers interviewed, 87.4 percent were aware of stock management practice, 81.1 percent adopted the practice (fish sorting), 32.9 percent fully adopted the practice, and 36.5 percent partially adopted the practice while 11.7 percent discontinue the practice.

xvii. *Test Cropping*

It was gathered that out of 222 fish farmers interviewed, 95.5 percent were aware of test cropping, 78.4 percent adopted the practice (Test cropping), 54.5 percent fully adopted the practice and 22.1 percent partially adopted the practice while 1.8 percent discontinues the practice.

xviii. *Harvesting Techniques*

From the table below, it was revealed that 86.0 percent were aware of different harvesting techniques, 85.1 percent adopted the practice (harvesting techniques), 41.8 percent fully adopted the practice, and 33.3 percent adopted the practice partially while 9.9 percent discontinue the use of the practice.

xix. *Post Harvest Technology*

It was gathered form table 2 below that majority (71.6%) of the respondents were aware of post harvest technology, 32.9 percent adopted the practice, 8.6 percent fully adopted the practice, 9.5 percent partially adopted the practice while 14.9 percent discontinue with the practice.

xx. *Processing techniques (Adding value to harvested fish)*

From the table below, it was revealed that (65.3%) of the respondents were aware of processing techniques, about 23.4 percent adopted the practice, 9.9 percent fully adopted the practice and 5.4 percent partially adopted the practice while 8.1 percent discontinue the practice.

Table 2 : Percentage distribution of the fish farmers according to awareness, adoption practice and level of adoption of recommended aquaculture production technologies (N = 222)

INNOVATIONS	Aware of Activity		Adopting Practice		Level of adoption of innovation introd uced to farmers		
	Yes Freq (%)	No Freq (%)	Yes Freq (%)	No Freq (%)	Full Adoption Freq (%)	Partial Adoption Freq (%)	Discontinued Freq (%)
Culture System	194 (87.4)	28 (12.8)	175 (78.8)	47 (21.2)	115 (51.8)	38 (17.1)	22 (9.9)
Pond Site Selection	211 (95.0)	11 (5.0)	209 (94.1)	2 (0.9)	101 (45.5)	74 (33.3)	34 (15.3)
Pond Construction system	217 (97.7)	5 (2.3)	203 (91.4)	14 (6.3)	144 (64.9)	49 (22.1)	10 (4.5)
Pond Installation system	198 (89.2)	24 (10.8)	173 (77.9)	25 (11.3)	101 (45.5)	59 (26.6)	13 (5.9)
Fish Pond Netting to Control Pest	222 (100)	0 (0.0)	222 (100)	179 (80.6)	43 (19.4)	0 (0.0)	0 (0.0)
Application of Lime	222 (100)	0 (0.0)	179 (80.6)	43 (19.4)	54 (24.3)	69 (31.1)	56 (25.2)
Fertilizer Application	222 (100)	0 (0.0)	201 (90.5)	21 (9.5)	99 (44.6)	61 (27.5)	41 (18.5)
Stocking Density/Ratio	215 (96.8)	7 (3.2)	201 (90.5)	14 (6.3)	143 (64.4)	41 (18.5)	17 (7.7)

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Feeding Method	220 (99.1)	2 (0.9)	220 (99.1)	0 (0.0)	175 (78.8)	47 (21.2)	0 (0.0)
Fish Feed Formulation (Compounded feed)	214 (96.4)	8 (3.6)	197 (88.7)	17 (7.7)	181 (81.5)	16 (7.2)	0 (0.0)
Use maggot to feed fish	222 (100)	0 (0.0)	201 (90.5)	21 (9.5)	111 (50.0)	70 (31.5)	20 (9.0)
Water Quality Monitoring	222 (100)	0 (0.0)	222 (100)	0 (0.0)	212 (95.5)	10 (4.5)	0 (0.0)
Artificial Production of fry/fingerlings	222 (100)	0 (0.0)	173 (77.9)	49 (22.1)	77 (34.7)	96 (43.2)	0 (0.0)
Culture of Hybrid	171 (77.0)	51 (23.0)	91 (41.0)	80 (36.0)	10 (4.5)	31 (14.0)	50 (22.5)
Live Fish Transportation	189 (85.1)	33 (14.9)	127 (57.2)	62 (27.9)	70 (31.5)	45 (20.3)	12 (5.4)
Stock Management (Fish Sorting)	194 (87.4)	28 (12.6)	180 (81.1)	14 (6.3)	73 (32.9)	81 (36.5)	26 (11.7)
Test Cropping	212 (95.5)	10 (4.5)	174 (78.4)	38 (17.1)	121 (54.5)	49 (22.1)	4 (1.8)
Harvesting Techniques	191 (86.0)	31 (14.0)	189 (85.1)	2 (0.9)	93 (41.9)	74 (33.3)	22 (9.9)
Post harvest technology	159 (71.6)	63 (28.4)	73 (32.9)	86 (38.7)	19 (8.6)	21 (9.5)	33 (14.9)
Processing techniques (Adding value to harvested fish)	145 (65.3)	77 (34.7)	52 (23.4)	93 (41.9)	22 (9.9)	12 (5.4)	18 (8.1)

Source: Field Survey, 2011

c) Limitation or constraints to adoption of recommended aquaculture production technologies

Major Limitation or constraints to adoption of recommended aquaculture production technologies Majority of the fish farmers (58.6%) claimed that land accusation is not a problem militating againt adoption of recommended aquaculture production technologies in Oyo state thus 40.5 percent claimed that is a serious problem. Most (57.2%) of the respondents claimed that insufficient labour is a problem while 42.8 percent claimed that is not a problem. 49.5 percent claimed that distance of the extension staff's office to the village/farm is not a constrain militating against adoption of recommended aquaculture production technologies but 41.5% claimed that is a serious problem. Preservation and processing facilities is considered to be a constraint affecting adoption of recommended aquaculture production technologies (75.2%).

Majority of the respondents (74.3% and 63.5%) does not consider absence of strong co-operative society and lack of finance (capital and credit) as major challenges affecting adoption of recommended aquaculture production technologies but majority of the fish farmers (90.1%) claimed that non-availability/high cost of quality fish seed is factor militating against adoption of recommended aquaculture production technologies. Likewise, majority of the fish farmers (94.6% and 96.0%) also claimed that poaching/ predators and high cost/lack of construction equipment respectively were one of the major challenges limiting adoption of recommended aquaculture production technologies. It was also show that all (100%) of the respondents considered market price fluctuation and high cost of fish feed as a problem hindering adoption of recommended aquaculture production technologies. Some other factors working against adoption of recommended aquaculture production technologies include; water shortage during dry season (92.3%), diseases and pest infestation (32.4%) and lack of technical know-how (42.4%).

Table 3 : Limitation or constraints to adoption of recommended aquaculture production technologies

Limitations	SEVERITY			
	Very serious Freq (%)	Serious Freq (%)	Not a problem Freq (%)	I don't know Freq (%)
Land accusation	18 (8.1)	72 (32.4)	130 (58.6)	2 (0.9)
Insufficient labour	48 (21.6)	79 (35.6)	95 (42.8)	0 (0.0)
Distance of the extension staff's office to the village/farm.	39 (17.6)	53 (23.9)	110 (49.5)	20 (9.0)
Preservation/Storage/Processing Facilities	71 (32.0)	96 (43.2)	40 (18.0)	15 (6.8)
Inadequate Motivation from extension officer	31 (14.0)	49 (22.1)	69 (31.1)	73 (32.9)
Absence of strong co-operative society	0 (0.0)	47 (21.2)	165 (74.3)	10 (4.5)
Lack of finance (capital and credit)	12 (5.4)	34 (15.3)	141 (63.5)	35 (15.8)
Non-availability/High cost of quality fish seed	152 (68.5)	48 (21.6)	22 (9.9)	0 (0.0)
Poaching/predators	40 (18.0)	170 (76.6)	12 (5.4)	0 (0.0)
High cost/lack of construction equipment	91 (41.0)	122 (55.0)	9 (4.1)	0 (0.0)
Market price fluctuation	167 (75.2)	55 (24.8)	0 (0.0)	0 (0.0)
High cost of fish feed	200 (90.1)	22 (9.9)	0 (0.0)	0 (0.0)
Water shortage during dry season	31 (14.0)	174 (78.4)	0 (0.0)	17 (7.7)
Disease and pest infestation	8 (3.6)	64 (28.8)	150 (67.6)	0 (0.0)
Lack of technical know-how	41 (18.5)	53 (23.9)	128 (57.7)	0 (0.0)

Source: Field Survey, 2011

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d) Hypotheses of the Study

This section shows the relationship/difference between some of the independent variables and dependent variables.

Ho_1: There is no significant relationship between the socio-economic characteristics of the fish farmers and adoption of recommended aquaculture production technologies.

The socio-economic characteristics of the respondents are significantly related to adoption of recommended aquaculture production innovations. The independents variables considered were; age, sex, educational level, occupation, marital status, years of experience, and house hold size. Each of these variables was tested against each of the scores for the dependent variables in line with the set hypotheses.

To test for the relationship between the variables in hypothesis one, Pearson Product Moment Correlation (PPMC) and Chi-square (χ^2) analysis were used. PPMC was used and the variables were measured at the interval level, while for Chi –square variables were measured at nominal level. The Chi – square analysis shows that, there is a significant association between adoption of innovations and sex ($\chi^2 = 2.16$, $p < 0.05$), educational level ($\chi^2 = 9.30$, $p < 0.05$), occupation ($\chi^2 = 4.81$, $p < 0.05$) and marital status ($\chi^2 = 5.32$, $p < 0.05$). The result (table 4) from the correlation coefficient obtained from the statistical analysis shows that, there is a significant relationship between adoption of innovations and age ($r = 0.05$, $p < 0.05$), years of experience ($r = 0.72$ $p < 0.05$) and house hold size ($r = 0.52$, $p < 0.05$) correlation coefficient obtained from the statistical analysis in table 5 shows that, there was a significant relationship between adoption of innovations and age ($r = 0.05$, $p < 0.05$), years of experience ($r = 0.72$ $p < 0.05$) and house hold size ($r = 0.52$, $p < 0.05$).

