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## of Science Frontier Research: D

# Agriculture & Veterinary

Conventional Protein Sources

Aspects of Growth Parameters

Highlights

Micro-Satellite DNA Markers

Resistance to Trembling Disease

Discovering Thoughts, Inventing Future

VOLUME 17 ISSUE 2 VERSION 1.0

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Agriculture & Veterinary

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# Micro-Satellite DNA Markers Associated with Resistance to Trembling Disease in Chinese Mitten Crab (*Eriocheir sinensis*)

By Ali Sserwadda, Tian-Hao Dai, Yuan-Chao Ma, Yacheng Hu & Huai-Shun Shen

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*Keywords: micro-satellite markers, Eriocheir sinensis (chinese mitten crab), trembling disease.*

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*Keywords: micro-satellite markers, Eriocheir sinensis (chinese mitten crab), trembling disease.*

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## I. Introduction

The aquaculture industry world enjoys an exceptionally profitable market in the whole world and deals with various valuable marine and fresh water vertebrate and invertebrate species (Chakrabarty 2015). In China, the Chinese mitten crab (*Eriocheir sinensis*) is ranked as one of the most economically important aquaculture species which is mainly attributed to its taste and nutritious value (Zhang 2013). The native range of the Chinese crab extends from the coastal estuaries of Korea in the North to the Fujian province of China to the south (Li 2016). Despite its wide distribution in the Northeast and South of China, the population of the Chinese crabs in the Yangtze River has the best reputation which is attributed to its big size and specific taste (Chang 2008). The wild populations of *E. sinensis* have however experienced a dramatic decline in the past decades which has been attributed to over fishing and water pollution (Li 2006). According to a study by (Chang 2006), the populations of the Chinese crabs particularly in the Yangtze River have diminished for several years and this has been attributed to dam construction, overfishing, and water pollution. In the same river, a study conducted by (Tang 2000)indicated that the number of crab fry has decreased significantly from 70tons in the 1960's to less than 10tons in 1980 and to less than 0.2tons in 1998.

The basic production technology of mitten crab populations has had a long history in China, with the conventional selective breeding programmes based on phenotypic assessment. Presently, attributed to the declining stocks in the natural water bodies such as the Yangtze River, the yield of *E. sinensis*is almost completely an attribute of artificial breeding (Li 2016). According to (Zhang 2004), culture of the Chinese crabs has increased rapidly mainly in the inland provinces of China. With the intensification of culture systems however, various diseases have emerged and these have gravely affected the production of *E. sinensis*. Of the various diseases attacking populations of *E. sinensis* under culture conditions, the "trembling disease" (TD) has caused serious economic losses since 1996. This "trembling disease" has been reported in the main culture provinces of Jiangsu, Zhejiang, Anhui and Shanghai (Zhang 2004). Crabs with TD exhibit signs like;

trembling of legs, sluggishness, and loss of appetite (Zhang 2004, Shen 2015).

According to (Wang 2006), TD of *E. sinensis* was first reported in culture ponds in Jiangsu province, China in 1994. Before then, a number of different virus-like particles had been observed in *E.sinensis* since 1996 (Jiang 1996, Lu 1999, Gong 2000, Zhang 2002). Studies conducted by Lu et al. (2009), (Gong 2000)and (Zhang 2002)proved that some of the viruses are pathogenic to *E. sinensis*. However, none of these studies have definitely confirmed the etiological agent of TD, although a rickettsia-like organism was reported to be the causative agent of TD by (Wang 2002)and (Chen 2011).

A double-stranded RNA virus that has 9 to 12 linear genome segments has been reported to having been found in many host species, including vertebrate and invertebrate animals and plants (Attoui 2005, Attoui 2006, MohdJaafar 2008, Chen 2011). A recent study by (Shen 2015)came up with the near-full length genome sequence of the novel reovirus from the Chinese mitten crab. Till lately, only one full-length genome sequence of a crab-originating reovirus (*Scylla serrata* reovirus SZ-2007 [SsRV]) has been sequenced (Chen 2011, Chen, Xiong et al. 2012, Deng, Lu et al. 2012). Using a deep-sequencing approach of a novel reovirus obtained from Chinese mitten crabs displaying signs of TD, a study by (Shen 2015) reported the near-full-length genome sequence of the novel reovirus from the Chinese mitten crab.

The "trembling disease" has been reported to cause severe economic losses in recent years, as the mortality of crabs with TD reaches up to 70% (Chen 2011). A number of breeding programmes have been conducted on the Chinese mitten crab in order to come up with a line that is resistant to diseases such as the trembling disease. It is well known that some resistant phenomena always lie in the repository of nature itself (Chakrabarty 2015). According to the law of nature, some individuals are always favored over the other individuals that are less fit hence nature tends to select for them. The favored individuals have better existence and resistance as well as preventive capability against any kind of odds like natural and artificial disasters. According to this law, it is more than clear that some kind of disease resistance phenomena might be present in the Chinese mitten crabs and some special genomic fingerprints may be responsible for such resistance. In this research, we examine crabs from the Yangtze River for their resistance against TD using micro-satellite markers.

A number of DNA fingerprinting techniques are employed in population genetic studies, genetic diversity analysis, classifying germplasm and selective breeding in plants and animals for disease resistance (Welsh 1990, Williams and 6535. 1990, Penner and Fedak 1993, Rao, Lakshminarasu et al. 2002, McElroy, Dekkers et al. 2005). Due to their preferable characteristics such as reproducibility, co-dominant expression type, even genomic distribution, small locus size and polymorphism, micro-satellite markers are vastly used. The enriched knowledge about DNA fingerprinting can be very useful in the isolation of resistant individuals from an economically important species and culturing them selectively as per the suitable genomic content (Chakrabarty 2015).

Micro-satellites or simple sequence repeats (SSRs) are tandemly repeated units of one to six nucleotides and have been abundant in all prokaryotic and eukaryotic genomes that have been analyzed to date (Weber 1990, Field and Wills 1996). Micro-satellite markers provide a powerful tool in genome researches due to their wide distribution, co-dominant inheritance and high polymorphism (Li 2016). Approximately, to-date, 83 micro-satellite markers have been developed and applied to *E. sinensis*to(Hanfling 2003, Chang 2006, Zhu 2006, Mao 2008, Gao 2010, Xiong 2012). Because of the large diploid number of chromosomes of *E. sinensis* (2n=146), much more works still need to be undertaken so as to identify more useful micro-satellite markers. This study is therefore intended to identify micro-satellite DNA markers that are associated with resistance to the trembling disease in the Chinese mitten crab (*E. sinensis).*

## II. Materials and Methods

*a) Specimens (crabs) used during the study*

A total number of 48 crabs were used for conducting the experiments of this study. The crabs used in this study were collected from an aquatic breeding farm in Yandu District, Yancheng city, Jiangsu Province in China. Twenty four (24) crabs were harvested from a pond heavily infested with the trembling disease and all these clearly manifested the signs of the disease. The remaining twenty four (24) crabs were collected from a pond that was free of the trembling disease infestation and these manifested no sign of the disease. To confirm that the healthy crabs were not infected by TD, they were grown in water tanks separately under natural photoperiod and fed with a commercial crab diet once a day for additional two weeks.

The crabs were collected from the farm during the month of August (autumn season in China) and then transported to the Fresh water Fisheries Research Center of Nanjing Agricultural University where the experiments were carried out from.

Muscle samples from the crabs were collected and stored in 100% ethanol at −80 °C. It is from these muscle samples that DNA was later extracted using the standard phenol-chloroform protocol as demonstrated by (Sambrook 2001).

*b) DNA extraction*

Genomic DNA was extracted from the leg muscles of the crabs using the phenol/chloroform method as elaborated by (Sambrook 2001). The genomic DNA obtained from the specimens was re-suspended in TE buffer (10mM Tris-HCL pH7.6, 0.1mM EDTA) forminga final concentration of 100ng/μl

*c) Micro-satellite amplification and analysis*

The amplifications of the collected DNA samples were done in a 25μl reaction containing 100ng of the DNA template, 0.8mM of the forward and reverse primers, 2.0mM$MgCl_2$, 0.2mM of each dNTP and 1.0 unit of *Taq* DNA polymerase.

*Table 1:* Primers used during PCR

| Loci | Primer Sequences (5′-3′) | Annealing temperature (°C) |
|---|---|---|
| locus75 | F:GGCAAACAAAGAGAGAAGGGAGAC | 58 |
| | R:GAAGAATTGAAAGACAGACACAAGCA | |
| locus62 | F:GAAGGTCAGTTACTTTTCCTCCCC | 58 |
| | R:ACATCACACACGTCTTCTGGGTTA | |
| locus57 | F:CTCAAGGCACCAGGACACTTATCT | 58 |
| | R:CACCTCTCCTCTCTAAATCACCCA | |
| locus4 | F:TTTCAACTTTTCTCCGGGTTGTTA | 58 |
| | R:CGGTGATCCTAATTACATTCTGGG | |
| locus1 | F:AACGGAGAGTACGAGAACACCAAG | 58 |
| | R:CGTACATATCACTCGCTTGGATTG | |
| locus254 | F:AAGCGCTGTACACCTCCCTTTAC | 58 |
| | R:CATCTACTTCATCCTCGTCCTCGT | |
| locus753 | F:ATAACAGATGCAAGTGGAGGTGGT | 58 |
| | R:TCTCCCCTCACAAGGACAAAACTA | |
| locus977 | F:GGAGAGCTTTAAGATGATGCCAAA | 58 |
| | R:TTGGAGGCAAGAAAGTTAGTGGAG | |
| locus358 | F:TTTGTGTGGTTTCTCGTTTGAAGA | 58 |
| | R:ATTCACATTTTTCCTTTCGTCAGC | |
| locus45 | F:GGGAGTGTTATTTAAATCCTCGTCG | 58 |
| | R:AAACACCAACACAGCATTCCTTCT | |

*F: forward primer; R: reverse primer. The annealing temperature for all the primers was set at 50degrees.*

Amplifications of the micro-satellites were carried out in PCR machine with the following protocol; three minutes (3) at 94°C, 35 cycles of 30seconds at 94 °C, 30seconds at annealing temperature and 30 seconds at 72°C, 72°C for seven minutes and a final extension at 10°C for 10 minutes. These PCR reactions were performed in triplicates for each DNA sample. The products obtained from the PCR experiments were then denatured and visualized on an eight percent (8%) denaturing polyacrylamide gel (PAGE). In order to visualize the bands, silver staining was then employed. The results obtaining from the silver staining process were the collected using a scanner after the gel had dried and analyzed using POPGENE.

*d) Statistical analysis*

At each locus, the number of alleles (*Na*), mean polymorphic information content (*PIC*) and the expected heterozygosity (*He*) were calculated.

Association of individual genotypes with their respective resistance to trembling disease were analyzed by the Shannon Diversity Index in POPGENE; Population Genetic Analysis (Version 1.32; 32-bit).

## III. Results

*a) Micro-satellite loci analysis*

Figure 1 clearly demonstrated the results of electrophoresis and the genotypes manifested by the healthy and sick individuals at loci 57.

Table 2 showed the mean number of alleles (Na), mean number of effective alleles (Ne), mean Shannon index (I), mean expected heterozygosity (He), mean observed heterozygosity (Ho) and the mean polymorphic information content (PIC) were 4.2, 3.2, 0.6628, 0.6466,0.6221 and 1.2, respectively.

*Table 2:* $N_a$, $N_e$, $H_e$, $H_o$, PIC and I for 10 micro-satellite loci of Chinese Mitten Crab

| loci | Mean number of alleles $N_a$ | Mean number of effective alleles $N_e$ | Mean Shannon Index I | Mean expected heterozygosity $H_e$ | Mean observed heterozygosity $H_o$ | Mean polymorphic information content PIC |
|---|---|---|---|---|---|---|
| loci75 | 4 | 2 | 1 | 0.5132 | 0.766 | 0.491 |
| loci62 | 4 | 3.3 | 1.3 | 0.7078 | 0.8478 | 0.672 |
| loci57 | 4 | 3.7 | 1.4 | 0.7419 | 0.5 | 0.685 |
| loci4 | 4 | 3.3 | 1.3 | 0.7062 | 0.5106 | 0.656 |
| loci1 | 4 | 3.8 | 1.4 | 0.7458 | 0.4167 | 0.689 |
| loci254 | 3 | 3.5 | 1 | 0.5996 | 0.7447 | 0.553 |
| loci753 | 9 | 4.3 | 1.8 | 0.7772 | 0.5319 | 0.741 |
| loci977 | 4 | 4 | 1.4 | 0.7558 | 0.8 | 0.734 |
| loci358 | 3 | 1.8 | 0.7 | 0.435 | 0.5652 | 0.396 |
| loci45 | 3 | 2.8 | 1 | 0.6452 | 0.7826 | 0.604 |
| mean | 4.2 | 3.2 | 1.2 | 0.6628 | 0.6466 | 0.6221 |

The associations of the individual marker alleles with resistance to the trembling disease were analyzed using the Shannon Diversity Index in POPGENE, the mean number of alleles (Na), the mean number of effective alleles (Ne), mean observed heterozygosity (Ho), mean expected heterozygosity (He), mean polymorphic information content (PIC) and mean Shannon index (I) in the individual populations were 4.2, 3.2, 0.6628, 0.6466, 0.6221 and 1.2, respectively.