Table 4 : Chi-square analysis of respondent's socio-economic characteristics and adoption of innovations by fish farmers

Variables	χ^2	Df	CC	Decision
Sex	2.16	1	0.03	S
Educational level	9.30	3	0.02	S
Occupation	4.81	3	0.01	S
Marital status	5.32	3	0.03	S

Source: Field survey, 2011.

χ^2= chi square calculated, df = Degree of freedom, S = Significant, NS = Not significant ($p < 0.05$).

Table 5 : Correlation analysis of the respondent's personal characteristics and adoption of innovations by fish farmers

Variables	R	P	Decision
Age	0.50	0.04	S
Years of experience	0.72	0.01	S
House hold size	0.52	0.00	S

Source: Field survey, 2011.

NS = Not significant, S = Significant ($p < 0.05$).

IV. Conclusion

This study examined the limitations to the adoption of recommended aquaculture production technologies by small-scale fish farmers in Oyo State. It observed that majority of the fish farmers were males and fall between the age ranges of 41 – 50 years. Majority of them were married and had 11 – 15 years of experience in fish farming. The study further revealed that majority of the fish farmers had a household size ranging between 4 – 7 and majority of the fish farmers had fish farming experience between 11 – 15 years. The study further showed that the major limitations to the adoption of recommended aquaculture production technologies in the study area were; "land accusation, non-availability/high cost of quality fish seed, preservation/storage/processing facilities, high cost/lack of construction equipment, poaching/predators, market price fluctuation and high cost of fish feed. Chi – square analysis and correlation coefficient shows that, there is a significant association and relationship between adoptions of recommended aquaculture production technology.

V. Recommendation

In the light of the major findings of this study, the following recommendations are advanced as a panacea to the limitations encountered by small-scale fish farmers Oyo State. There should be effective and stronger co-operation or linkage between the fish farmers and agricultural extension programmes. In this case, the extension agents should endeavour to organize farmers' Clubs with the assistance of national research institute (Research institutions and University). These efforts should be directed mostly towards the

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active fish farmers to achieve higher results. In order to surmount the limitations to the adoption of recommended aquaculture production technologies by these farmers, efforts should be made by extension workers to organize training programmes directed toward fish farming, fish processing and marketing. Seminars, workshops and agric. show on improved fish production and management practices should be organized for farmers. This will definitely improve the knowledge, skills and techniques in fish production which will lead to increased production of animal protein and hence a better and improved health status of the final consumers.

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Study of Beef Quality in Slovak Pied Breed (Slovak National Breed) in Relation to Sex

By Kvetoslav Zaujec & Sharaf E. Idriss

Univerzity of Nitra, Slovakia

Abstract - The objective of this contribution was to compare the quality and sensorial evaluation in two categories: cows (n=26) and bulls (n-16) of the Slovak Pied breed. We found highly significant differences between the categories in the basic characteristics of animals. The greatest differences were noticed in age, weight of carcass and live weight before slaughter.

Approximately equal qualitative parameters were noticed in both categories when meat quality was studied. We noticed significant results in the parameter intramuscular fat in favour of the category of bulls, and in pH_{48} and colour richness (a) in favour of the category of cows. The rest of results was variable, although more favourable parameters of meat quality were noticed for the category of bulls. More favourable results were also in sensorial evaluation of meat in favour of the category of bulls.

Keywords : cows, bulls, meat quality, sensory panel.

GJSFR-D Classification : FOR Code: 630103, 070201

STUDY OF BEEF QUALITY IN SLOVAK PIED BREED SLOVAK NATIONAL BREEDIN RELATION TO SEX

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Kvetoslav Zaujec [α] & Sharaf E. Idriss [σ]

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I. Introduction

The Slovak Pied breed is one of the registered breeds kept in the Slovak Republic. Research in meat of the Slovak Pied breed was more focused on quantity than quality of meat (Mojto et al., 1998, 1999, 2004; Zaujec et al., 2005). The tendency is opposed at present, i.e. meat quality is in the first place (Zaujec and Mojto, 2007; Zaujec et al., 2006, 2010). Whereas till 2000 was the quality aimed at quality in bulls, at present more than a half of killed animals are slaughter cows (more than 55 %), because of lack of slaughter bulls, to meet the needs of market. Galli et al. (2008) recommend using the meat of slaughter cows purely for produces of meat or tinned food. In some countries is distribution of cows' meat for sale into trade network prohibited. According to Jedlička (1988) the cows' meat should be distributed into trade network for sale till the age of 3 years of the animal. Some experiments of authors (Kim et al., 1998) show that the main attributes of beef are meat colour, intramuscular fat – so called marbling – and shear force. Many factors such as sex, age, way of breeding, can affect these attributes (Ramsey et al., 1963; Crouse et al., 1989). Marbling of beef can at higher levels influence the tenderness of meat after heat treatment (Zaujec et al., 2006 and Yamazaki et al., 1989). According to Rhodes et al. (1955), Van Syncler and Brough (1958) and Ramsey et al. (1963) flavour influences the consumer after heat treatment of meat. Koch et al. (1982), Mc.Keith et al. (1985), Galli et al. (2008) and Zaujec et al. (2010) confirmed this statement in their works.

The objective of this contribution was to compare meat quality in cows and bulls of the Slovak Pied breed as well as to find out if larger amount of intramuscular fat influences sensorial parameters of meat.

II. Material and Method

a) Animals

Slaughter cows (26 animals) and slaughter bulls (16 animals) of Simental breeds were used in this experiment. Basic characteristic of this set is in table 1. The animals came from different agricultural enterprises and they were killed at the slaughter house in Dunajská Streda. The carcasses were evaluated after killing according to the regulation No. 206/2007 MA SK. We replaced classes of conformation with numbers: P-1, O-2, R-3, U-4, and E-5 to calculate the average class of conformation. The weight of warm carcass was detected after the classification. This indication served us further to calculate live weight before slaughter, which we obtained by multiplying the weight of warm carcass by the coefficient relevant for the given category.

b) Chemical Analysis

At the slaughter house were taken meat samples from the right carcass side between 9th – 10th rib 48 hours after killing. The meat samples were wrapped in microten wrapping and stored in portable refrigerator at the temperature 4^0 C during the transport (approx. 1 hour). The samples were tempered to 20° C after the transport. Then a number of parameters were studied in meat. Marbling of meat was assessed at fresh cut. Degree of marbling was determined on the basis of a 10 points American scale (USDA 1997), where 1: very abundant marbling, 10: traces or practically devoid of marbling. Percentage of proteins, fat and total water content was assessed in 100 g minced meat sample in the apparatus Infratec 1265 Meat Analyser. Combined glass electrode and portable pH meter (type 3071) were used to measure pH_{48} value. Values of meat colour (L, a, b) were measured on cutting area of *m. longissimus dorsi* by the apparatus Mini Scan E Plus (Hunter lab., USA). The method by Grau-Hamm (modified by Palanská and Hašek 1976) was used to assess water

Author α : Institute for Animal Breeding and Product Quality, Slovak Agricultural Research Centre of Nitra, Slovakia.
E-mail : zaujec@cvzv.sk
Author σ : Faculty of Biotechnology and Food Sciences, Univerzity of Nitra, Slovakia. Ing. Kvetoslav Zaujec, PhD, Slovak Agricultural Research Centre, Hlohovecka 2, 951 41 Luzianky, Slovakia.

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holding capacity. Shear force of meat was measured in a sample of grilled meat on day 7 after killing the animals. Meat sample (thickness 2.5 cm, m. longissimus dorsi) was put into a contact grill, model PM-1015 (RM Gastro, Czech Republic) and grilled at a temperature 200° C for 4 minutes. After grilling the value of shear force was measured in grams, converted to kg, in the apparatus Texture Analyser TA.XT2i (Stable Microsystems, England).

c) Sensorial Parameters

Sensorial parameters of meat were assessed by 5 points scale (Jedlčka 1988) valid for all kinds of meat (5 points – very high, 1 point – without). Out of meat properties were assessed the following ones: flavour, taste, juiciness and tenderness.

d) Statistics

With all results were calculated: mean ($\bar{x}$) and standard deviation (s). Differences in means between categories were tested in individual parameters by Two-Sample T-test, using the programme Statistix for Windows, version 8 (Analytical Software, Tallahassee, USA). Mean values were statistically evaluated by significance of differences to $P < 0.05$.

III. Results and Discussion

Values in table 1 show statistically significant differences were found between the groups almost in all parameters. These differences were worse in the group of cows. In this group we found higher variability compared with the group of bulls, namely in all studied parameters. We found the highest variability in the parameter carcass weight, live weight before slaughter and age. These facts indicate that cows of different live weight and age are slaughtered in Slovakia. It can be caused by different reasons of culling, either efficiency or reproduction.

With the parameters conformation we noticed better results in group of bulls. However, the group of bulls was not so excellent conformation as we supposed. The value 2.37 indicates only medium muscularity, which corresponds with class O of the Europ system. The value 1.64 in the group of cows indicates below-average muscularity, which corresponds with class P of the Europ system. With the parameter fat cover showed both groups on average very slight to slight development of subcutaneous fat, which corresponds with classes 1 to 2 according to the Europ system in practice. Similar results reports Zaujec and Mojto (2007) and Zaujec et al. (2006) in bulls. Gondeková et al. (2008) reported similar results with cows. Marbling of meat is a parameter closely bound to the class of fat cover. We found no statistically significant differences between the groups; however, we found higher degree of marbling in the group of cows, which corresponds with slight degree of marbling. The marbling degree was even lower in the group of bulls. Similar results reported Gondeková et al. (2008) and also Patten et al. (2008). On the contrary, Zaujec et al. (2006) noticed marbling degree 8 in slaughter bulls. Prado et al. (2008) reported marbling degree 6 in the crosses Aberdeen Angus.

We found no statistically significant differences between the groups in basic parameters (total water and proteins; table 2). This fact confirms that total water and proteins are constant in meat and they are influenced more by genetics than by surroundings. The intramuscular fat is the most variable parameter. We noticed larger amount of intramuscular fat in the group of cows (more than 3 g.100 g^{-1}) compared with the group of bulls (more than 1.5 g.100 g^{-1}). Differences were statistically significant on $P<0.01$ with this parameter. These findings indicate close relation between intramuscular fat, marbling of meat and class of fat cover. The higher is the content of intramuscular fat, the higher is the class of fat cover and the higher is the marbling degree in meat. Mojto et al. (2004) found higher values of intramuscular fat in bulls. On the other hand, Zaujec et al. (2010) and Corazzin et al. (2012) found lower values of intramuscular fat in the category of bulls and higher values in the category of cows.