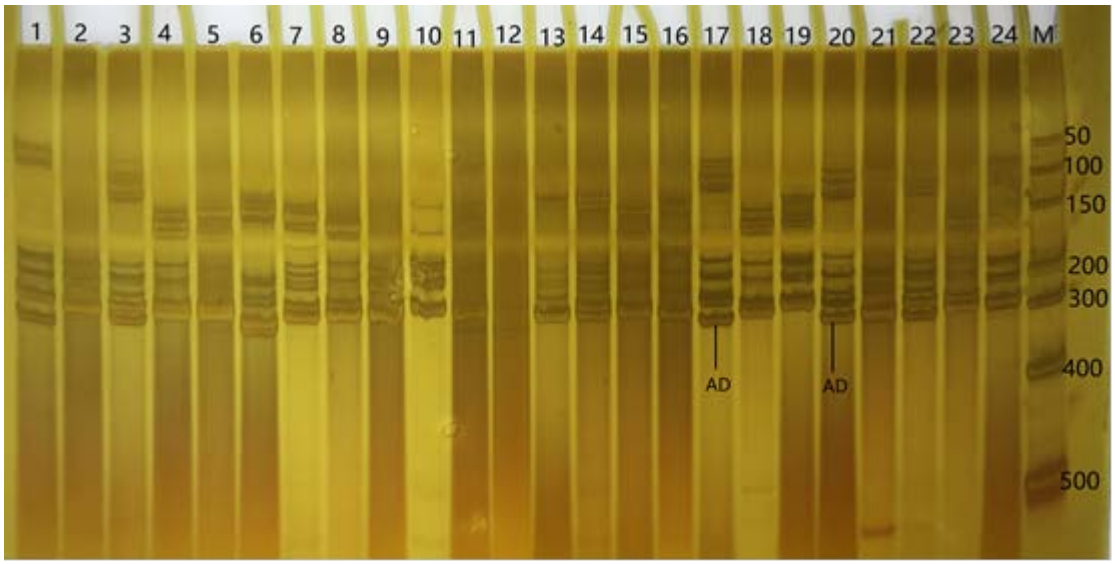
*Table 3:* Genotypes for the sick and healthy individuals at the eight (8) loci

| loci | genotypes | length /bp | positive / all sick individual | Probability of sick individual | positive / all healthy individual | Probability of healthy individual | P |
|---|---|---|---|---|---|---|---|
| locus 57 | AD | 290/314 | 0/24 | 0 | 5/24 | 21% | 0.022 |
| locus 57 | AA | 290/290 | 1/24 | 4% | 5/24 | 21% | 0.043 |
| locus57 | AC | 290/308 | 5/24 | 21% | 1/24 | 4% | 0.043 |
| locus 45 | BB | 390/390 | 7/23 | 30% | 13/23 | 57% | 0.011 |
| locus 62 | BB | 400/400 | 9/22 | 41% | 5/24 | 21% | 0.043 |
| locus 254 | BB | 340/340 | 13/23 | 57% | 9/24 | 38% | 0.043 |
| locus 358 | BC | 315/321 | 5/22 | 23% | 10/24 | 42% | 0.022 |
| locus 977 | BB | 393/393 | 3/23 | 13% | 7/25 | 28% | 0.043 |

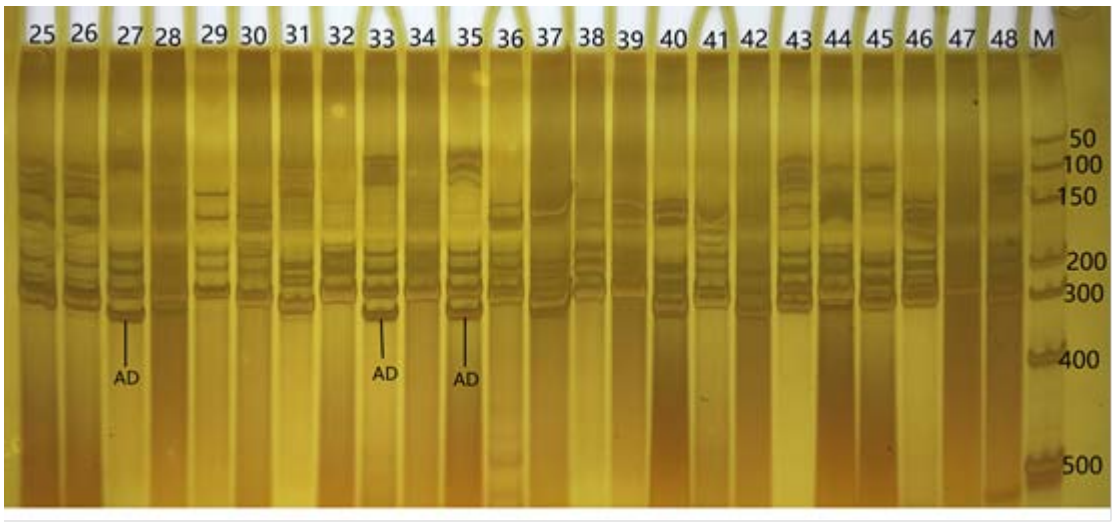
Through association analysis, micro-satellite loci of 57, 62 and 254 were associated to the sick individuals of Eriocheirsinensis ($P<0.05$) while micro-satellite loci of 57, 45, 358 and 977 were associated to the healthy individuals of Eriocheir sinensis ($P<0.05$). Through, the micro-satellite loci that showed significant

differences were tested for the associations between their genotypes and sick traits. The observed genotypes for sick individuals were AC (290/308) at loci of 57, BB (400/400) at loci of 62 and BB (340/340) at loci of 254. The favorable genotypes for healthy individuals were AD (290/314) at loci of 57, AA (290/290) at loci of 57, BB (390/390) at loci of 45, BC (315/321) at loci of 358 and BB (393/393) at loci of 977.

*Figure 1:* Title




(a)




(b)

*Figure 1:* Micro-satellite DNA marker analysis of crab and the trembling disease virus genomic DNA. Genomic DNA was extracted from the leg muscles of Eriocheirsinensis and then subjected to micro-satellite DNA marker analysis. PCR amplified DNA fragments were then electrophoresed in 8% agarose gel and photographed after the silver staining process. Lanes 1-16 and 41-48 indicate PCR amplified DNA bands from sick individual of E. sinensis. Lanes 14-40 indicate PCR amplified DNA bands from the healthy individuals of E. sinensis. Lane M indicates the molecular weight marker. The numbers on the right indicate the molecular size of the molecular weight marker (50bp, 100bp,150bp, 200bp, 300bp, 400bp and 500bp). AD is the preferred genotype of the healthy individuals of Eriocheirsinensisat loci57

*b) Association analysis of micro-satellite DNA markers at the 10 loci of the sick and health individuals*

Association analysis suggested that micro-satellite loci of 57, 62 and 254 were significantly associated with the sick population ($P<0.05$); micro-satellite loci of 57, 45, 358 and 977 were significantly associated with the healthy population ($P<0.05$).

The observed genotypes for sick individuals were AC (290/308) at loci of 57, BB (400/400) at loci of 62 and BB (340/340) at loci of 254. The favorable

genotypes for healthy individuals were AD (290/314) at loci of 57, AA (290/290) at loci of 57, BB (390/390) at loci of 45, BC (315/321) at loci of 358 and BB (393/393) at loci of 977.

## IV. Discussion

In aquaculture species, a number of Quantitative Trait Loci (QTL), have been mapped and characterized (Jackson 1998, Danzmann 1999, Sakamoto 1999, Ozaki 2001, Perry 2001, Robison 2001, Shirak 2002, Xiong 2012, Qiu 2016). In our study, four (4) (Table 2) loci were discovered and these were associated with the resistance to trembling disease in the Chinese mitten crabs. Through association studies, the effects of distinct genotypes (Table 2) at the eight (8) loci were significantly different. The results obtained in this study are expected to play a significant role for future marker-assisted selection (MAS) programmes in the Chinese mitten crab.

With crab mortalities reaching 70% (Chen 2011), the trembling disease has been reported to cause major economic losses to crab farmers in China. In order to come up with a family of crabs resistant to the trembling disease, a number of breeding programmes have been undertaken though no study to date had endeavored to associate resistance of trembling disease to micro-satellite markers in the Chinese mitten crab. In this study, however, we demonstrated the potential use of marker-based analysis in the association between resistance to disease and co-dominant DNA markers. Crabs were selected depending on their manifestation of the characteristics of the trembling disease as described by (Shen 2015)&(Zhang 2004). Crabs that showed all the characteristics of the trembling disease were considered to be susceptible while those that manifested no signs of the disease were considered to be resistant. It is on this basis that a micro-satellite marker analysis was conducted in order to establish the association of moro-satellite DNA markers with resistance to trembling disease in the Chinese mitten crab.

In a study carried out by (Xiong 2012), a total number of 15,000 simple sequence repeats (SSR) or micro-satellite markers were isolated from mitten crabs which were reported to be suitable for construction of genetic linkage maps. In a more recent study by (Qiu 2016), nine quantitative trait loci (QTL) associated with growth traits and two QTL related to sexual precocity in the mitten crabs were identified on a linkage map. All the micro-satellite markers that have been reported to date are quantitative trait loci (QTL). To the best of our knowledge, there hasn't been any genetic linkage study associating micro-satellite DNA markers with resistance to the trembling disease in the Chinese mitten crab (*Eriocheirsinensis*).

This study demonstrated a total of four (4) micro-satellite markers that can be associated with resistance to the trembling disease in the Chinese mitten crab. These results are expected to be used as a baseline for future marker-assisted selection programmes in the Chinese mitten crab. The study, being the first of its kind is further expected to pave way for future related studies. More studies in the same line are necessary in order to come up with more micro-satellite markers that can be associated to disease resistance in the Chinese mitten crab.

## V. Conclusion

In this study, were able to identify four micro-satellite markers that are associated with resistance to the trembling disease in the Chinese mitten crab; *Eriocheirsinensis*. There is however need to develop more micro-satellite DNA markers that are associated with resistance to trembling disease in *E. sinensis* which are expected to paint a much clearer picture about the polygenic status of trembling disease resistance in *E. sinensis*. Further establishment of the role of these mirco-satellite DNA markers to the trembling disease resistant populations of *E. sinensis* will be of additional importance. There is need to carry out more such studies on bigger numbers of *E. sinensis* which can be a good representative of the entire *E. sinensis* populations. This study therefore suggests that future studies of molecular pathogenicity in *E. sinensis* are inevitable. This study will provide the theoretical basis for molecular marker-assisted breeding in *Eriocheirsinensis* in future.

## VI. Acknowledgements

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Conflict of interest (s)

The authors of this study herein disclaim any conflict (s) of interest (s).

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# Length-Weight Relationship, Condition Factor and Aspects of Growth Parameters of the Black Tiger Shrimp (*Penaeus monodon*) in the Andoni River System, Niger Delta, Nigeria

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*Abstract-* The investigation of length-weight relationship, condition factor and some growth parameters of the black tiger shrimp (*Penaeus monodon*) were carried out in a monthly sampling over a period of twelve months in Andoni river system. The length-weight relationship of the shrimp was estimated using linear regression, a technique incorporated in the FAO-ICLARM Stock Assessment Tool (FiSAT). The condition factor of the shrimp was estimated from Fulton Condition factor (K) while age & growth structure of the shrimps were estimated using the modified Peterson method also known as the integrated method. The length-weight relationship showed a negative allometric growth pattern with values ranging from 1.4604 ± 0.0828 to 1.2999±0.0692 while Condition factor (K) varied from 0.5914 to 0.6909. The age or longevity of the oldest tiger shrimp was 3.448 years. Asymptotic length (L∞) and growth coefficient (K) were 31.5cm and 0.870yr-$^{1}$ respectively. The length at first capture $L_c$ was 12.44cm. The growth performance index ($\phi$) was 2.936.

*Keywords:* *Black tiger shrimp, morphometry, longevity, well-being, Andoni River, Nigeria.*

*GJSFR-D Classification:* *FOR Code: 070799*


*Strictly as per the compliance and regulations of :*

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Komi, Gentle Wilson [α] & Francis, Amiye [σ]

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## I. Introduction

The study of length-weight relationship and condition factor of the black tiger shrimp (*Penaeus monodon)* in the Andoni River System, comes on the heels of the invasion and establishment of the black tiger shrimp in the coastal waters of Nigeria. Its invasion was first reported in 1999 by a trawl fishing company (FAO 2000). The natural distribution is Indo-West-Pacific, ranging from the eastern coast of Africa, the Arabian Peninsula, South-east Asia and the sea of Jordan as well as eastern Australia and the Mediterranean Sea. Further invasive populations have become established in Hawaii and the Atlantic coast of the USA --Florida, Georgia and South Carolina (Suthep, 2015; Fuller *et al*., 2014).

*a) Length-weight relationship*

Length and weight data studies are used to estimate growth rates, age structure and other aspects of crustacean population (Nahavandi *et al.,* 2010). Length-weight relationship is an indicator of condition of marine crustaceans which reflects fluctuations in energy uptake, utilization and well being of the stock. Factors that affect crustacean morphometry include overcrowding, disease outbreak, stress, food, and reproductive cycle (Nahavandi *et al*., 2010, Pauly, 1993; Chu *et al*., 1995). Length-weight relationship varies among species, sexes, sampling sites and seasons. Seasonal changes in length-weight relationship of wild shrimp populations correlate with seasonal variation in reproductive biology and mature shrimps have heavier weight at length than immature ones (Nahavandi *et al*., 2010, Chu *et al*., 1995).

In the use of the formula $W = aL^b$ for length-weight relationship, 'a' which is the intercept while 'b' is the slope which indicates the growth coefficient or relative growth rate (Amin *et al*., 2009). A characteristic feature of length-weight relation is the exponent "b". When the value of b is 3, growth in weight is said to be isometric (without changing shape). This is on the assumption that weight increase is proportional to the cube of length increment. When 'b' value is less than or greater than 3, weight growth is said to be allometric (crustacean changes weight as it grows larger). If slope value 'b' is significantly less than 3 (negative allometric), it implies that the crustacean becomes slender as it increases in length whereas b> 3 (positive allometric) indicates stoutness (Kurup *et al*., 2000).

*b) Condition Factor*

Condition factor (K) is an index of the interaction between living and non-living factors on the physiological condition of an aquatic organism (shrimp). It is an index of the well-being of a given population assessed based on the weight at a given length of the species (Lalrinsanga *et al.,* 2012). Condition factor is an indicator of the energetic condition or energy reserves in a species (Lambert and Dutil, 1997). Though condition factor (K) does not show the qualitative (protein, lipid, Ash, nitrogen free extract and moisture content) value of a fish, it is complementary to proximate analysis (Sutton *et al.,* 2000). Condition factor indicates recent biological and physical interactions and fluctuations especially as

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it relates to feeding condition, parasitic infections, physiological factors, food reserves and general well-being of fish (Le Cren, 1951, Lalrinsanga *et al.,* 2012). Condition factor K determined by Lalrinsanga *et al*. (2012) ranged from 0.79 to 1.41. Kunda *et al*. (2008) reported condition factor K of 1.09 in *Metapanaeus rosenbergii*. Okayi, & Iorkyaa (2004) reported condition factor of 1.014 and 2.031 for *Atya gabonensis* and *Macrobrachium felicinium* in Mu River. Araneda *et al.* (2008) reported high condition factor (K) of 0.674 in 180shrimpm$^{-2}$ treatment, 0.670 in 130shrimpm$^{-2}$ and 0.663 in 90shrimpm$^{-2}$ treatments of the Pacific white shrimp *Litopenaeus vannamei* cultured in fresh water. Okayi *et al*. (2012) attributed low condition factor to poor adaptability to fresh water. Condition factors of fresh water shrimp *A. gabonensis* from two water bodies in Nigeria ranged from 1.875 for species in Jebba Lake to 3.330 for species at Lokoja river suggesting habitat difference and changing conditions all year round (Okayi *et al*., 2012).

*c) Age and Growth*

Amin *et al.* (2009) used the estimated growth coefficient (K=1.4yr$^{-1}$) of *A. japonicus* to predict longevity ($t_{max}$ = 3/k) to be 2.14 years. It is assumed as in ELEFAN-I analysis that the value of the third parameter of the Von Bertalanffy growth function '$t_0$' to be zero. Hence, the sizes attained by *A. japonicus* were 6.16mm, 10.7mm, 14.64mm, 17.70mm, 19.98mm and 21.91mm at the end of 2, 4, 6, 8, 10, and 12 months of age, respectively, given that $L_\infty$ = 29.08mm and K=1.4yr$^{-1}$. Yassien (2004) used the Von Bertalanffy growth equations to describe the age-at-length of *Penaeus semisulcatus* $L_t$ = 19.721 (1-e$^{-1.104}$ (t-0.018) for females. Estimating $L_\infty$ = 19.721, K = 1.104, $t_o$ = -0.230 and $\Phi$ = 2.056 for males and $L_\infty$ = 22.149 cm, K =1.004, $t_o$ = 0.018 and $\Phi$ = 2.090 for females. Lalitha (1987) reported Von Bertalanffy growth parameters in *Penaeus monodon*, *Metapenaeus monoceros* and *M. dobsoni*. $L_\infty$, K and $t_0$ in *P. monodon* were estimated to be 35.7cm, 1.206 and 0.41 respectively, in females while 29.69cm, 2.316 and 0.138 respectively, in males. In *M. monoceros* the values were $L_\infty$ = 21.62cm, K = 0.996 and $t_c$ = -0.044 in females while in males $L_\infty$ = 20.84cm, K = 0.972 and $t_a$ = -0.063. In *M. dobsoni* the value of $L_\infty$ = 14.00cm, K = 1.69 and t = 0.115.

In the assessment of tiger shrimp (*P. monodon*) in Kuala Bara, Miri Sarawak, male shrimp sizes ranged from 10.35cm (total length, weight of 20g) to 22.07cm (total length and weighed 156g). The size of female shrimps caught ranged from 16.3cm (total length, weight of 30g) to 28.2cm (total length, weighed 210g) (Hadil & Albert, 2001). The Asymptotic length ($L_\infty$) and growth constant (K) of some penaeid shrimps of Bangladesh (Khan et al., 2003) were $L_\infty$ = 29.0cm and K = 1.29yr$^{-1}$ for males of *P. monodon* while females were $L_\infty$ = 32.5cm and K = 1.2yr$^{-1}$. *P. semisulcatus* $L_\infty$ = 24.7cm and K = 1.36yr$^{-1}$ for male, $L_\infty$ = 25.6cm and K = 1.28yr$^{-1}$ for females. P. *merguiensis* $L_\infty$ = 17.92, K = 1.235 for males while $L_\infty$ = 22.10 and K = 1.299 for female. In males of *Metapenaeus monoceros* $L_\infty$ = 17.50cm and K = 1.40yr$^{-1}$ while female $L_\infty$ = 18.0cm and K = 1.32yr$^{-1}$. All available research on penaeid shrimps show *P. monodon* to have the highest asymptotic length. *Metapenaeus elegans* has maximum length of 4.26cm at 1.3yr$^{-1}$ growth rate (K) (Suradi, 2010).

Dinh *et al*., (2010) reported the growth of eight species of shrimps in littoral marine waters of the Mekong Delta as follows: *Haliporodes sibogae* $L_\infty$ = 12.8cm and K = 0.77yr$^{-1}$, *Harpiosquilla harpax* $L_\infty$ = 21.0cm and K = 0.89yr$^{-1}$, *Metapenaeus affinis* $L_\infty$ 19.0cm and K = 1.00yr$^{-1}$, *Metapenaeus brevicomis* $L_\infty$ = 15.5cm and K = 0.87yr$^{-1}$, *Metapenaeus tenuipes* $L_\infty$ = 14.5cm and K = 0.78yr$^{-1}$, *Parapenaeopsis cultrirostris* $L_\infty$ = 19.0cm and K = 0.45yr$^{-1}$, *Parapenaeopsis* gracillima $L_\infty$ = 10.2cm and K = 0.79yr$^{-1}$ and *Parapenaeopsis maxillipedo* $L_\infty$ = 13.5cm and K = 1.30yr$^{-1}$. The largest size shrimp (*Harpiosquilla harpax*) was 21.0cm while the smallest (*Parapenaeopsis gracillima*) was 10.2cm (Dinh *et al.,* 2010). Shrimps grow rapidly and reach reproductive maturity at the age of six months. Commercial value increase as they grow larger over 9 to 12 months (Dichmont *et al*., 2007).

This research was necessitated by the paucity of knowledge in length-weight relationship, condition factor, age and growth of this economically important invasive shrimp species which is established in Nigeria's waters. The study therefore, aimed at providing a baseline data on some aspects of the biology of the black tiger shrimp (*Penaeus monodon*) for further investigation.

## II. Materials and Methods

*a) Study Area*

The Andoni river is located between latitudes 4$^0$28' to 4$^0$45' N and longitudes 7$^0$45' E (Figure 1). It is a major fish nursery in the Niger Delta region of Nigeria, West coast of Africa.

The Andoni River, which is one of the numerous rivers through which rivers Niger and Benue drain into the Atlantic Ocean, is located within the rainforest belt of Nigeria (Francis, 2003).

The fishers use tide movement to aid their transport during fishing since they primarily use dugout canoe (unmotorized canoe) in fishing. The Andoni river is brackish with annual salinity range of 10 – 28% (Yoloye, 1976), 5% to 22% (Francis, 2003).

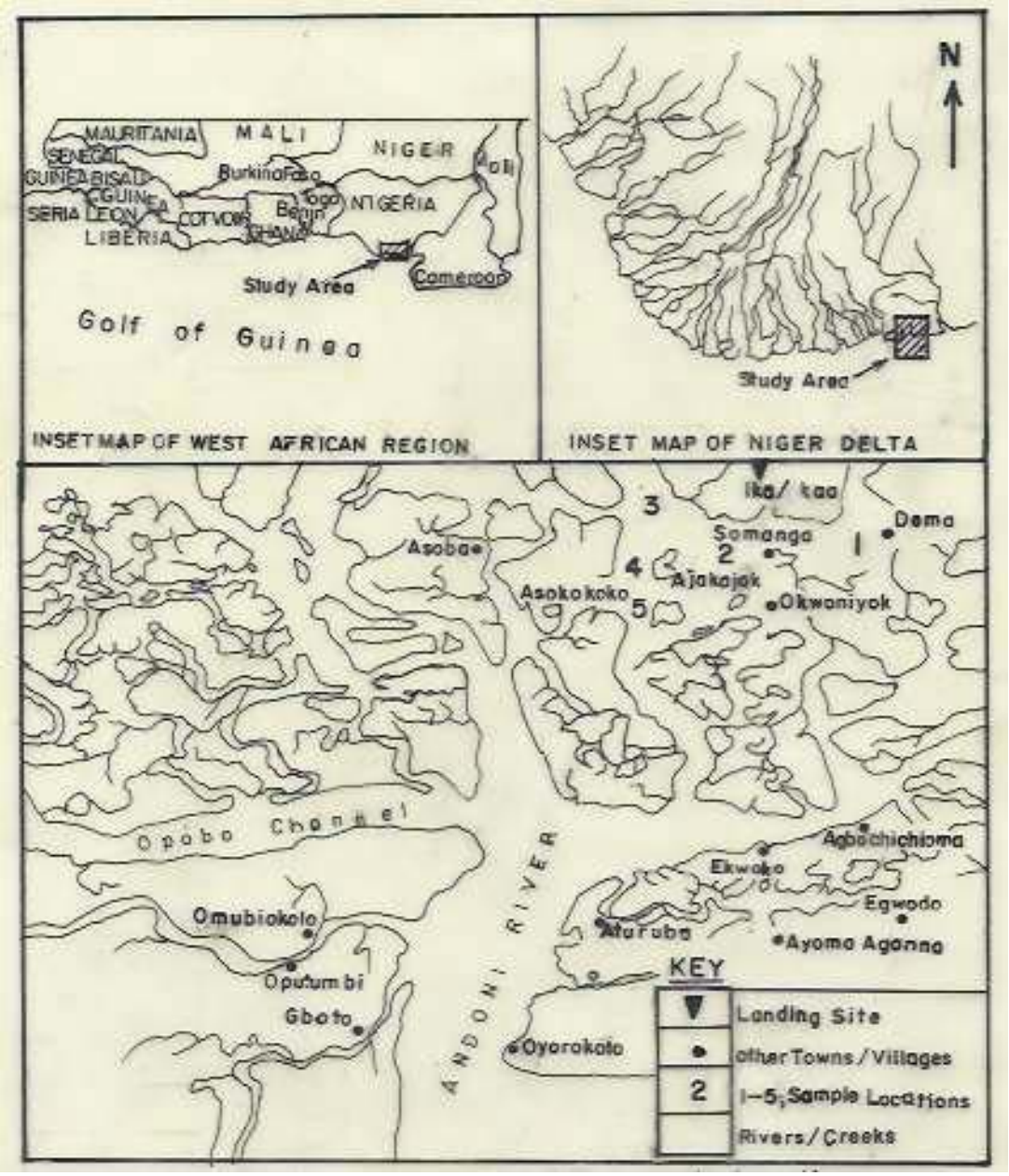


*Fig. 1:* Map of Andoni river system showing sample locations (Source: Francis *et al.*, 2007)

The Andoni river system has two main landing sites viz; Kaa water front and Oyorokoto fishing settlement. Kaa water front is located between $4^0$33.915'N to $4^0$34.248'N and $7^0$21.746'E to $7^0$22.637'E (fig 1). Kaa (Ika) fish market is the major point of sales of live, fresh and smoked fish products.