Value of pH is worth mentioning out of chemical and technological parameters. The average values, which we observed (over 6.3) indicate the occurrence of DFD meat in the group of bulls. We detected statistically significant differences ($P<0.05$) in comparison with the group of cows. We assume that the occurrence of DFD meat can be connected with greater physical activity of bulls before slaughter. Kim et al. (1998) noticed lower pH values in the Hanwoo breed, when comparing bulls and cows. Similarly, Mojto et al. (2004) and Zaujec et al. (2010) noticed lower pH values in bulls.

Value of pH is closely connected with further parameters as colour of meat and water holding capacity. In our case proved the relation the higher the pH the darker the meat colour. Darker meat colour (L), although statistically non-significantly, was detected in the group of bulls with higher pH value. We found statistically significant differences ($P<0.01$) in richness of meat colour (a): the group of bulls had darker brightness of meat compared with the group of cows. Galli et al. (2008), Kim t al. (1998), Kim et al. (2003), Chávez et al. (2012), Franco et al. (2011) found somewhat higher values in meat colour (value L) and colour richness in cows. French et al. (2001), Orellana et al. (2009) reported higher values in richness of meat colour in bulls. On the other hand, Zaujec et al. (2010) reported higher values of meat colour in meat of cows than in bulls.

In the parameter water holding capacity we found lower values by more than 3 g.100 g^{-1} in the group of bulls compared with cows. Such low values can be

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put into connection with higher pH value and darker meat colour, which manifested itself also in our case.

There were less unfavourable values in the group of bulls; however, their meat was softer than the meat in the group of cows, but statistically nonsignificant. It can be related to lower age at slaughter but also to higher content of insoluble elastin. Conclusions of Yamazaki et al. (1989) that intramuscular fat influences shear force in meat were not confirmed with this parameter. Similar results reported Gondeková et al. (2008) in slaughter cows. On the other hand, Crouse et al. (1989), Ramsey et al. (1963) found much lower values of shear force in bulls (5.88 kg or 6.35 kg).

More favourable results in all parameters, although without statistical significance, were found in sensorial parameters (tab. 3) of bulls. In both groups was taste evaluated as the most favourable, followed by juiciness and flavour; tenderness was the least favourable. Similar results reported also French et al. (2001) and Zaujec et al. (2010) for bulls. On the other hand, Cerdeño et al. (2006), Faucitano et al. (2008) noticed better results at panel evaluation than those obtained in our experiment with bulls. Kim and Lee (2003) noticed better sensorial evaluation with cows. We cannot agree with authors Koch et al. (1982), McKeith et al. (1985), Galli et al. (2008) that flavour is the dominant parameter in sensorial evaluation as in our case was taste the dominant parameter with the most points (4.08 and/or 3.75).

IV. Conclusion

We can say that there were found not so great differences between the animal categories, which would confirm or disprove the hypothesis that the meat of cows or bulls is better or worse in the studied Slovak Pied breed. More favourable results, mainly in sensorial evaluation, were in the group of bulls. The hypotheses that the intramuscular fat can influence the sensorial evaluation of meat were not confirmed either. Further on, we can state that if we study the categories of one breed, we obtain more compact results than in case when no breed is taken into account.

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Table 1 : Basic characteristics of animals and carcass

Parameter	cows			bulls			t- test
	n	$\bar{x}$	s	n	$\bar{x}$	s	
age (months)	26	85.80	11.42	16	21.06	4.65	+++
final live weight (kg)	26	508.90	42.11	16	540.06	39.23	+++
carcass weight (kg)	26	262.32	53.36	16	297.06	43.38	+++
conformation score	26	1.64	0.56	16	2.37	0.50	++
fatness score	26	1.92	0.84	16	1.18	0.40	++
marbling score	26	7.46	1.60	16	8.12	0.88	

+++ $P < 0.001$, ++ $P < 0.01$

conformation score: 1- P(very poor conformation)... 5 – E (very good conformation)
fatness score: 1 – very lean ... 5 very fat
marbling score: 1 – very abundant ... 10 - traces or practically devoid

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Table 2 : Qualitative parameters of meat

Parameter	cows			bulls			t- test
	n	$\bar{x}$	s	n	$\bar{x}$	s	
total water ($g.100g^{-1}$)	26	75.52	2.05	16	76.18	1.04	
proteins ($g.100g^{-1}$)	26	20.39	0.99	16	21.00	0.49	
intramuscular fat ($g.100g^{-1}$)	26	3.06	1.96	16	1.81	0.82	++
pH_{48}	26	5.86	0.42	16	6.50	0.57	+
meat colour lightness L	26	30.17	3.84	16	29.09	4.06	
redness a	26	10.77	2.29	16	7.93	2.98	++
yellowness b	26	7.30	1.51	16	6.06	2.09	
water holding capacitance ($g.100g^{-1}$)	26	27.67	5.11	16	24.72	4.19	
shear force (kg)	26	10.66	4.18	16	9.20	3.48	

++P < 0.01, +P< 0.05

Table 3 : Sensory evaluation of meat quality

Traits	cows			bulls			t- test
	n	$\bar{x}$	s	n	$\bar{x}$	s	
flavour	26	3.75	0.50	16	4.08	0.58	
taste	26	3.55	0.56	16	3.92	0.62	
tenderness	26	3.41	0.86	16	3.77	0.88	
juiciness	26	3.69	0.71	16	3.95	0.66	

Scale: 1 – without flavour. taste. tenderness. juiciness. .... 5 – very high flavour. taste. tenderness. juiciness

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Assessment of Socio-Economic Analysis of Fish Farming in Oyo State, Nigeria

By Olaoye, O. J, Ashley-Dejo, S. S, Fakoya, E. O, Ikeweinwe, N. B, Alegbeleye, W. O, Ashaolu, F.O & Adelaja, O. A

Federal University of Agriculture, Abeokuta

Abstract - This study assessed the socio-economic analysis of fish farming in Oyo State, Nigeria. A multi-stage random sampling technique was used to select 222 fish farmers from all the four agricultural zones in the state. Data collected were analyzed using descriptive statistics, budgetary analysis and profitability ratios. The study revealed that the mean age, household size and fish farming experience were 46 years, 6 persons per household and 9.3 years respectively. The result of the budgetary analysis show that average total cost (TC) of N 2,883, 515.08 was incurred, total revenue (TR) of N 4,873,521.29 was realized and a returning gross margin (GM) of N 2,376,616.36. The profitability ratio gave a benefit-cost ratio of 1.69, rate of return of 0.69 gross revenue ratio (GRR) of 0.59 and expense structure ratio (ESR) of 0.15. This is an indication that fish farming is profitable in the study area. Constraints perceived by most of the farmers include high cost of fish feed and market price fluctuation. Significant level of profit obtained from the study is evidence that it has the potential in alleviating household poverty in the country thus; government should provide credit facilities with small interest rate to fish farmers.

Keywords : fish farming, fingerlings, income, revenue, total cost.

GJSFR-D Classification : FOR Code: 079999, 070401, 070499

ASSESSMENT OF SOCIO-ECONOMIC ANALYSIS OF FISH FARMING IN OYO STATE, NIGERIA

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Assessment of Socio-Economic Analysis of Fish Farming in Oyo State, Nigeria

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Abstract - This study assessed the socio-economic analysis of fish farming in Oyo State, Nigeria. A multi-stage random sampling technique was used to select 222 fish farmers from all the four agricultural zones in the state. Data collected were analyzed using descriptive statistics, budgetary analysis and profitability ratios. The study revealed that the mean age, household size and fish farming experience were 46 years, 6 persons per household and 9.3 years respectively. The result of the budgetary analysis show that average total cost (TC) of ₦ 2,883, 515.08 was incurred, total revenue (TR) of ₦ 4,873,521.29 was realized and a returning gross margin (GM) of ₦ 2,376,616.36. The profitability ratio gave a benefit-cost ratio of 1.69, rate of return of 0.69 gross revenue ratio (GRR) of 0.59 and expense structure ratio (ESR) of 0.15. This is an indication that fish farming is profitable in the study area. Constraints perceived by most of the farmers include high cost of fish feed and market price fluctuation. Significant level of profit obtained from the study is evidence that it has the potential in alleviating household poverty in the country thus; government should provide credit facilities with small interest rate to fish farmers.

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I. Introduction

Fish farming is the fastest-growing animal based food production sector, particularly in the developing countries – mainly from China and other Asian countries (Green facts, 2004). In Africa, the governments of the continent under the tutelage of the African Union, have identified the great potential of fish farming and are determined to encourage private sector investment (NEPAD, 2005). The potential exists for fish farming to make a difference as shown by pilot projects, although these pilot projects fail when they are scaled up (New Agriculturists, 2005). In Africa, the fish sector provides income for over 10 million people engaged in fish production, processing and trade (New Partnership for African Development, 2005). Fish has also become a leading export commodity for Africa with an annual export value of $2.7 billion (U.S.). Yet these benefits are at risk as the exploitation of natural fish stocks is reaching its limits (Mutume, 2002). Although there is a paucity of information on the status of the fisheries industry and the role it plays, it is estimated that Africa produced 7.3 million tonns in 2003, and 4.8 million tonns was from marine fisheries (FAO, 2005). Aquaculture, was introduced to Nigeria in the early 1950s and fish production through aquaculture has risen steadily from a few hundred kilograms to over 45,000 metric tonns in 2004 (FAO, 2007). Prior to the 1990s, aquaculture development in Nigeria was driven by socio-economic objectives including, nutrition improvement of rural communities, generation of additional family income, creation of employment and diversification of income generating activities; and was promoted by International Organizations and agencies and the government at Federal, State and Local Government levels.

Nigeria has over 14 million hectares of inland water surface, out of which about 1.75 million are available and suitable for aquaculture (FAO, 2006). In Nigeria, aquaculture is predominantly an extensive land based system, practiced at subsistence levels in fresh waters (Anyawu-Akeredolu, 2005). Commercial farming has yet to become widespread (Fagbenro, 2005). At present, most fish farmers operate small-scale farms ranging from homestead concrete ponds (25 - 40 meters) to small earthen ponds (0.02 - 0.2 hectares). The industry produced over 85,000 tonns of fish in 2007 (FDF, 2008).