*b) Research design*

Landing survey, otherwise known as catch assessment survey described by Stamatopoulos (2002), was conducted at Kaa landing site once in every first week of the month for a period of twelve months (from March, 2012 to February, 2013). The data collected included quantity of catch, species composition, associated effort, and other secondary data such as prices, weight and length of the black tiger shrimp landed (Sobo, 2004).

*c) Fish Sampling*

A representative minimum sub-sample of 30 pieces of the Black tiger shrimp (*P. monodon)* was collected monthly at Kaa landing site. The sub-sample was an estimated fraction of the entire catch landed per day.

*d) Length Measurement*

Total length (distance from tip of rostrum to the tip of telson) of each shrimp of the sub-sample was measured using a digital Vernier caliper and transparent plastic ruler. Measurement of lengths was recorded in centimeter.

*e) Weight measurement*

The weight of each specimen was determined using Ohaus electronic weighing balance. Measurement of weight of shrimp was done by zeroing the weight of a plastic bowl and then placing the specimen in the bowl. Weight was measured in grams.

Length analysis was in accordance with FAO ICLARM Stock Assessment Tool (FiSAT) software format Gayanilo and Pauly (1997) in which only the mid-lengths and mean weights of the classes were employed. ELEFAN1 method (Gayanilo *et al.,* 1989) incorporated in FiSAT software with starting sample 11 and starting length 27.50 gave the best score function of 0.911. This generated the best combination of growth parameters.

*f) Length-Weight Relationship*

The length-weight relationship of the shrimp was estimated using linear regression (Pauly, 1983). The technique is incorporated in the FAO ICLARM Stock Assessment Tool (FiSAT) Gayanilo and Pauly (1997) which is used in fisheries.

The length-weight relationship was obtained from the equation;

$$W = aL^b \quad \text{(Pauly, 1983; Sparre } et.al.,\text{ 1989)----------} \quad (1)$$

Where
W = Weight of shrimps (g)
L = Length of shrimps (cm)
a = Intercept
b = Slope

The values of 'a' and 'b' was given a logarithmic transformation according to the following formula:

$$\text{Log}_{10}\, W = a + b \log L \text{ (Pauly, 1983) ----------} \quad (2)$$

The intercept "a" in the formula was estimated with the formula:
Where $Y = \log_{10} W$
and $X = \log_{10} L$
Y = Weight of shrimps
X = Length of shrimps

This formula corresponds to the linear regression routine option 3 in FiSAT (FAO-ICLARM Stock assessment tool) software used for the analysis. The data used in this analysis were lengths and weights measurement of *P. monodon* landed at Kaa landing site of the Andoni river system from March 2012 to February 2013.

*g) Condition factor*

Condition factor is the plumpness of a shrimp. It determines the well being of shrimp species in a particular water body. The condition factors of the shrimps were estimated from Fulton's Condition (K) as suggested by (Enin, 1995; Gayanilo *et al.,* 1989).
For isometric growth

$$K = \frac{100W}{L^3} \quad \text{.....(3)}$$

For allometric growth

$$K = \frac{100W}{L^{3.5}} \quad \text{.....(4)}$$

Where K = Condition factor
W = Wet weight of sampled shrimp (g)
L = Total length of the shrimp (cm)

The data used in this analysis were the monthly lengths and weights measurements of *P. monodon* landed at Kaa landing site of the Andoni river system.

*h) Age and growth*

Age structure of the shrimps obtained during the period of study was estimated using the modified Peterson method also known as the integrated method (Pauly, 1983; Sparre *et al*., 1989). Monthly length measurement was pooled and plotted on a graph to obtain length frequency distribution for the period of study (March, 2012 to February, 2013) at 5cm class interval. The same process was repeated along the time axis on the assumption that growth pattern repeats itself from year to year. Pauly's integrated frequency model is based on the assumption that growth in length is rapid initially, then decreasing smoothly, passing through most of the discrete peaks. The single smooth curve is assumed to represent the average growth of *P. monodon* as the growth pattern repeats itself yearly.

The relative age and corresponding modal lengths of *P. monodon* from the Andoni river system were read from the length-frequency distribution plot. The data obtained from the relative ages and their modal lengths were fed into FiSAT as length- at-age data to produce estimates of asymptotic length ($L\infty$), growth performance index ($\phi$), slope (b), growth rate (K), and longevity ($t_{max}$). The relative ages and modal lengths of *P. monodon* were determined by tracing the progression of modes identified in the Pauly (1983) integrated distribution curve (Figure 3) and represented in Table 3.

## III. Results

*a) Length-Weight Relationship*

The parameters of length-weight relationships (Table 1) for combined sexes of *P. monodon* from the Andoni river system indicated that the 'b' values ranged from 1.2999±0.0692 to 1.4604±0.0828, while 'a' values varied from -0.0332 to -0.1567 and the regression coefficient 'r' ranged from 0.9401 to 0.9781during the period of the study. The regression between total length and total body weight (Figure 2) showed negative allometric growth pattern.

*b) Condition Factor*

The Condition Factor (K) from March 2012 to February 2013 ranged from 0.5914 to 0.6909 (Table 2). Variation was very negligible indicating that the species grew in the same habitat and are exposed to the same condition throughout the period of study.

*Table 1:* The Regression of Length-Weight Relationship of *P. monodon* in the Andoni river system

| Month | N | A | b±SD | 95% CI of b | R |
|---|---|---|---|---|---|
| Mar-12 | 30 | -0.0332 | 1.3813±0.0562 | 1.2661-1.4965 | 0.9776 |
| Apr-12 | 30 | -0.1567 | 1.4604±0.0828 | 1.2906-1.6302 | 0.9578 |
| May-12 | 30 | -0.1515 | 1.3920±0.0954 | 1.1964-1.5875 | 0.9401 |
| Jun-12 | 32 | -0.0742 | 1.2999±0.0692 | 1.1587-1.4412 | 0.96 |
| Jul-12 | 30 | -0.1015 | 1.3677±0.0781 | 1.2076-1.5279 | 0.9572 |
| Aug-12 | 32 | -0.1101 | 1.4063±0.0777 | 1.2479-1.5647 | 0.9572 |
| Sep-12 | 32 | -0.0552 | 1.3838±0.0537 | 1.2741-1.4934 | 0.9781 |
| Oct-12 | 30 | -0.0712 | 1.3904±0.670 | 1.2530-1.5277 | 0.969 |
| Nov-12 | 32 | -0.0738 | 1.4074±0.0674 | 1.2700-1.5448 | 0.9673 |
| Dec-12 | 30 | -0.0863 | 1.4232±0.0672 | 1.2854-1.5610 | 0.9701 |
| Jan-13 | 33 | -0.0889 | 1.3754±0.0702 | 1.2335-1.5173 | 0.9619 |
| Feb-13 | 35 | -0.0738 | 1.3923±0.0616 | 1.2692-1.5155 | 0.9692 |

*Where N=Sample size, a and b= parameters of the Length-weight Relationship, SD= standard deviation of slope b, CI= Class Interval, r= Coefficient of correlation.*

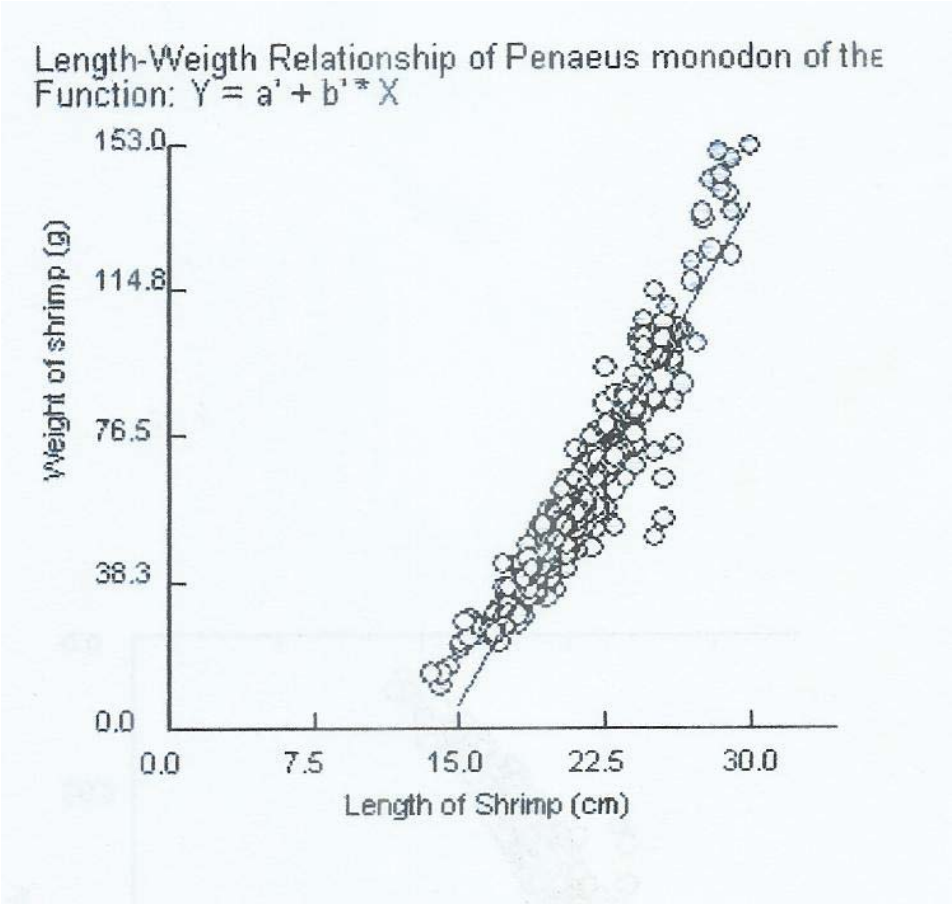


*Fig. 2:* Length-Weight Relationship of *P. monodon* of the Andoni river system

*Table 2:* Condition Factor of *Penaeus monodon* of the Andoni river system (March, 2012 to February, 2013)

| S/N | Month | Mean Weight(g) | Mean Length(cm) | Condition Factor (K) |
|---|---|---|---|---|
| 1 | Mar-12 | 68.37 | 22.18 | 0.6266 |
| 2 | Apr-12 | 65.59 | 21.35 | 0.6739 |
| 3 | May-12 | 47.64 | 19.83 | 0.6109 |
| 4 | Jun-12 | 38.26 | 18.4 | 0.6142 |
| 5 | Jul-12 | 52.13 | 20.48 | 0.6069 |
| 6 | Aug-12 | 60.79 | 21.38 | 0.622 |
| 7 | Sep-12 | 66.74 | 22.3 | 0.6018 |
| 8 | Oct-12 | 67.28 | 22.49 | 0.5914 |
| 9 | Nov-12 | 63.53 | 20.95 | 0.6909 |
| 10 | Dec-12 | 72.07 | 22.52 | 0.631 |
| 11 | Jan-13 | 54.56 | 20.72 | 0.6133 |
| 12 | Feb-13 | 58.81 | 50.57 | 0.6757 |

*c) Age and growth Determination*

Figure 3 showed that age was proportional to annual increment. As the stock gets older, growth slows down. The curve cutting through the ages (Figure 3) describes the growth pattern relative to age. Specimens were at their growth peak at age 2+. Five cohorts were identified. The 0+ cohort had a modal length ($L_T$) of 14cm while the 5$^{th}$ cohort had a modal length of 30cm as seen on Table 3.

From the length frequency distribution *P. monodon* of length 21cm was most abundantly caught during the fishing seasons. This length corresponds to two years (2+) of age (Table 3).

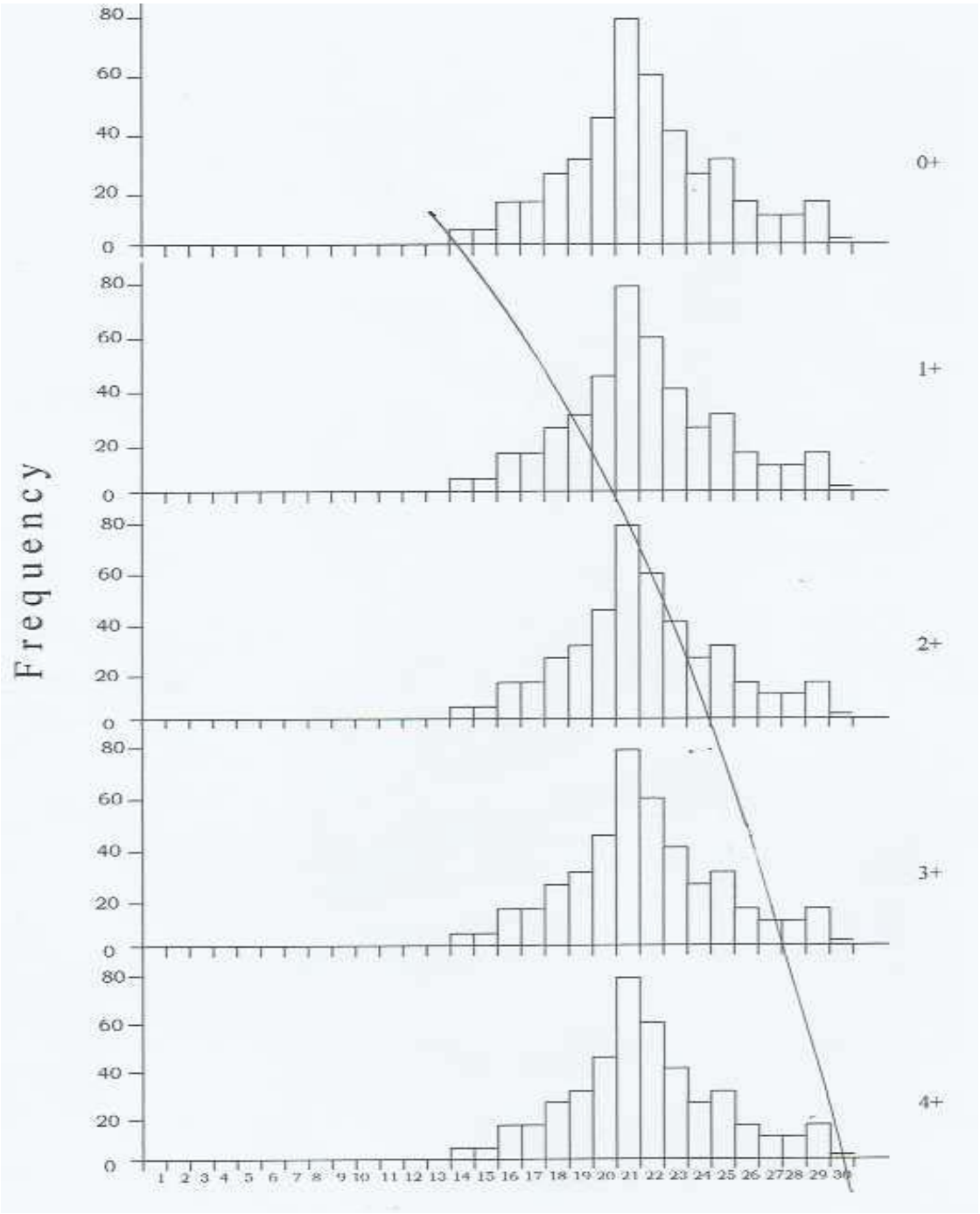


*Figure 3:* Pauly's Integrated Length-Frequency Method for estimating relative age of *P. monodon*

*Table 3:* Length at age and annual length increment of *P monodon* in Andoni river system

| Age | Modal length $L_T$ (cm) | Annual Increment | $L_T+1$ |
|---|---|---|---|
| 0+ | 14 | 14 | 19 |
| 1+ | 19 | 5 | 21 |
| 2+ | 21 | 2 | 27 |
| 3+ | 27 | 6 | 30 |
| 4+ | 30 | 3 | |

*$L_t$ +1 = Length separated by one year interval*

## III. Discussion and Conclusions

*a) Length-Weight Relationship*

The length-weight relationship of *P. monodon* in the Andoni River indicated negative allometric growth pattern. The slope 'b' of the length-weight regression ranged from 1.2999 $\pm$ 0.0692 to 1.4604 $\pm$ 0.0828. These values are significantly less than 3 implying that the black tiger shrimp (*P. monodon)* becomes slender as it increases in length (Kurup *et al.*, 2000, Lalrinsanga *et al.*, 2012). Hadil and Albert (2001) reported negative allometric growth pattern in *P. monodon* of Kuara Baram (b = 2.16 & 2.43 for males & females respectively). Lalitha (1987) observed isometric growth in *P. monodon* (b = 3.19 & 3.25 for males & females respectively) of Kakinada. In Tanzania, Teikwa & Mgaya (2003) reported isometric growth in males and negative allometric growth patterns in females of *P.monodon* (b = 3.106 in males & b = 2.299 in females).

The growth rate of the black tiger shrimp (*P. monodon)* in the Andoni river system may likely be influenced by competition and adaptation challenges. Being an alien species, *P. monodon* requires some more time before population explosion can occur.

The low 'b' values indicated lower weight gained relative to increase in length. Similar low weight gain was reported by Lalrinsanga *et al.* (2012) in their studies on giant freshwater prawn. The low 'b' value reported in this study can also be attributed to lack of berried females in the landed population. Weight of maturing and berried females increases the b values (Lalrinsanga *et al.*, 2012). Peixoto *et al.* (2003) attributed about 8% of total body weight of *P. monodon* to additional weight of ovaries while in wild *Fenneropenaeus paulensis* 13% of body weight is attributed to the weight of ovaries.

*b) Condition factor*

The condition factor (K) of the black tiger shrimp (*P. monodon)* from the Andoni river system ranged from 0.5914 to 0.6909. These values are relatively lower compared to those of Lalrinsanga *et al*. (2012) where K ranged from 0.79 to 1.41, Okayi, & Iorkyaa (2004) where K = 1.014 and 2.031 and Okayi *et al.* (2012) in which K was 1.875 for *A. gabonensis* in Jebba River.

Indigenous species seem to have higher condition factor than exotic species. However, upon adaptation, exotic species compete favourably and in most cases dominate the population. The low condition factor of the black tiger shrimp can be attributed to competition and physico-chemical parameters of the new environment.

*c) Age and growth*

The asymptotic length ($L\infty$) of the black tiger shrimp (*P. monodon)* in the Andoni river system was 31.5cm and the growth coefficient (K) = 0.87yr$^{-1}$. Asymptotic length, however, ranged from 25.8 to 36.3cm. This is comparable to the asymptotic length ($L\infty$) of 35.7cm reported by Lalitha (1987) for *P. monodon* in Kakinada, India.

The black tiger shrimp in Andoni river system is estimated to live up to 3.5yrs which is relatively higher than that of *Acetes japonicus* whose $t_{max}$ is 2.14 years (Amin *et al.,* 2009). This is as a result of difference in species. *Penaeus notialis* (Farfantepenaeus) was estimated to live for 22 to 23 months and referred to as short-lived considering their longevity (Nwosu, 2009).

Length-at-age of the black tiger shrimp (*P. monodon)* in Andoni river system were 14cm, 17cm, 19cm, 21cm and 26cm for ages of 0, 1, 2, 3 and 4 years. Shrimps grow rapidly and reach reproductive maturity at 6 months of age. The larger the size, the higher the commercial value (Dichmont *et al.*, 2007), hence, the black tiger shrimp (*P. monodon)* was the most expensive shrimp species.

The growth performance index of the black tiger shrimp (*P. monodon)* ($\Phi$ = 2.936) was an indication of rapid growth rate which enhances the aquaculture potential of the species. Amin *et al*. (2009) reported the growth performance index of *Acetes japonicus* to be 3.073 which is quite high compared with 2.10 and 1.97 for females and males *Acetes chinensis* respectively (Oh and Jeong, 2003).

The length-weight relationship, condition factor, age and growth parameters are comparable to works done by earlier researchers indicating that the Andoni river system was suitable for the growth and wellbeing of the black tiger shrimp. A comparative study of the growth parameters of the native species of shrimps with the exotic black tiger shrimp (*P. monodon*) is however required for a holistic assessment of the quality of the brackish water condition of Andoni river system for sustainable production of the stocks.

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# Irish Potato (Solanum Tuberosum) Variety Evaluation at Bule Hora District of Borena Zone

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*Abstract-* Adaptability of crops can vary from location to location depending on the agro-ecology of a particular area. Therefore, it is essential to conduct location specific adaptation trial to identify suitable variety/varieites. Accordingly, an adaptation trial of Irish potato varieties was conducted in Bule hora district to identify potato varieties that is better in adaptation, yield and other agronomic characteristics, and pest and disease tolerant. The released varieties (Gudane, Jalane, Marachere, Guassa, Gorobela and Gera) were brought from Holeta Agricultural research center. Local variety was also included. The seven treatments (varieties) were laid out in RCBD with three replications. Significant variation was observed among the varieties for days to flowering, days to maturity, Unmarketable yield, marketable yield, number of tubers per hill, tuber weight per hill, stand count and tuber yield. There was no significant difference for tuber drymatter.

*Keywords:* *Irish potato; variety; adaptation.*

*GJSFR-D Classification:* *FOR Code: 079999*


*Strictly as per the compliance and regulations of :*

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*Abstract-* Adaptability of crops can vary from location to location depending on the agro-ecology of a particular area. Therefore, it is essential to conduct location specific adaptation trial to identify suitable variety/varieites. Accordingly, an adaptation trial of Irish potato varieties was conducted in Bule hora district to identify potato varieties that is better in adaptation, yield and other agronomic characteristics, and pest and disease tolerant. The released varieties (Gudane, Jalane, Marachere, Guassa, Gorobela and Gera) were brought from Holeta Agricultural research center. Local variety was also included. The seven treatments (varieties) were laid out in RCBD with three replications. Significant variation was observed among the varieties for days to flowering, days to maturity, Unmarketable yield, marketable yield, number of tubers per hill, tuber weight per hill, stand count and tuber yield. There was no significant difference for tuber drymatter. The varieties Gorobella and local were earlier in maturity than other varieties except Jalane and Gudane. Even though significantly higher number of tubers was recorded in local, most of them were unmarketable. This is because, local was significantly higher in unmarketable yield but significantly lower in total yield and marketable yield than Gorobela, Gudane and jalane. The varieties Gorobela, Gudane and Jalane were significantly higher in total yield than all the varieties except Guassa. But, they were significantly higher in Marketable yield than all the varieties. They have got 66.3, 63.8 and 53.3% marketable yield increments over local respectively. Therefore, the varieties Gorobela, Gudane and Jalane can be appropriate varieties to be recommended for the farmers in the area to improve their Irish potato productivity.

*Keywords: Irish potato; variety; adaptation.*

## I. Introduction

An Irish potato is an edible tuber from the *Solanum tuberosum* plant, which is actually native to South America, not Ireland. Irish potatoes are named after Ireland because they are closely associated with the Irish potato famine, a historical famine caused by a mold infestation of the Irish potato crop [1, 2] Irish potato is the fourth most important crop in the world after wheat, maize, and rice with annual production of 314.1 million tons cultivated on about 18.1 million hectares of land [3]. In Ethiopia Irish potato has promising prospect in improving the quality of the basic diet in both rural and urban areas [4]. It is a short duration crop that can mature within short period of time. Potato production has been considered as the first priority compared to other food crops because of its contribution to food security, income generation and double cropping advantages and its utilization in different forms [5, 6]. White potato became an essential staple in the diets of common people throughout Europe. In Ireland, where the crop did extremely well, potato was the only staple food. It is also advantageous in that its' consumable part, the tubers, are below the ground that not subjected to some vertebrate pests like birds and to some insect pest attack.