According to Akegbejo-Samsons (1997) while human population with growth is rising at a rate of about 4 - 5% and livestock production is rising at a rate of 2 – 3%. This shows that there is wide gap between supply and demand of animal protein. The consequence of the sceneries is the soaring cost of animal protein. This has made it almost impossible for the poverty stricken Nigerian to meet their animal protein needs.

Despite the abundance fisheries resources and the relatively high consumption of fish in Nigeria that is the largest simple consumer of fish products in Africa (FDF, 2005; 2008), its domestic output of 0.62 million metric tonns still falls short of demand of 2.66 million metric tonns (FDF, 2008). A supply of deficit of 2.04 million metric tonns is required to meet the ever increasing demand for fish in Nigeria. This large deficit between the demand and supply of fish is augmented by massive importation of frozen fish and consequently

Authors σ ω ¥ χ : Department of Aquaculture and Fisheries Management, Federal University of Agriculture, Abeokuta.
E-mail : adeolu247@yahoo.com
Author α : Agricultural Media Resources and Extension Centre, Federal University of Agriculture, Abeokuta.
Author ρ : Departmnet of Agricultural Extension and Rural Development, Federal University of Agriculture, Abeokuta.
Author § : Departmnet of Agricultural Economics and Farm Management, Federal University of Agriculture, Abeokuta.

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effect on the exchange earnings of the national economy as well as caput consumption 9.68kg/ head/year (FDF, 2008). The species imported are mainly herring, mackerel and stock-fish to offset the deficit of 2.04 million metric tonns. Quantity of fish imported rose from 557,884.00 tonns to 739,666.12 tonns between 2000 and 2007. The amount of foreign exchange on fish importation also rose from US$ 241,066.54 million in 2000 to US$ 594,373.69 million in 2007. Nigeria is a large importer of fish with official records indicating 681,000 metric tonns while export in 2008 was 0.065 million metric tonns and valued at US$40.5 million. The local supply consists of productions from the artisanal (89.5% - 85.5%), industrial (5% - 2.5%), and aquaculture (5.5% - 12.0%) sub-sectors (FDF, 2009). However, it has been shown that Nigeria can substitutes fish importation with domestic production to create jobs, reduce poverty in rural and peri-urban areas where 70% of the population live and ease the balance of payment deficits (Areola, 2007; FDF, 2005, 2009; Olaoye, 2010).

According to FAO (2006), fish supply in Nigeria is 400, 000 tonns in comparison to 800, 000 tonns of demand hence there is need to close the gap between fish demand and fish supply in the country including Oyo State. However, the following research questions need to be addressed;

1) What are the socio-economic characteristics of the fish farmers in the Study area?
2) What are the types of fish farming practices and characteristics in the study area?
3) What are the constraints of fish farming in the study area?
4) What are the costs and returns of fish farming in the study area?
5) Is fish farming profitable in the study area?

II. Objectives of The Study

The broad objective of this study is to carry out socio-economic analysis of fish farming in Oyo State Nigeria. The specific objectives are to:

1) describe the socio-economic characteristics of fish farmers in the study area.
2) identify the types of fish farming Practices and characteristics in the study area
3) identify the production constraints affecting aquaculture development in the study area.
4) determine the costs and returns of fish farming in Oyo State.
5) determine the profitability ratio of fish farming in the study area.

a) Research Hypothesis

The following null hypothesis has been formulated for this study;

Ho_1: Fish farming is not profitable in Oyo State.

III. Methodology

a) The Study Area

The study was conducted in Oyo State South - West Nigeria. Oyo State is one of the thirty-six states of the Federal Republic of Nigeria. It came into existence with the break-up of the old Western State of Nigeria during the state creation exercise of 1976. Ibadan, the capital which is reputed to be the largest indigenous city in Africa, South of the Shara, had been the centre of administration of the old Western Region since the days of the British colonial rule in Nigeria.

The state has an estimated population of over 5,591,589 million people (N.P.C, 2006). The state is located in the rainforest vegetation belt of Nigeria within longitude $7^0 23' 47''$N and $3^0 55' 0''$. It is bounded in the south by Ogun State and in the north by Kwara State, in the west by the Republic of Benin while in the east it is bounded by Osun State (Figure 1). Oyo state exhibits the typical tropical climate of averagely high temperatures, high relative humidity and generally two rainfall maxima regimes during the rainfall period of March to October. Oyo State now consists of thirty three Local Governments and the capital of the state is Ibadan. The main occupations of the people in the state are: Agriculture which is the mainstay of the economy of the State. The tropical nature of the climate favours the growth of variety of food and cash crops are yam, maize, cassava, millet, plantain, banana, rice and fishing.

It is concerted efforts to revitalize agriculture in the state and thereby boost food production, the State Government has established the sate-wide Oyo State Agricultural Development Programme (OYSADEP), which is an offshoot of the defunct Oyo North Agricultural Development Project (ONADEP).According to OYSADEP, Oyo State was divided into four Agricultural extension zones namely: Ibadan/Ibarapa, Ogbomoso, Oyo and Saki.

b) Sampling Procedure and Sample Size

Multi-stage random sampling technique was used for the selection of two hundred and twenty two (222) fish farmers throughout the four extensional zones. In stage 1, 60% extensional blocks from each of the four zones to give a total of 16 blocks were purposively selected for the study. In stage 2, from each of the selected extensional blocks 60% were also randomly selected to give a total of 79 circles in all the selected blocks. In stage 3, from each circle, 60% fish farmers were selected using simple randomly sampling techniques to give a total of 222 fish farmers. Thus a total number of two hundred and twenty (222) fish farmers were selected throughout the four extensional zones.

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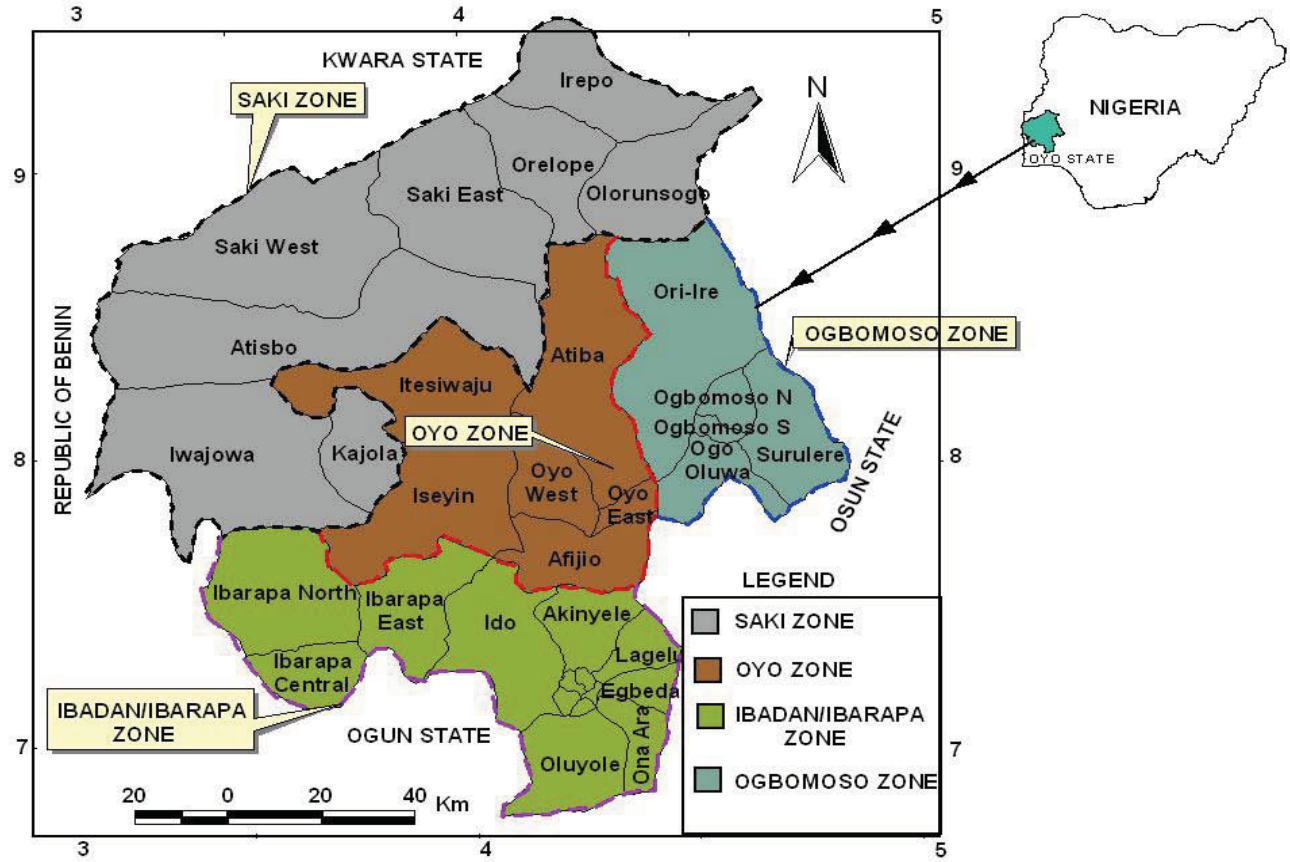

Source : Field Survey, 2011

Figure 1 : Oyo State ADP Zones & Blocks showing study location

c) Data Collection Instruments

A well structured interview schedule was administered to two hundred and twenty two (222) respondents which were used for primary data collection. The interview schedules were divided into four (4) sections: A, contains socio-economic characteristics of fish farmers in the study area, B, contains the types of fish farming practices and characteristics, C, contains the costs and returns involved in fish farming in the study area and D, contains the constraints'/problems of fish farming in the study area.

d) Data Analysis Techniques

Various analytical tools were used to achieve the objectives of the study and they include: simple descriptive statistics such as frequency distribution tables, percentages, averages (mean), net farm income (NFI), gross margin (GM) and profitability ratios.

i. *Gross Margin (GM)*

Gross margin is the difference between the gross farm income and the total variable cost (Olukosi and Erhabor, 1989).