It is the world's fourth-largest food crop, following rice, wheat, and maize. Long-term storage of potatoes requires specialized care in cold warehouses [3]. It is also widely produced in Ethiopia. From vegetable crops it stands second next to enset (*Ensete ventricosum*) in area coverage in Ethiopia and also gives high yield per unit area [7]. Most of the small holder farmers were used low yielding and susceptible to potato disease because of limited availability of improved variety in the country [8, 9]. Lack of proper storage system is among the liming factors contributing to the low yield of potato in the region, which is the case at the country level [10].

In the study area, Bule hora district, potato varieties available at hand of farmers are poor yielders which have been under production for many years. Therefore developing and making available adaptable, high yielding and pest and disease tolerant varieties of potato is a priority concern in its productivity increase strategy.

*a) Objective*

- To identify potato varieties that is better in adaptation, yield and other agronomic characteristics, and pest and disease tolerant.

## II. Materials and Methods

*a) Description of the study area*

The experiment was conducted at Gerba research site which was found in Bule hora district of Borena zone and it is located south of Addis Ababa at 453 Km. The site is characterized by bimodal rain fall. The first is from March to June and the second is from September to November. The altitude of the area is 2243. Potato is the most staple food crop and coffee is major cash crop in Bule hora district.

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*b) Planting materials and experimental methodology*

Six improved and recommended potato varieties namely: Jallane, Guddane, Gorobela, Marechere, Guassa, Gera introduced from Holeta research center and with one local variety was tried for their adaptation at gerba research site. The site was cleared; ploughed, harrowed, and fine seed bed was prepared. Planting of tubers was carried out with spot application of phosphorous in the form of DAP at time of planting while nitrogen top dressing was carried out after full emergence as the recommendation by [8] (Girma, 2001).The experimental design was RCBD with three replications.

*c) Data collected and statistical analysis*

The data collected were days to flowering 50%, Days to maturity, disease and pest score, harvestable fresh yield at maturity (kg/ha), Above ground biomass, harvest index (dry mater partitioning), stand count at harvest, total tuber number per plant or hill, average tuber weight /plant or hill, Marketable yield, Unmarketable yield, Tuber DM (%). Data was analyzed using SAS software and mean separation was done using LSD.

## III. Result and Discussion

*a) Phenological parameters*

i. *Days to flowering*

There was a significant variation among the varieties for days to flowering (table 1). The variety Gorobela was the fastest in flowering followed by Gudane (Table 2. Guassa and Marachere were significantly higher in number of days to maturity. It took 60 days for both varieties.

ii. *Days to maturity*

Days to maturity were significantly different among the varieties (Table 1). Gorobella and local varieties were significantly earlier in maturity than other varieties except Jalane and Gudane (Table 2). It took significantly longest time (128.7 days) for Guassa, but not significantly different from Marachere (125.6 days).

*b) Tuber yield and yield components*

i. *Number of tubers per hill (NTPH)*

In the case of number of tubers per hill there is a significant difference among the varieties (Table 1). Local variety significantly exceeded all other varieties (Table 2). Gera and Marachere are significantly lower in NTPH than local, Guassa and Jalane but not significantly different from Gorobela and Gudane. In Gorobella, Gudane and Jalane the number of tubers are relatively lower but they have got large size so that large weight. In contrary, local has got largest number of tubers but most of the tubers are small below marketable size and were unhealthy.

ii. *Unmarketable yield (UNMY)*

Unmarketable tubers include unhealthy and less than 25g size category and calculated on the basis of t/ha. UNMY was significantly different among the varieties. Local is significantly higher than all other varieties with total amount of 3.38 t/ha UNMY (Table 2). The improved varieties are not significantly different. This implies that in local cultivar large amount of the yield is below the size required on market and also unhealthy.

iii. *Marketable yield (MY)*

In the case of MY, there was also significant variation among the varieties (Table 1). Gorobela, Gudane and Jalane are significantly higher in MY when compared to the other varieties except Guassa (Table 2). They have got 66.3, 63.8 and 53.3% marketable yield increments over local respectively. The varieties Marachere and Gera are not significantly different from local in which the lowest MY was recorded. This implies that even though large number of tubers was recorded in local variety, most of them are of below the size important on market. But, varieties Gorobella, Gudane and Jalane have got smaller number of tubers which were large enough for market and were healthy.

*Table 1:* Mean squares of days to flowering, days to maturity, unmarketable yield, marketable yield, number of tubers per hill, tuber dry matter, tuber yield, Stand count and tuber weight per hill as affected by variety and replication

| | Mean squares | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Source of variation | DF | DM | UNMY | MY | NTPH | TDM (%) | TYLD (t/ha) | SC | TWPH |
| Varieties | 6 | 143.15* | 19.78*** | 276.36* | 51.25*** | 57.63ns | 256.19* | 37174211.2*** | 0.113064ns |
| Replication | 2 | 10.71ns | .o6ns | 66.61ns | 5.07ns | 26.35ns | 66.73ns | 4291593.2ns | 0.02436ns |
| Error | 12 | 10.65 | 0.1496 | 57.98 | 3.62 | 54.16 | 56.49 | 3605722.1 | 0.04630686 |

*DF-degree of freedom, DM-day of maturity UNMY- Unmarketable yield, MY-marketable yield*
*NTPH-Number of tuber per hill TDM-Tuber dry matter TYLD-Total yield Sc-stand count TWPH-tuber weight per hill*

*c) Tuber Dry matter (TDM)*

There was no significant difference among the varieties. That means dry matter content among the varieties is not statistically different.

*d) Tuber weight per hill*

Tuber weight per hill was significantly affected by difference in varieties (Table). The varieties Jalane, Gudane and Gorobella were significantly higher in tuber weight per hill than Marachere and Gera. But they were not significantly different from the local. This might be due to the fact that larger number of tubers per hill recorded in local could contribute to the weight as well. Gorobella, Gudane and Jalane were significantly lower in tuber number per hill but their healthy and larger sized tubers enabled them to have significantly higher tuber weight than other improved varieties.

*e) Stand count*

There was also significant difference in stand count (Table 2). Gudane, Marachere, and Gorobella are significantly higher in stand count when compared to the other varieties. But, they were at par with the variety Guassa. The lowest number of plants was recorded in the local variety.

*f) Tuber yield (TYLD)*

In the case of tuber yield, there was a significant difference among the varieties (Table 1). So that the varieties Gorobella, Gudane and Jalane were significantly higher in TYLD than the other varieties except Guassa which was not significantly different from Marachere and local as well (Table 2.). The variety Gera is the least of all varieties. In Gorobella, Gudane and Jalane the higher tuber weight per hill was the major yield component contributing to higher yield recorded. Stand count might also be another factor for higher tuber yield in Gorobella and Gudane.

*Table 2:* Mean values of Days to maturity, Unmarketable yield, Marketable yield, Number of tubers per hill, tuber dry matter, tuber yield, stand count and tuber weight per hill as affected by varieties

| | Days to flowering | Days to maturity | UNMY | MY | NTPH | TDM | YLD (t/ha) | SC /ha | T. weight/hill |
|---|---|---|---|---|---|---|---|---|---|
| Varieties | | | | | | | | | |
| Jalane | 57.67c | 121.7bc | 1.07b | 50.94a | 15.26b | 27.78 | 52.01a | 35556bc | 1.46a |
| Gudane | 54.00e | 124.0abc | 0.68bc | 54.44a | 12.59bc | 27.15 | 55.12a | 39630a | 1.39a |
| Guassa | 60.00a | 128.7a | 1.34b | 36.49bc | 14.84b | 31.88 | 48.83ab | 38519ab | 1.27ab |
| Maracher | 6.00a | 125.6ab | 1.09b | 36.92bc | 11.03c | 27.68 | 38.01bc | 39259a | 0.97b |
| Local | 55.33d | 118.3c | 3.38a | 33.22c | 22.23a | 20.19 | 36.40bc | 30741d | 1.19ab |
| Gorobella | 51.00f | 119.0c | 0.95bc | 55.25a | 12.44bc | 34.10 | 56.20a | 40741a | 1.39a |
| Gera | 58.67b | 125.7ab | 0.31c | 34.33bc | 9.63c | 29.36 | 34.64c | 34815c | 1.00b |
| LSD 5% | 0.71 | 5.8 | 0.69 | 13.55 | 3.39 | NS | 13.37 | 3378.1 | 0.38 |

## IV. Conclusion

Potato was required to be cultivated in Borana zone for consumption and selling purpose also. Adapting best suited varieties in the environment for increasing production and productivity and resistant to disease was a best strategies to overcome economic and food security. Adaptation and evaluation of varieties for local adaptation continued to part of strategic approach of Yabello research center in developing and promoting appropriate crop technologies in the area. In this experiment the potato varieties Gorobela, Gudane and Jalane were significantly higher in total and Marketable yield respectively than all varieties. Therefore, the varieties Gorobela Gudane and Jalane can be recommended for the farmers in the area to improve their Irish potato productivity under normal rain fall condition in the area.

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# Determinants of Market Outlet Choice of the Smallholder Mango Producers: The Case of Boloso Bombe Woreda, Wolaita Zone, Southern Ethiopia: A Multivariate Probit Approach

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*Abstract-* This study aimed at identifying of factors affecting market outlet choice of the smallholder mango producers in Boloso Bombe District, Southern Ethiopia. The survey was conducted in four randomly selected kebele administrations in the district. About 120 smallholder mango producers have been selected randomly from the four kebele administrations proportionally. Both qualitative and quantitative types of data were used. Sample households were used as source of the primary data used for the study. Both close ended and open ended (semi-structured) questionnaire was prepared to collect the data. Personal interview, focus group discussion and group discussions was used to capture adequate data. Both descriptive and inferential statistics were used to analyze the data. Multivariate probit model was used to identify factors affecting market outlet choices of the smallholder mango producers.

*Keywords:* *mango, market outlet choice, multivariate probit model.*

*GJSFR-D Classification:* *FOR Code: 079999*


*Strictly as per the compliance and regulations of :*

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*Abstract-* This study aimed at identifying of factors affecting market outlet choice of the smallholder mango producers in Boloso Bombe District, Southern Ethiopia. The survey was conducted in four randomly selected kebele administrations in the district. About 120 smallholder mango producers have been selected randomly from the four kebele administrations proportionally. Both qualitative and quantitative types of data were used. Sample households were used as source of the primary data used for the study. Both close ended and open ended (semi-structured) questionnaire was prepared to collect the data. Personal interview, focus group discussion and group discussions was used to capture adequate data. Both descriptive and inferential statistics were used to analyze the data. Multivariate probit model was used to identify factors affecting market outlet choices of the smallholder mango producers. The result obtained from multivariate probit model indicated that variables such as family size, distance to the market, quantity of mango produced, price offered, access to market information and access to non- farm income determined the decision of choice of wholesaler, collector, retailer and consumer market outlets at different significance level. Therefore, variables affecting the choice of wholesaler and consumer market outlet should be promoted and farm gate and retail price intervention is quite important to maximize the economic benefit of farmers. Quantity of mango produced and price should be promoted and get special attention to increase the contribution of mango to the household livelihood.

*Keywords: mango, market outlet choice, multivariate probit model.*

## I. Introduction

Mango fruit crop has significant importance with a potential for domestic and export markets and industrial processing (James *et al*., 2008). However, a review of literature in agro-industry value chain in Ethiopia indicated that the sector faces many challenges due to limited market outlets, limited efforts in market linkage activities and poor market information among actors (Dereje, 2007; Kaleb, 2008; Dendena *et al*., 2009). It is common in Ethiopia that majority of mango producers sell their products at nearby local market. Most of the time mango producers sell their produce to consumers and sometimes to retailers because of the market fluctuation and lack of marketing infrastructures. The other reason is maturity stage and harvesting time of mango fruit is similar. This condition increase the supply at that time and the demand is less compare to that of the supply. In this situation the price of the fruit become less and less and as result of this farmers are obliged to sale their produce at local market (Seid and Zeru, 2013). In addition to this, farm gate sale of mango is also common in Ethiopia. The main sales channels of mango in Ethiopia include direct sale to consumer, hotels, large retailers and supermarkets, wholesalers and small retailers and kiosks (James *et al*., 2008). Marketing system of mango in Ethiopia is characterized by use of traditional transportation means and marketing is mainly oriented on local market. The main constraints of mango marketing are mentioned as lack of markets to absorb the production, low price for the products, poor product handling and packaging, imperfect pricing system and lack of transparency in market information system mainly in the export market.

Marketing channel choice decisions are among the most complex and challenging decisions facing farmers and chosen channels intimately affect all other marketing decisions (Berry, 2010). Giuliani and Padulosi (2005) indicated that systematic identification of factors faced by households in market outlet choice decision along agricultural value chain is increasingly seen by agricultural research as important component of any strategy for reaching the millennium development goals especially eradication of poverty and hunger. But, studies conducted earlier on mango sector in Ethiopia (James *et al*., 2008, Tigist *et al*., 2009, Timoteos, 2009, Tiruneh, 2009, Bezabih, 2010, Ayelech, 2011, Seid and Zeru, 2013) did not touch factors affecting market outlet choice decision of small scale mango producers in spite of the fact that it is indispensable for the agricultural development programs. Mango is one of potential fruit crop produced in Boloso Bombe Woreda in Wolaita Zone which has a significant contribution to the livelihood of small scale farmers in the area thereby

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contributing to the income of the majority of smallholder producers as well as ensuring of food security. Farmers in the study area can sale their mango via multiple outlets in order to maximize expected utility thereby making a joint decision. Although farmers sale mango through different market outlets, no empirical evidences has been done on factors affecting market outlet choice of smallholder mango producers in the area. Therefore, this study was conducted with the main objective of identifying factors affecting market outlet choice of smallholder mango producers in the area.

## II. Methodology of the Study

*a) Sample Size Determination and Sampling Techniques*

Boloso Bombe Woreda was selected purposively as the study area based on the extent of mango production and participation of farmers in mango marketing. There are 18 rural kebele administrations in the Boloso Bombe Woreda. From the se rural kebele administrations, 4 kebele administrations were selected randomly. Accordingly, Adila, Bombe, M ehal Ambe and Para wocha kebele administrations were selected randomly. There are about 1150, 1210, 1220, a nd 1360 mango producers in Adila, Mehal Ambe, Bomb e and Para Wocha kebele administration, respectively. S ample frame was drawn for the study population of sele cted kebele administration and by employing Probability Proportional to Size (PPS), the number of farmers taken from each kebele was determined. Finally, based on the sampling frame drawn from each kebele administration, simple random sampling technique was applied to select the sample mango producing households. Accordingly, about 120 households have been selected randomly from the four kebele administrations proportionally.

*b) Types, Sources and Methods of Data Collection*

To conduct this study, both qualitative and quantitative types of data were used. Qualitative data collected may include demographic, socio-economic and institutional characteristics of mango producers and market outlet choices available for in the area. In addition to this, farmers' access to non-farm income and owning of on farm transport means were also collected. Quantitative data like age of the farmer, volume of mango produced, quantity of mango sold through each outlet, selling price of the mango in unit of measurement, marketing experience and distance to the nearest market were collected. Sample households were used as source of the primary data used for the study. To capture adequate data for the study, first both close ended and open ended (semi- structured) questionnaire was prepared. To collect the data, personal interview and Participatory Rural Appraisal (PRA) tools such as focus group discussion group discussions were used.

*c) Method of Data Analysis*

To change the raw data of the study into fact, both descriptive and inferential statistics were used. Descriptive statistics such as frequency, mean and percentage were used in the process of comparing socio-economic, demographic and institutional characteristics of households across market outlets choices. In addition to this, descriptive tools such as tables were used to present the results. Inferential statistics such as F-test (log-likelihood ratio test), Wald test, and pseudo $R^2$ were used to test adequacy of the model and hypothesis for the statistical significance of parameters.

*d) Econometric approach*

Determinants of the market outlet choices were identified by using multivariate probit model. Some recent empirical studies of market outlet choices assume that farmers consider a set (or bundle) of possible outlets and choose the particular marketing outlet that maximizes expected utility. They also assume that the addition or deletion of alternative outcome categories does not affect the odds among the remaining outcomes and the odds of choosing a particular market outlet over the other do not depend on which other outcomes are possibly chosen. However, in the present study more than one marketing outlet is available in the study area and farmers are more likely to simultaneously choose more than one market outlet in order to address their multiple needs. In this case, the dependent variables are the dichotomous variables indicating whether sales are made through the relevant marketing chain. The market outlets have been categorized into four groups: wholesaler, collector, retailer and consumer market outlets. Each farmer can use one or more marketing outlets or several combinations of different outlets which maximize the expected utility and due to this there is some overlapping and many farmers sell on more than one market outlet. This is to mean that farmers do not sell mango permanently to the particular market outlet and use the available market outlets alternatively in the absence or presence of the possible choices. Since farmers may market their mango via multiple outlets, the multinomial logit model would be infeasible due to the resultant very large number of possible choices. The relative risk of selecting one outlet can be affected by the relative risk of the selecting the other and violate the Hausman assumption of Independence of Irrelevant Alternatives (IIA) in multinomial logit model. If simultaneity in decision-making exists, this approach yields biased, inefficient and inconsistent estimates (Maddala, 1983; Greene, 2003). Thus, the decision of choosing market outlets is inherently multivariate and attempting univariate modeling excludes useful economic information contained in interdependent and simultaneous choice decisions. Failure to capture

unobserved factors and inter-relationships among choice decisions regarding different market outlets will lead to bias and inefficient estimates (Menale *et al*., 2012).

The multivariate probit model takes into account the potential interdependence in market outlet choices and the possible correlation in the choice of alternative outlets. The probability of preferring of any particular market outlet is estimated conditional on the choice of any other related outlet. The multivariate probit model assumes that each subject has distinct binary responses, and a matrix of covariates that can be any mixture of discrete and continuous variables. Generally speaking, the multivariate probit model assumes that given a set of explanatory variables the multivariate response is an indicator of the event that some unobserved latent variable falls within a certain interval. The multivariate probit is an extension of the probit model (Greene, 2003) and is used to estimate several correlated binary dependent variables jointly. The model is specified as follows:

$$Y_{im} = \beta_m x_{im} + \varepsilon_{im} \quad \text{..... (2)}$$

Where **Y***im (m = 1... k) represent the unobserved latent variable of market outlets chosen by the i[th] farmer (i=1…n). Therefore, in this case k = wholesaler, collector, retailer and consumer outlets, Xim is a 1 × k vector of observed variables that affect the market outlets choice, βm is a k× 1 vector of unknown parameters to be estimated, $\boldsymbol{\Sigma}$im, m = 1,…, M are the error terms distributed as multivariate normal, each with a mean of zero, and variance-covariance matrix V, where V has values of 1 on the leading diagonal and correlations (Cappellari and Jenkins, 2003). Equation (9) is a system of m equations that as shown in Equation 10 below;

$$Y_1^* = x_1\beta_1 + \varepsilon_1 \quad Y_1 = 1 \text{ if } Y_1^* \text{ is} > 0, Y_1 = 0 \text{ otherwise}$$
$$Y_2^* = x_2\beta_2 + \varepsilon_2 \quad Y_2 = 1 \text{ if } Y_2^* \text{ is} > 0, Y_2 = 0 \text{ otherwise}$$
$$Y_3^* = x_3\beta_3 + \varepsilon_3 \quad Y_3 = 1 \text{ if } Y_3^* \text{ is} > 0, Y_3 = 0 \text{ otherwise}$$
$$Y_4^* = x_4\beta_4 + \varepsilon_4 \quad Y_4 = 1 \text{ if } Y_4^* \text{ is} > 0, Y_4 = 0 \text{ otherwise} \text{.... (3)}$$

This system of equations is jointly estimated using maximum likelihood method. There are six joint probabilities corresponding to the six possible combinations of preferring and not preferring each of the four market outlets. The probability that all four market outlets have been preferred by household 'i' is given as:

$$\Pr(y_{1i} = 1, y_{2i} = 1, y_{3i} = 1, y_{4i} = 1) =$$
$$\Pr(\varepsilon_{1i} \le \beta_1 x_{1i}, \varepsilon_{2i} \le \beta_2 x_{2i}, \varepsilon_{3i} \le \beta_3 x_{3i}, \varepsilon_{4i} \le \beta_4 x_{4i}) = \Pr(\varepsilon_{4i} \le \beta_4 x_{4i} / \varepsilon_{3i} \le \beta_3 x_{3i} / \varepsilon_{2i} \le \beta_2 x_{2i}, \varepsilon_{1i} \le \beta_1 x_{1i} \times \Pr(\varepsilon_{3i} \le \beta_3 x_{3i} / \varepsilon_{2i} < \beta_2 x_{2i} / \varepsilon_{1i} < \beta_1 x_{1i} \times \Pr(\varepsilon_{1i}\, \beta_1 x_{1i}) \text{ ..... (4)}$$

## III. Results and Discussion

*a) Market Outlet Choices of the Households*

Market outlet choices available for sale of mango in the study area include wholesaler, collector, retailer and consumer outlets. As indicated in the Appendix Table1, about 89.1%, 76.8%, 76%, and 74.6% of sample households sell their mango via wholesaler, consumer collector, and retailer outlets, respectively. Conversely, about 25.4%, 24%, 23.2% and 10.9% of sample households do not sell their mango via the retailer, collector, consumer and wholesaler market outlet, respectively. The survey has further indicated that no farmer has used cooperative as a market outlet in the study area except those who have been organized in mango processing unit.

*b) Households' characteristics by market outlet choices*

The effect of continuous variables over market outlet choice is examined by using mean comparison as Berhanu *et al*. (2013) and Geoffrey *et al*. (2014) have used. As shown in the Appendix Table 2, the mean age of sample households who sale mango to the retailer, consumer, collector and wholesaler, market outlet is 44, 43.34, 43.3 and 42.8, years old, respectively. This indicates that households who sale mango to the wholesalers are younger than households who sale to other market outlets. And conversely, households who do not sale mango to the wholesalers are older than households who not sale to other market outlets.

The mean family size of sample households who sale mango to wholesaler, retailer, consumer and collector market outlet is 7.53, 6.59, 6.53 and 6.38, respectively. Accordingly, households who sale and do not sale mango to the collectors have smaller and larger mean family size, respectively in comparison to households who sale and do not to other outlets. This indicates that inadequacy of labor at household level obliges to sale mango at farm gate and labor endowment promotes involvement in formal marketing. The mean distance to the nearest market for households who sale their mango to the collectors (30.1 minutes walk) is greater than those who sale to another market outlets. This indicates that when distance to market is large, farmers prefer to sale their mango at farm gate. The mean quantity of mango produced for households who sale to wholesaler (9.45 quintal) is greater than households who sale to other market outlets. This implies that households who produce more prefer wholesale market since wholesalers purchase bulk quantity of mango. The mean price paid for a unit kg of mango in birr is lowest for households who sale mango to the collectors in comparison to the households who

sale to other outlets. This is due to the fact that farmers sale immature mango to the collectors at farm gate with a minimum price. This is in line with Montshwe (2006) stated that the farm gate sale tends to reduce farmers" revenue since the prices are relatively low.

c) *Socio-economic characteristics of households by market outlet*

The effect of dummy variables over market outlet choice is examined by the frequency of households selling to each market outlets as Berhanu *et al.* (2013) and Geoffrey *et al.* (2014) have used. Proportion of household characteristics by mango market outlets is given in Appendix Table3. About 53.9%, 42.9%, 33.3%, and 30.4% of the male headed households used wholesaler, consumer, collector, retailer, and market outlet choices, respectively as a choice of marketing outlets. On the other hand, 69.6%, 66.7%, 57.1% and 46.1%, of the female headed households used retailer, collector, consumer and wholesaler, respectively as the choice of mango marketing outlets. This shows that the male headed households who used wholesale as the choice of marketing outlets were more than their counterparts. About 92.9%, 91%, 87% and 80.7% of households who have access to extension service used consumer, wholesaler, retailer and collector, respectively as market outlet choices. Households who have access to extension service have a minimum probability of selling mango to the collector market outlet. This is because extension service discourages selling of unripe mango as it increases postharvest loss and retards benefit derived from selling of it. About 87%, 84.3%, 72%, and 66.7% of households who have access to credit sell their mango to the retailer, wholesaler, consumer and collector, respectively as the market outlet. The proportion of households who have access to credit that sell mango to the collector market outlet (66.7%) is less than proportion of households who sell mango to the other market outlets. This indicates that access to credit enables farmers to endow economic resources in order to involve in formal marketing.

About 74.2%, 71.4%, 69.6% and 41.7%, of households who have access to market information sell mango to the wholesalers, consumers, retailers and collectors, respectively as market outlet choice. This indicates that about 41.7% of households who have access to market information sell mango to the collector which is less than proportion of households selling to the other market outlets. This implies that when farmers are getting informed about opportunities in final market, their tendency of selling to collector at farm gate decreases. About 100%, 100%, 97.8%, and 91.7% of households who have access to market sell mango to retailer, consumer, wholesaler and collector, respectively, as market outlet choice. The proportion of households who have access to market that sell mango to the collector (91.7%) is less than proportion of households selling to the other market outlets. About 42.9%, 19.1%, 13% and 8.3% of households who own transport means sell their mango to the consumer, wholesaler, retailer and collector, respectively, as market outlet choice as shown in the Appendix Table3. The proportion of households who own transport means that sell their mango to the consumer outlet (42.9%) is greater than proportion of households selling mango to other market outlets. This implies that owning transport means facilitate efficient delivery of mango to the terminal market thereby reducing cost of transaction.