Therefore; GM = GFI – TVC

Where GM = Gross margin

GFI = Gross farm income

TVC = Total variable cost

ii. *Net Farm Income (NFI)*

According to Olukosi and Erhabor (1989), net farm income gives an overall level of profitability of an enterprise by putting both fixed and variable costs into consideration and subtracting the cost from the total revenue.

Therefore; NFI = TR - TC

Where TR = Total Revenue

TC = Total cost.

iii. *Profitability Ratios*

Profitability ratio is a class of financial metrics that helps investors assess a business's ability to generate earning compared with its expenses and other relevant costs incurred during a specific period.

When these ratios are higher than a competitor's ratio or than the company's ratio from a previous period, this is a sign that the company is doing well (Okwn and Acheneje, 2011). Some examples of profitability ratios are listed and explained below:

iv. *Benefit Cost Ratio BCR)*

Benefit cost ratio or analysis is the term that either refers to helping to appraise, or assess the case for a project programme or policy proposal and an approach to making economy decision of any kind. From the above definition, the process involves whether explicitly or implicitly weighing the total expected costs

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against the total expected benefits of one or more actions in order to choose the best or most profitable option.

Therefore; BCR = TR/TC

Where TR = Total Revenue

TC = Total cost

Expense structure ratio (ESR) = FC/VC

Where, FC = Fixed cost and VC = Variable cost

Rate of return (ROR) = NR/TC

Where, NR = Net Return

Gross Revenue Ratio (GRR) = TFE/GI

Where, TFE = Total farm expenses and

GI = Gross income.

IV. Results and Discussion

a) *Socio-economic characteristics of small scale fish farmers from Oyo State*

Table 1 shows the distribution of fish farmers with respect to their socio economic characteristic. Most (49.1%) of the fish farmers fall within the age bracket of 41 – 50 years, 37.8 percent fall within 31 – 40 years, 8.1 percent were above 50 years of age while 2.0 percent fell within the age range of 21 – 30 years. This age bracket is a productive age which portends better future for catfish production also it is considered as economically active age (Olowosegun *et al.,* 2004). This indicates that very few young and old people are involved in fish farming. This is because fish farming requires adequate attention and a lot of sense of responsibility.

Sex plays a very important role in fish farming and agriculture, in terms of property acquisition, for example, fixed assets like land and machines. Majority (84.2%) of the fish farmers were male while 15.8 percent were female. This result can be justified by the assertion of Brummett *et al.,* (2010) that fisheries activities are mostly dominated by men. Ekong, 2003 pointed out that marriage in our society is highly cherished. This ascertain was further confirmed by the report of Fakoya (2000) and Oladoja *et al.,* (2008) who assert that marriage confer some level of responsibility and commitment on individual who are married. In this study, it was discovered that majority of the farmers were married (46.1%) while very few were single, widowed and separated. Respondents without formal education were 3.2 percent while 87.3 percent had tertiary education. This means that fish farming is dominated by the educated class and mostly by those armed with high level of education. This is so because fish farming requires a lot of technical and scientific knowledge to be successfully undertake. Majority (58.1%) spent above 15 years in school, 23.0 percent spent between 11 – 15 years while 14.4 percent spent. It was found that, majority (53.2%) of the fish farmers were Christians, 43.2 percent of them practiced Islam while 3.6 percent were traditional worshippers. The mean household size was found to be 9 people per household. This was an indication that the more educated and urban-based an individual is, the less family-size that individual will keep (Yarhere, 2004). Based on farmer's response during field survey, it was discovered that some of the respondents engaged in other occupation apart from fish farming. Occupation remains valid in our society as people have one or two things they engaged in which gives them sense of satisfaction and belonging in the society. Assessing the occupational status of the respondent, majority (63.1%) of the fish farmers engaged more in other farming actives part from fish farming than any other occupation. It revealed that 40.5 percent had fish farming experience ranging between 11 – 15 years, 35.6 percent had between 5 – 10 years, and 15.8 percent had less than 5 years while 8.1 percent had above 15 years experience in fish farming. As a result, the respondents with the highest number of years of experience should have good skill and better approaches to fish farming business. The respondents with longer years of experience were also able to forecast market situation in which they sell their products at higher prices. Those with less years of experience, especially with less than 5 years faced many risks in the early days of their fish farming business. Majority (67.6%) of the respondents purchased the land they are using for fish farming, 23.0% rented the land, while 7.7% and 1.8% got the land through inheritance and gift respectively.

Table 1 : Percentage distribution of the socio-economic characteristics of small scale fish farmers in Oyo states (N = 222)

VARIABLES	FISH FARMERS			
	Frequency	Percentage (%)	Mean($\overline{X}$) / Mode	Std
Age (years)				
Bellow 20	0.0	0.0		
21-30	11	5.0		
31-40	84	37.8		
41-50	109	49.1		

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Above 50	18	8.1		
Total	**222**	**100.0**	**46**	**0.709**
Sex				
Male	187	84.2		
Female	35	15.8		
Total	**222**	**100.0**	**Male**	**0.365**
Marital Status				
Single	25	11.3		
Married	169	76.1		
Widowed	20	9.0		
Separated	8	3.6		
Total	**222**	**100.0**	**Married**	**0.588**
Educational status				
No formal Education	7	3.2		
Adult Education	0	0.0		
Primary Education	44	19.8		
Secondary Education	62	27.9		
Tertiary Education	88	39.6		
Others	21	9.5		
Total	**222**	**100.0**	**Tertiary**	**0.670**
Number of years spend in school				
1 – 5	10	4.5		
6 – 10	32	14.4		
11 – 15	51	23.0		
Above 15	129	58.1		
Total	**222**	**100.0**	**16**	**0.866**
Religion				
Christianity	118	53.2		
Islam	96	43.2		
Traditional	8	3.6		
Total	**222**	**100.0**	**Christianity**	**0.569**
House Hold Size (Persons)				
1 – 3	35	15.8		
4 – 7	152	68.5		
8 – 11	35	15.8		
Total	**222**	**100.0**	**6**	**0.563**
Other Occupation that Generate Income apart from Fish Farming				
Farming	140	63.1		
Civil service	40	18.0		
Trading	20	9.0		
Vocational job	22	9.9		
Total	**222**	**100.0**	**Farming**	**0.670**
Fish Farming Experience (Years)				
Less than 5	35	15.8		
5 – 10	79	35.6		
11 – 15	90	40.5		
Above 15	18	8.1		
Total	**222**	**100.0**	**9.3**	**0.850**
Mode of Land Acquisition				
Purchase	150	67.6		
Lease/Rent	51	23.0		
Inheritance	17	7.7		
Gift	4	1.8		
Total	**222**	**100.0**	**Purchase**	**0.865**

Source : Field Survey, 2011.

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b) Fish Farming Practices and characteristics by the Fish Farmers

Table 2 reveals that most (89.2%) of the fish farmers went into fish farming in other to make profit while (8.6 % and 2.3%) went into fish farming to augment income and for household consumption respectively. Source and quantity of water available are one of the most important factors to be considered when selecting a site for aquaculture practice. The quantity of water needed for commercial aquaculture varies with the production method employed, type of aquaculture chosen, scale of operation, and species cultured. Most (61.7%) of the respondents depend directly on either stream or river as their major source of water, 25.2 percent depend on deep well as source of water, while 13.1 percent depend on borehole. This may be due to the fact that Oyo State has rivers located within the geographical area of the state. In terms of holding/rearing structure, majority (44.1%) of the respondents used both concrete and earthen ponds, 27.5 percent of the respondents used concrete pond only, 26.1 percent of the respondents used earthen pond only, while 2.3 percent used fish trough/ holding/rearing structure. Fish farmer in the study area preferred monoculture to polyculture system. This may be as a result of poor market price for tilapia. Majority (66.7%) of fish farmers adopt monoculture of African Catfish (*Clarias gariepinus*). This was also supported by Rundquist (1984) who observed that fishes grow better when cultured individually under monoculture system and also help the specie to grow to its biggest size. Based on the types of species cultured, majority (73.9%) of the fish farmers in the study area culture mainly *Clarias spp.* under the influence of high market price, greater demand preferences, hardiness of the stock, fast growth, high feed conversion ratio high survival rate under captivity. This may be due to the fact that cat fish appears to be hardy and generally accepted by people. Majority (63.1%) of the respondents get their fish seed from owned fish farms. This is an indication that they are well trained and they have acquired needed information to operate a personal fish hatchery, while 28.4 percent source fish seed from other fish hatcheries and (8.6%) minority depend on governments' farms for fish seeds. The fact is that the fingerlings sourced from fish farms are more likely to be healthier and well breed.

Based on culturing period (production of table size), more than half of the respondents (57.7%) cultured their fish for five months, 22.1 percent cultured for six months, 14.4 percent cultured for four months, while a very low percentage (13.0%) cultured their fish for more than six months. Furthermore, majority (86.9%) of the respondent harvest twice a year, while 7.2 percent and 5.9 percent do harvest once and thrice respectively. The choice of culture period is usually influenced by factors such as timing towards festive period or due to the lack of feeds as explained by Okoye and Omorinkoba (1994).

Cooperative society is a social participation that helps farmers to pool their resources in order to have access to fisheries inputs and to have insights in their fishing issues. Membership of cooperatives is also a factor that influences the adoption of improved fisheries technologies and poverty alleviation. This shows that majority (62.6%) of the respondents in the study areas were members of cooperative societies while others do not belong to any registered or unregistered society which may be as a result of lack of awareness and interest. Hence, being a member of association group could create peer pressure for farmers to adopt new technologies. This was in line with Akinbile, (1998) who observed that groups ensure that members derive benefits from the groups in which they cannot derive individually if they were acting alone. More than one quarter of the farmers did not have group status so they operated as ordinary members and this may have effect on their access to credit facilities and adoption of technologies, as it is easier to pass information to a group than individual farmers. The status of fishers' group had significant differences between the study areas.

Table 2 : Fish Farming Practices and characteristics by the Fish Farmers (N = 222)

VARIABLES	FISH FARMERS Frequency	Percentage (%)	Mean($\overline{X}$) / Mode	Std
Reason for going into Fish Farming				
To make profit	198	89.2		
To argument income	19	8.6		
For house hold consumption	5	2.3		
Total	222	100.0	Profit	0.399
Source of Water				
Stream/river	137	61.7		
Borehole	56	25.2		
Deep well	29	13.1		

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Total	222	100.0	Stream/river	0.716
Rearing Structure/Facilities				
Earthen pond and concrete tank	98	44.1		
Concrete pond only	61	27.5		
Earthen pond only	58	26.1		
Fish trough	5	2.3		
Total	222	100.0	Earthen pond and concrete tank	1.281
Types of culture				
Monoculture	148	66.7		
Polyculture	53	23.9		
Integrated	21	9.5		
Total	222	100.0	Monoculture	0.560
Types of Cultured Specie				
Clarias spp	164	73.9		
Clarias and *Tilapia spp*	47	21.1		
Heterobranchus spp	11	5.0		
Total	222	100.0	*Clarias spp*	0.813
Source of Fingerlings				
Own fish farm	140	63.1		
Fish hatchery	63	28.4		
Government fish farm	19	8.6		
Total	222	100.0	Own fish farm	0.576
Culturing Period				
Four months	32	14.4		
Five months	128	57.7		
Six months	49	22.1		
More than six months	13	5.9		
Total	222	100.0	Six months	0.751
Harvesting Period (Year)				
Once	16	7.2		
Twice	193	86.9		
Thrice	13	5.9		
Total	222	100.0	Twice	0.362
Cooperative Society				
Yes	139	62.6		
No	83	37.4		
Total	222	100.0	Yes	0.484
Source of finance				
Personal savings	106	47.8		
Friends/Relatives	22	9.9		
Cooperatives society	55	24.8		
Bank loan	39	17.6		
Total	222	100.0	Personal savings	0.461

Source : Field Survey, 2011

c) Cost and Return of Fish Farming in the Study Area

Estimate of cost and return analysis were made from fish farming using average cost (Fixed and Variable) and yield data generated by each of the sampled fish farmers per cropping season. The cost and return analysis in table 3, reveals that the variable cost accounted for the largest proportion (86.68%) of the total cost of fish farming in the study area. This shows that large amount of money spend by fish farmers in the study area was majorly for purchase of fish feeds and fingerlings. This finding is in agreement with Louise (1977) who said that the cost of feeds was very high in catfish production. This is followed by cost of fingerlings. The fixed cost of production consists of

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cost of land purchase/rent, water pump, concrete tanks, earthen pond, deep well, generator building/shed, drag net, wheel barrow etc which accounted for 13.40% of the total cost. Also, the result shows that an average total cost (TC) of ₦ 2,883, 515.08 was incurred by a respondent per cropping season while total revenue (TR) of ₦ 4,873,521.29 was realized with a returning gross margin (GM) of ₦ 2,376,616.36 and a net farm income (NFI) of ₦ 1,990,006.21. This indicates that fish farming in the study area was profitable. This result is consistent with the finding of Ashaolu *et al.*(2006) who observed that fish farming is profitable and also confirmed in table 4 (Profitability ratio).

Table 3 : Economic analysis of the respondents (N = 222)

ITEMS	Amount (₦)	% Total Cost
VARIABLE COST		
Fish Feed	2,158,456.01	74.86
Fish seed	211,801.59	7.43
Lime/Fertilizer	3,473.18	0.12
Labour	69,296.88	2.40
Fuel	21,314.19	0.74
Transportation	17,351.08	0.60
Others	15,212.00	0.53
TOTAL VARIABLE COST	2,496,904.93	86.68
FIXED COST		
Land purchase/rent	18,616.43	0.65
Water pump	9,293.85	0.32
Concrete tanks	78,154.59	2.71
Deep well	21,570.00	0.75
Earthen pond	26,514.11	0.92
Plumbing materials	3,010.45	0.10
Building/Shed	167,856.00	5.82
Generator	45,761.00	1.59
Drag net, Weighing Scale/Cutlass/	10,694.62	0.37
Wheel barrow/ Shovel/ Head pan/ Bowls	5,139.10	0.18
TOTAL FIXED COST	386,610.15	13.40
TOTAL COST	2,883,515.08	
TOTAL REVENUE	4,873,521.29	
GROSS MARGIN	2,376,616.36	
NET FARM INCOME	1,990,006.21	

Source : Field survey, 2011

d) Profitability and Viability Estimate of Fish Farming in the Study Area

The analysis of ratios in table 4 reveals that the Benefit cost ratio (BCR) was greater than one. This ratio is one of the concepts of discount method of project evaluation. As a rule of thumb, any business with benefit cost ratio greater than one, equal to one or less than one indicate profit, break-even or loss respectively (Olagunju *et al.,* 2007). It is also in agreement with the work of Emokaro and Ekunwe (2009) who examined the efficiency of resource-use among catfish farmers to be viable. Since the ratio (BCR = 1.69) it implies that fish farming in Oyo state is profitable. It is therefore much possible to have higher value of BCR with increase in capitals and skilled labour.

i. *Rate of Return (ROR)*

The rate of returns in fish production in the study area is 0.69. This shows that for every N1.00 invested, 69kobo is gained by the respondent.

ii. *Gross Revenue Ratio (GRR)*

Gross revenue ratio of 0.59 indicates that for every one naira return to fish farm enterprise, 59kobo is being spent.

iii. *Expense Structure Ratio (ESR)*

The value of the ratio is 0.15 which implies that about 15% of the total cost of production is made up of fixed cost component. This make the business worthwhile since increase in the production with variable cost will increase the total revenue leaving the fixed cost unchanged.

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Table 4 : Profitability Ratios

RATIOS	VALUES
Benefit Cost Ratio (BCR)	1.69
Rate Of Return (ROR)	0.69
Expense structure ratio (ESR)	0.15
Gross Revenue Ration (GRR)	0.59
Net Profit Margin (NPM)	0.41

Source : Field survey, 2011

e) Aquaculture production constraints Oyo State

Information on aquaculture production constraints was elicited and presented in table 5. Various factors which affect fish farming in the study area were rated according to the degree of severity. Majority of the fish farmers (58.6%) claimed that land accusation is not a problem facing aquaculture development in Oyo state thus 40.5 percent claimed that is a serious problem. Most (57.2%) of the respondents claimed that insufficient labour is a problem while 42.8 percent claimed that is not a problem. 49.5 percent claimed that distance of the extension staff's office to the village/farm is not a constrain militating against aquaculture development but 41.5% claimed that is a serious problem. Preservation and processing facilities is considered to be a constraint affecting aquaculture production by most (75.2%) of the respondents. Majority of the respondents (74.3% and 63.5%) does not consider absence of strong co-operative society and lack of finance (capital and credit) as major challenges affecting aquaculture production in the study area but majority of the fish farmers (90.1%) claimed that non-availability/high cost of quality fish seed is factor militating against aquaculture development in Oyo State. Likewise, majority of the fish farmers (94.6% and 96.0%) also claimed that poaching/predators and high cost/lack of construction equipment respectively were one of the major challenges facing aquaculture development in the study area. It was also show that all (100%) of the respondents considered market price fluctuation and high cost of fish feed as a problem facing fish production. Some other factors militating aquaculture production include; water shortage during dry season (92.3%), diseases and pest infestation (32.4%) and lack of technical know-how (42.4%).

Table 5 : Percentage distribution of the fish farmers by aquaculture production constraints (N = 222)

PROBLEMS	SEVERITY			
	Very serious Freq (%)	Serious Freq (%)	Not a problem Freq (%)	I don't know Freq (%)
Land accusation	18 (8.1)	72 (32.4)	130 (58.6)	2 (0.9)
Insufficient labour	48 (21.6)	79 (35.6)	95 (42.8)	0 (0.0)
Distance of the extension staff's office to the village/farm.	39 (17.6)	53 (23.9)	110 (49.5)	20 (9.0)
Preservation/Storage/Processing Facilities	71 (32.0)	96 (43.2)	40 (18.0)	15 (6.8)
Inadequate Motivation from extension officer	31 (14.0)	49 (22.1)	69 (31.1)	73 (32.9)
Absence of strong co-operative society	0 (0.0)	47 (21.2)	165 (74.3)	10 (4.5)
Lack of finance (capital and credit)	12 (5.4)	34 (15.3)	141 (63.5)	35 (15.8)
Non-availability/High cost of quality fish seed	152 (68.5)	48 (21.6)	22 (9.9)	0 (0.0)
Poaching/predators	40 (18.0)	170 (76.6)	12 (5.4)	0 (0.0)
High cost/lack of construction equipment	91 (41.0)	122 (55.0)	9 (4.1)	0 (0.0)
Market price fluctuation	167 (75.2)	55 (24.8)	0 (0.0)	0 (0.0)
High cost of fish feed	200 (90.1)	22 (9.9)	0 (0.0)	0 (0.0)
Water shortage during dry season	31 (14.0)	174 (78.4)	0 (0.0)	17 (7.7)
Disease and pest infestation	8 (3.6)	64 (28.8)	150 (67.6)	0 (0.0)
Lack of technical know-how	41 (18.5)	53 (23.9)	128 (57.7)	0 (0.0)

Source : Field Survey, 2011

f) Profitability of Fish Farming in the Study Area

The null hypothesis which stated that fish farming was not profitable in Oyo State is rejected while the alternative hypothesis (fish farming is profitable in Oyo State) is accepted. From table 3 and 4 an average total cost (TC) of ₦ 2,883,515.08 was incurred by a respondent per cropping season while total revenue (TR) of ₦ 4,873,521.29 was realized with returning gross

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revenue (GR) of ₦ 2,376,616.36 and a net farm income (NFI) of ₦ 1,990,006.21. This indicates that fish farming in Oyo State was profitable.

This result agrees with that of Ashaolu *et al.* (2006) which said that fish farming is profitable. Also, the profitability ratio in table 4 reveals that the benefit cost ratio (1.69) is above one emphasizing the profitability of fish farming in the State. The finding in this study compares favourably with that of Emokaro and Ekunwe (2009) who examined the profitability and viability of cat fish farming and found it to be profitable. The rate of returns in fish production in the study area is 0.69. This shows that for every N1.00 invested, 69kobo is gained by the respondent and a gross revenue ratio of 0.32 indicates that for every one naira return to fish farm enterprise, 32kobo is being spent. This also confirmed profitability. The result is corroborate with the work Emokaro and Ekunwe (2010) who examined the profitability and viability of catfish farming in Kogi state, Nigeria.

V. Conclusions and Policy Implication

These study asses the socio-economic analysis of fish farming in Oyo State, Nigeria. Economic analysis and profitability ration was employed for this analysis. The empirical results show that, an average GR and NFI was N 2,376,616.36 and N 1,990,006.21 respectively, was obtained from the study. The rate of returns in fish production in the study area is 0.69. This shows that for every N1.00 invested, 69kobo is gained by the respondent and a gross revenue ratio of 0.32 indicates that for every one naira return to fish farm enterprise, 32kobo is being spent. This also confirmed profitability.

Based on this, we draw the following conclusions from the study: first, aquaculture production is a profitable investment considering the size GR obtained from the study. Secondly, the farms were fairly efficient in use of their resources considering the size of technical efficiency obtained. Thirdly, it is evident that fish farming is capable of creating employment, augmenting income and improving the standard of living of the people. However, feeds were found to be the major factor (input) affecting the output of fish farming in the study area. Lastly, significant level of profit observed among the farms is synonymous to improve efficiency environment among the farms from the study.

This study, therefore, suggests that policy variables such as extension, education, and credit identified in the study as important determinants of technical efficiency of the farms should strengthen as variable of policy concern for sustainable fish production in the Sate and Nigeria at large.

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Study Regarding the Multiple Stress Influence over Productive Performances of Laying Quails *(Coturnix Coturnix Japonica)*

By Lucian Ioniță, Elena Popescu-Miclosanu, Ion Custură & Consuela Roibu

University of Agronomic Sciences and Veterinary Medicine Bucharest, Romania

Abstract - Being acquainted with the fact that in the field of quails breeding the literature is still deficient and that these birds have a very intense metabolism, which makes them more sensitive to stress in comparison with other species, a research has been conducted on a total number of 3368 of mixed and meat quails divided in 6 differentiated lots based on age and productive specialization. They have been exposed for 5 hours to multiple stresses (without light, ventilation, water, food). It can be affirmed that the stress effect over the quails that are in the first part of the laying curve (until the three laying month) is affecting less the laying process, but influences more their death rate. The situation is reversed for the quails that are in the second part of the laying curve (after the sixth month of laying), the effect of multiple stress applied to those birds being more influential on the laying process and less in the death rate. The consumption of compound feed and the feed conversion have varied very little while the birds were under stress, with the exception of the most elder lot, that was in the XIIth month of laying, for which the feed conversion rose by 14% in the week that followed the stress conditions, getting up with 22,5% bigger in the fourth week after the applied stress, while the laying has been reduced proportionally with less than half of these values.

Keywords : mixed quails, meat quails, egg produ-ction, multiple stresses.

GJSFR-D Classification : FOR Code: 830501, 300499

STUDY REGARDING THE MULTIPLE STRESS INFLUENCE OVER PRODUCTIVE PERFORMANCES OF LAYING QUAILS COTURNIX COTURNIX JAPONICA

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Study Regarding the Multiple Stress Influence over Productive Performances of Laying Quails *(Coturnix Coturnix Japonica)*

Lucian Ioniță [α], Elena Popescu-Miclosanu [σ], Ion Custură [ρ] & Consuela Roibu [ω]

Abstract - Being acquainted with the fact that in the field of quails breeding the literature is still deficient and that these birds have a very intense metabolism, which makes them more sensitive to stress in comparison with other species, a research has been conducted on a total number of 3368 of mixed and meat quails divided in 6 differentiated lots based on age and productive specialization. They have been exposed for 5 hours to multiple stresses (without light, ventilation, water, food). It can be affirmed that the stress effect over the quails that are in the first part of the laying curve (until the three laying month) is affecting less the laying process, but influences more their death rate. The situation is reversed for the quails that are in the second part of the laying curve (after the sixth month of laying), the effect of multiple stress applied to those birds being more influential on the laying process and less in the death rate. The consumption of compound feed and the feed conversion have varied very little while the birds were under stress, with the exception of the most elder lot, that was in the XIIth month of laying, for which the feed conversion rose by 14% in the week that followed the stress conditions, getting up with 22,5% bigger in the fourth week after the applied stress, while the laying has been reduced proportionally with less than half of these values.

Keywords : mixed quails, meat quails, egg produ-ction, multiple stresses.

I. Introduction

The strong concentration of the quails in a farm requires a special care for all the activities, as well as the correct functioning of all technological systems (watering and feeding systems, ventilation, etc.) because any fluctuation of these factors leads to the decrease of the production and the rise of the death rate due to the high sensitivity of the quails to induced stress in exploiting conditions.

II. Materials and Methods

The research has been made in the S.C. Ferma Nova S.R.L. farm in Bucharest on a flock of laying quails from the egg-meat population "Balotesti" and a flock of "Faraon" meat population that have been exposed to multiple stress conditions. The stress has been produced in the month of June, for 5 hours, during which period the electrical power has been shut down. As a result, the ventilation, the lighting and the water systems were not functioning, the temperature in the breeding room has risen, water was missing and the birds were unable to feed themselves due to the lack of illumination. Thus the quails have been exposed to stress from all these point of view.

The stress effect has been monitored by analyzing the egg production, the death rate and the compound feed consumption, that have been performed in the week prior to the multiple stress exposure (referred to further on in the study as week I) and for the following 4 weeks after the stress exposure (referred to further on in the study as week II, III, IV and V). The study has been undertaken on an initial group of 3040 "Balotesti" layers divided by age in five relatively equal batches, as follows: batch L1 – quails in the first laying month, L2 – quails in the third laying month, L3 – quails in the VI th laying month, L4 – quails the VIIIth laying month, L5 – quails in the XIIth laying month. The "Faraon" lot (L6) has comprised 328 layers in the first laying month.

The data processing was done with the aid of the software program Microsoft Excel 2003. The testing of the significance of the differences among the averages values has been done with the aid of the Student test.

III. Results and Discussion

At the laying quails of the mixed "Balotesti" population that were in their first laying months (batch L1), the exposure to multiple stress didn't modified the laying process in a negative manner, that rosed in the weeks that followed the stress exposure (from 4,88 ± 0,11% in week I, before the stress to 34.78±0,51 % in week II, 64.88±0,52 % in week III, 72.55±0.56% in week IV and 75.34±0.45% after the stress exposure, table 1, figure 1). On the other hand, the death rate (table 2, figure 2) increased (0,68±0,08% in week II, to 1.09±0,10% in week III, 0.89 ±0,10% in week IV and 0.65±0,10% in week V after the stress exposure, in comparison to 0,13±0,03% in week I, before the stress exposure).

Author α : University of Agronomic Sciences and Veterinary Medicine Bucharest, Faculty of Animal Sciences, 59 Mărăsti Bv., Bucharest, Romania. E-mail : ionita_luc@yahoo.com
Authors σ ρ ω : S. Nova Farm SRL, 20 C. Ressu Bv., Bucharest, Romania. E-mail : elenapopescu50@yahoo.com

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At "Balotesti" quails that were in the third laying month (lot L2) the same evolution was ascertained as well as for the quails in their first laying month, with death rate and laying percentages corresponding to their age (table 1 and table 2).

For the quails in the VI th month of laying (batch L3) the situation is changing, meaning that the stress exposure has led to the decrease of the laying percentage and the increase of the death rate percentage during the first week after the stress exposure (from 74,88±0,79 medium egg laying percentage in week I, before stress exposure, to 71,87±0,71% in week II, 76.94±0,87% in week III, 75.65±0.44% in week IV and 76.55±0.34% in week V after the stress exposure, and regarding the medium death rate percentage, in relation to 1,85±0,11 in week I, prior to the stress exposure, 2,37±0,12% in week II, 1,05±0,09 % in week III, 0.95±0.05% in week IV and 0.85±0,10% in week V after the stress exposure).

For the "Balotesti" quails in their VIII th egg laying month (lot L4) stress exposure has led to tendency of laying percentage decrease, which is not statistically insured, as the laying was constant (table 1). The death rate percentage was also on a normal trajectory for this age (table 2), without being influenced by the five hours stress.

For the "Balotesti" quails in their XII th egg laying month (lot L5) stress exposure has led to a stronger decrease in laying, of about 7% in the first week after stress exposure, the difference being still significantly lower in the following weeks in comparison with week I. The death rate percentage seems not to have been influenced, remaining practically constant in the second week and following a normal trajectory for these ages. Related to the „Faraon" meat quails population, in the first laying month during the multiple stress exposure, the research has revealed a resembling situation to those of the mixed "Balotesti" population, with the difference that the death rate percentage increased more in the „Faraon" quails in comparison to "Balotesti" quails in the following week after the stress exposure (on an average of 0, 76% at L6 in comparison with 0, 68% at L1).

Table 1 : The evolution of the laying before and after the exposure to the multiple stresses

Batch	Productive age	Specification	Week I	Week II	Week III	Week IV	Week V
L1	1 month of laying	Laying %	4,88 ± 0,11 [aaa bbb ccc ddd]	34.78 ± 0,51 [aaa eee fff ggg]	64.88 ± 0,52 [bbb eee hhh iii]	72.55 ± 0.56 [ccc fff hhh jjj]	75.34 ± 0.45 [ddd ggg iii jjj]
		Eggs/per capita/week)	0.34 ± 0.46	2.43 ± 0.34	4.54 ± 0.23	5.08 ± 0.25	5.27± 0.44
L2	3 months of laying	% laying	84,97 ± 0.66 [bbb ccc ddd]	86.72 ± 0.42 [eee fff ggg]	88.76 ± 0.36 [bbb eee hhh iii]	87.54 ± 0.54 [ccc fff hhh jjj]	86.55 ± 0.54 [ddd ggg iii jjj]
		Eggs/per capita/week)	5.94± 0.23	6.07± 0.24	6.21± 0.33	6.12± 0.34	6.06 ± 0.42
L3	6 months of laying	Laying %	74.88 ± 0.79 [aaa bb]	71.87 ± 0,71 [aaa eee fff ggg]	76.94± 0,87 [bb eee hhh iii]	75.65± 0.44 [fff hhh jjj]	76.55± 0.34 [ggg iii jjj]
		Eggs/per capita/week)	5.24 ± 0.64	5.03± 0.64	5.38± 0.74	5.29± 0.34	5.35± 0.54
L4	8 months of laying	Laying %	59.45 ± 0.91	58.77 ± 0.86	60.45 ± 0.85	58.55 ± 0.56	57.54 ± 0.68
		Eggs/per capita/week)	4.16± 0.4	4.11± 0.4	4.23± 0.4	4.09± 0.4	4.02± 0.4
L5	12 months of laying	Laying %	53,65 ± 0.41 [aaa bbb ccc ddd]	46.63 ± 0.41 [aaa eee ff gg]	49.65 ± 0.41 [bbb eee hhh iii]	47.55 ± 0.34 [ccc ff hhh jj]	44.13 ± 0.35 [ddd gg iii jj]
		Eggs/per capita/week)	3.75 ± 0.54	3.26± 0.36	3.47 ± 0.48	3.32 ± 0.57	3.08 ± 0.56

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L6	1 month of laying	Laying %	44.19 ± 0.34 aaa bbb ccc ddd	60.09 ± 0.61 aaa eee fff ggg	70.16 ± 0.91 bbb eee hhh iii	74.57 ± 0.58 ccc fff hhh jjj	77.78 ± 0.78 ddd ggg iii jjj
		Eggs/per capita/week)	3.09 ± 0.74	4.21 ± 0.46	4.91 ± 0.65	5.22 ± 0.84	5.44 ± 0.67

Note: among the figures marked with the same 3 letters the difference is highly significant, among those marked with 2 the difference is distinctly significant and among those marked with 1 letter the difference is significant. Among the unmarked figures the differences are not significant.

The combined feed consumption (table 2) varied little in accordance with multiple stress exposure of the birds for five hours. The feed conversion has also been influenced with the exception of lot L5, being in its XII th laying month, for which it increased by 14% in the week following the stress exposure, although the laying has decreased with only 7.02%, being with 22.5% higher in the IV-th week after the stress exposure, whereas the egg laying has decreased with only 9.5 %.

Table 2 : The evolution of the death rate, of feed consumption and feed conversion

Lot	Productive age	Specification	Week I	Week II	Week III	Week IV	Week V
L1	1 month of laying	Death rate (%)	0,13 ± 0,02 aaa bbb ccc ddd	0,68 ± 0,08 aaa eee fff ggg	1.09 ± 0,10 bbb eee hhh iii	0.89 ± 0,10 ccc fff hhh jjj	0.65 ± 0,10 ddd ggg iii jjj
		Feed consumption (g/capita/day)	28.05 ± 0.45	27.5 ± 0.35	29.5± 0.34	30.3± 0.24	30.6± 0.34
		Feed conversion (g/egg)	574.79 ± 2.42	79.07± 0.66	45.47± 0.34	41.76± 0.24	40.61± 0.43
L2	3 months of laying	Death rate (%)	0,64 ± 0,08 aaa bbb ccc ddd	1,86 ± 0,15 aaa eee fff ggg	1,05 ± 0,09 bbb eee hhh iii	0.95 ± 0.05 ccc fff hhh jjj	0.85 ± 0,10 ddd ggg iii jjj
		Feed consumption (g/capita/day)	33.45 ± 0.43	32.44 ± 0.33	33.85 ± 0.34	33.95± 0.45	34.35± 0.46
		Feed conversion (g/egg)	39.37 ± 0.34	37.40 ± 0.55	38.14 ± 0.35	38.78± 0.67	39.68± 0.64
L3	6 months of laying	Death rate (%)	1,85 ± 0,11 aaa bb	2.37 ± 0,12 aaa eee fff ggg	1.65 ± 0,11 bb eee hhh ins	1.74 ± 0.12 cns fff hhh jjj	1.65 ± 0.09 dns ggg ims jjj
		Feed consumption (g/capita/day)	35.57 ± 0.43	35.00 ± 0.54	36.34 ± 0.44	36.85 ± 0.46	36.95 ± 0.36
		Feed conversion (g/egg)	47.5 ± 0.56	48.69 ± 0.67	47.23 ± 0.54	48.71 ± 0.35	48.27 ± 0.76
L4	8 months of laying	% Death rate	2,29 ± 0,13	1,91 ± 0,12 eee fff ggg	2.79 ± 0,12 eee	2.55 ± 0.15 fff	2.27 ± 0.34 ggg
		Feed consumption (g/capita/day)	37.35 ± 0.55	37.65 ± 0.37	37.85 ± 0.45	38.10± 0.54	38.20± 0.64
		Feed conversion (g/egg)	62.82 ± 0.55	64.06± 1.05	62.61 ± 0.87	65.10 ± 0.65	66.38 ± 0.76

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L5	12 months of laying	Death rate (%)	2,59 ± 0,16 [cc]	2.58 ± 0,11 [ee ff g]	2.98 ± 0,15 [ee ii]	2.88 ± 0,23 [cc ff jj]	2.68 ± 0.15 [g ii jj]
		Feed consumption (g/capita/day)	39.25 ± 0.75	39.65 ± 0.35	40.45 ± 0.38	41.25 ± 0.67	41.65± 0.67
		Feed conversion (g/egg)	73.15 ± 0.65	85.03± 0.54	81.47 ± 1.03	86.75 ± 0.98	94.38± 0.88
L6	1 month of laying	Death rate (%)	0,22 ± 0.05 [aa bb cc dd]	0,76 ± 0.11 [aa g]	0.71 ± 0.09 [bb i]	0.78 ± 0.07 [cc j]	0.98 ± 0.08 [dd gg i j]
		Feed consumption (g/capita/day)	29.1 ± 0.55	30.2 ± 0.64	30.45 ± 0.34	31 ± 0.44	31.23± 0.54
		Feed conversion (g/egg)	65.85 ± 0.77	50.26 ± 0.67	43.54 ± 0.75	41.57 ± 0.56	40.16 ± 0.45

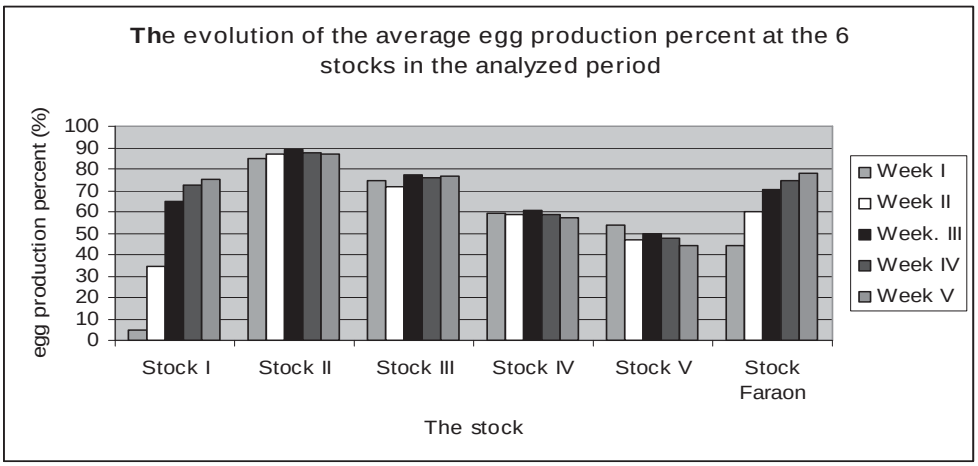

Figure 1 : The average percentages of laying for the analyzed lots during the five weeks

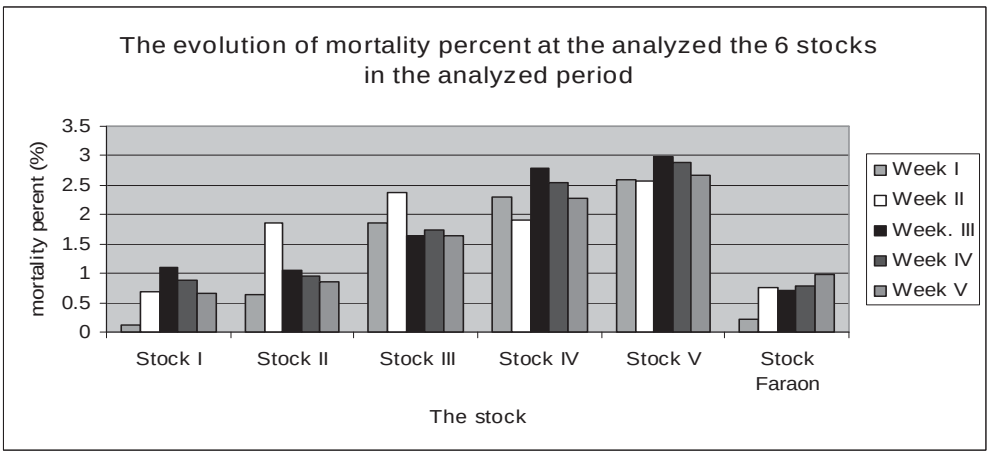

Figure 2 : The average percentages of death rates in the analyzed lots

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IV. Conclusions

After exposing to a five hours multiple stress (increase of the shelter temperature, lack of light, water and food) the quails of the Balotesti and Faraon populations the following conclusions can be presented.

For the quails in their first 3 months of egg laying, the stress didn't lead to a decrease of the laying percentage, this being on an increasing curve. On the other hand the death rate has increased, 5.2 times over for the "Balotesti" quails and 3.4 times for the „Faraon" quails in the following first week after the stress exposure.

For the quails over six months of laying, there has been a decrease of the medium laying percentage especially in the first week after the stress exposure, the death rate being on a relative normal slope for this age.

In the second week after the multiple stress exposure (third week in the tables), the quails are starting to recover, meaning that the egg production for the following three weeks is increasing in comparison to the second week and their death rate is decreasing.

The combined feed consumption varied very little in accordance with the stress exposure of the birds for five hours. The feed conversion has also less been influenced with the exception of the lot being at the end of the laying cycle, for which it increased in the weeks following the stress exposure, being with 22,5% higher in the fourth week after the stress exposure, period during which the laying decreased less pro rata.

As a general conclusion, it can be affirmed that if the quails are exposed to a multiple stress for five hours, in the first week after this exposure, the laying percentage and the death rate are affected in a differentiated way in accordance with the layers` age, that are recovering in the immediate following week. Specials problems are created by the death rate, having as consequence the decreasing of the number of productive quails. The study on the effects of a multiple stress exposure longer than five hours of the quails remains an open subject.

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References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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