About 46.2%, 26.9%, 15.4% and 11.5% of sample households who have membership in group sell mango to the wholesalers, retailers, consumers and collectors, respectively, as market outlet as indicated in Table3. The proportion of households who have membership in group that sell mango to the collector market outlet (11.5%) is less than the proportion of households selling to other market outlets. This implies that farmers who are member in group do not want to sell mango to the collectors at their village.

d) *Factors affecting market outlet choice of the mango producers*

The multivariate probit model was estimated jointly for four binary dependent variables namely wholesaler, collector, retailer and consumer market outlets. The P-value of the Wald test statistics for the overall significance of the regression is low (0.0268) indicating that the multivariate regression is significant. Further, the likelihood ratio test of rho is significant (P-value = 0.0133) indicating that a multivariate probit specification fits the data. The significance of the off-diagonal elements of the covariance matrix shows that there are unobserved heterogeneities that influence the choice decisions on the different market outlets. The correlation coefficients among the error terms are significant indicating that the decision to choose one market outlet affects the decision of choosing the other. The correlation coefficients between the wholesaler and consumer and collector and consumer market outlets is negative and significant at the 5% level indicating that farmers who choose one market outlet are less likely to choose another (Appendix: Table5).

According to the result obtained from the multivariate probit model, the probability of choosing wholesaler market outlet was influenced by family size, distance to the nearest market centre, quantity of mango produced and price as indicated in Appendix Table 4. Family size is positively correlated with the choice of wholesaler outlet at less than 1% level of significance, respectively. This is due to the fact that households with the larger family size have plenty of labor force to deliver mango to final market. This is in line with the Tewodros (2014) who indicated that large family size implies better labour endowment so that

households are in a position to travel to get wholesalers in the district or nearby town markets. Distance to the nearest market centre is negatively correlated with the choice of wholesaler market outlet at 5% level of significance. This indicates that when distance to the nearest market is increasing, the likelihood of selling mango to the wholesale market outlet is decreasing because of the transaction costs related with the delivering of mango.

Quantity of mango produced also determined the choice of wholesaler market outlet positively at less than 1% level of significance. This indicates that when quantity of mango produced increases, probability of selling to the wholesalers is increasing because wholesalers purchase high quantity of mango at once without selection. The price paid for a unit kg of mango determined the choice of wholesaler market outlet positively at less than 1% level of significance. This is due to the fact that wholesalers purchase mango without any selection and overestimate the price paid for a unit kg of mango in relative to other market outlets.

The probability of choosing collector market outlet was determined by the family size, distance to the nearest market, quantity of mango produced, price and access to non-farm income as indicated in the Appendix Table4. Family size determined the probability of choosing collector outlet negatively at 10% level of significance. This implies that large family size has a plenty of labor force for delivering of mango to the final market and plenty of labor force disfavor selling of mango to the collector market which pays low price at farm gate. Distance to the nearest market centre is also negatively correlated with the probability of choosing collector outlet at 5% level of significance. When distance to the nearest market increases, transaction cost of delivering mango to the final market also increases and because of this farmers choose to sell at farm gate with few transaction cost. Quantity of mango produced determined the choice of collector market outlet positively at 10% level of significance. This implies that collector can purchase a significant volume of mango at farm gate which in further sell to other traders like wholesalers. The probability of selling mango to the collector market outlet choice is negatively correlated with the price paid for a unit kg of mango at farm gate at 5% level of significance. This indicates that a low price worth to unripe mango by collectors at farm gate discourages farmers from selling their mango to the collectors. This is in line with Montshwe (2006) who stated that farm gate sale tends to reduce farmers' revenue since the prices are relatively low. Access to non-farm income determined the probability of choosing collector outlet negatively at 5% level of significance. This is due to the fact that farmers who have access to non-farm income are not quick enough to harvest immature mango for temporary cash need because they can derive income needed for the households' basic needs from other activities like trading. In addition to this, farmers who have been engaged in non-farm activities like trading have more knowledge in economic value of selling mango in formal market and they know as farm gate price diminishes their benefit from selling of mango. In other case, they can derive income from non-farm activities which enable them to sell mango at formal market.

The probability of choosing retailer market outlet was determined by the quantity of mango produced and price as indicated in the Appendix Table 4. The two variables determined the probability of choosing retailer market outlet negatively at less than 1% level of significance. The negative correlation in the case of quantity of mango produced implies that famers who produce a large volume of mango prefer wholesale market than retailer as retailers purchase a small quantity of mango. In the case of price, retailers often underestimate the price paid for a unit kg of mango and try to deceive farmers thereby reflecting their bargaining ability.

The probability of choosing consumer market outlet was determined by quantity of mango produced, access to market information and price as indicated in Appendix Table 4. Quantity of mango produced is negatively correlated with the probability of choosing consumer outlet at less than 1%. This implies that farmers who produce a high quantity of mango do not prefer selling of mango to the consumers because consumer demands a small quantity of mango for spot consumption. Access to market information determined the probability of the choosing consumer outlet positively at 10%. Price information about local market informs the farmer on prevailing pricing condition. This implies that accessibility of market information related with price condition in local market fosters choice of consumer in local market. This is in line with the Geoffrey *et al*. (2014) who indicated that market price information had a positive influence on the choice of the local market. Price paid for the unit kg of mango also determined the probability of choosing consumer outlet positively at less than 1% level of significance. This implies that end user of the product pays a better price for ripe mango in local market and indicates that farmers who sell ripe mango can drive better income.

## IV. Conclusion and Recommendation

The result obtained from the MVP model revealed that about six variables were found to be statistically significant at different significance level by determining the choice of wholesaler, collector, retailer and consumer market outlets. The result has indicated that variables such as family size, distance to the market, quantity of mango produced and price offered are the significant determinants of the choice of wholesale market outlet. Farmers' choice of collector

market outlet is determined by the family size, distance to the nearest market, quantity of mango produced, price offered and access to non-farm income. The choice of retailer market outlet is determined by the variables such as quantity of mango produced and price offered. Consumer market outlet choice is determined by the variables such as quantity of mango produced, price offered and access to market information. Based on the result obtained from the model variables affecting the choice of wholesaler and consumer market outlet should be promoted and farm gate and retail price intervention is quite important to maximize the economic benefit of farmers. Quantity of mango produced and price are the key determinants of households' market outlet choice. Therefore, these variables should be promoted and get special attention. Establishment of cooperative and small scale mango processing industry diversifies marketing alternatives of the farmers, efficient use of the resources and better for the bargaining ability. Therefore, attention should be payed on these issues for the further improvement of mango marketing in the study area.

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## Appendix

*Table 1:* Proportion of market outlet choice of the households

| Market outlets | Category | Frequency (n) | Percentage (%) |
|---|---|---|---|
| Wholesaler | Yes | 107 | 89.1 |
| | No | 13 | 10.9 |
| Collector | Yes | 91 | 76 |
| | No | 29 | 24 |
| Retailer | Yes | 90 | 74.6 |
| | No | 30 | 25.4 |
| Consumer | Yes | 92 | 76.8 |
| | No | 28 | 23.2 |

*Source: Survey result (2015)*

*Table 2:* Mean household characteristic by market outlet choices

| Variables | Category | Market outlet choices | | | |
|---|---|---|---|---|---|
| | | Wholesaler | Collector | Retailer | Consumer |
| Age in year | Yes | 42.80 | 43.29 | 43.88 | 43.34 |
| | No | 43.67 | 41.67 | 40.00 | 41.44 |
| Family size in number | Yes | 7.53 | 6.38 | 6.59 | 6.53 |
| | No | 6.39 | 6.94 | 6.29 | 6.47 |
| Distance to the market in | Yes | 29.15 | 30.1 | 25.72 | 24.65 |
| minutes of walk | No | 14.87 | 19.64 | 33.14 | 27.81 |
| Quantity of mango | Yes | 9.45 | 6.89 | 6.3 | 4.8 |
| produced in quintal | No | 5.83 | 6.93 | 12.1 | 9.9 |
| Price in birr | Yes | 3.2 | 2.01 | 2.18 | 2.5 |
| | No | 2.22 | 2.77 | 3.24 | 1.8 |

*Source: Survey result (2015)*

*Table 3:* Household characteristics by market outlet choices

| Variables | Category | Proportion (%) | | | |
|---|---|---|---|---|---|
| | | Wholesalers | Collectors | Retailers | Consumers |
| Sex | Female | 46.1 | 66.7 | 69.6 | 57.1 |
| | Male | 53.9 | 33.3 | 30.4 | 42.9 |
| Access to extension service | No | 9 | 19.3 | 13 | 7.1 |
| | Yes | 91 | 80.7 | 87 | 92.9 |
| Access to credit | No | 15.7 | 33.3 | 13 | 28 |
| | Yes | 84.3 | 66.7 | 87 | 72 |
| Access to market information | No | 25.8 | 58.3 | 30.4 | 28.6 |
| | Yes | 74.2 | 41.7 | 69.6 | 71.4 |
| Access to market | No | 2.2 | 8.3 | 0 | 0 |
| | Yes | 97.8 | 91.7 | 100 | 100 |
| Owning transportation means | No | 80.9 | 91.7 | 87 | 57.1 |
| | Yes | 19.1 | 8.3 | 13 | 42.9 |
| Membership in group | No | 30.4 | 22.2 | 24.1 | 23.2 |
| | Yes | 46.2 | 11.5 | 26.9 | 15.4 |

*Source: Survey result (2015)*

*Table 4:* Result of multivariate probit regression

| Variables | Market outlets | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Wholesaler | | Collector | | Retailer | | Consumer | |
| | Coef. | P>/Z/ | Coef. | P>/Z/ | Coef. | P>/Z/ | Coef. | P>/Z/ |
| AGE | -0.0053 | 0.726 | 0.0057 | 0.603 | 0.0084 | 0.510 | 0.0077 | 0.538 |
| FMSZ | 0.3420 | 0.002*** | -0.1074 | 0.081* | 0.0411 | 0.551 | 0.0716 | 0.225 |
| SEX | -0.2493 | 0.608 | -0.3862 | 0.215 | -0.1434 | 0.640 | 0.2102 | 0.539 |
| EDUC | -0.5835 | 0.168 | 0.2075 | 0.491 | -0.1272 | 0.678 | 0.0714 | 0.815 |
| DISNEAMKT | -0.0337 | 0.026** | -0.0160 | 0.025** | -0.0095 | 0.111 | -0.0005 | 0.937 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ACCEXSER | 0.4320 | 0.389 | -0.3965 | 0.330 | -0.0229 | 0.956 | 0.1216 | 0.735 |
| ACCCRE | -0.3907 | 0.442 | 0.1865 | 0.581 | 0.2131 | 0.535 | -0.1674 | 0.620 |
| QUNMAPR | 0.1322 | 0.009*** | 0.0367 | 0.092* | -0.0698 | 0.005*** | -0.0644 | 0.004*** |
| ACCMKT | -4.1063 | 0.984 | -0.0723 | 0.940 | -3.494 | 0.989 | 1.4949 | 0.154 |
| OWNTRAME | 0.5915 | 0.428 | -0.702 | 0860 | 0.2533 | 0.558 | -0.1017 | 0.793 |
| MEMBER | 0.3413 | 0.557 | -0.0940 | 0.822 | -0.2826 | 0.568 | 0.2569 | 0.569 |
| ACMKTINFO | 0.1502 | 0.772 | -0.1432 | 0.644 | -0.3554 | 0.321 | 0.5238 | 0.070* |
| PRICE | 0.4367 | 0.001*** | -0.2287 | 0.014** | -0.3729 | 0.004*** | 0.6270 | 0.003*** |
| ACNONFAIN | -0.0835 | 0.843 | -0.6245 | 0.033** | -0.1250 | 0.683 | 0.3688 | 0.215 |
| Constant | 7.8076 | 0.970 | 1.4692 | 0.249 | 5.483 | 0.982 | -2.874 | 0.045** |

*N=120, Wald chi2 (56) = 78.18, Prob>chi2 = 0.02668, log likelihood = -204.49657, ***, ** and * are statistically significant at 1%, 5% and 10% level*

*Source: Survey result (2015)*

*Table 5:* Error covariance matrix and correlations of the MVP model

| Correlation | Coef. | Std.err | Z | P>/Z/ |
|---|---|---|---|---|
| /atrho21 | .4940 | .2165 | 2.28 | 0.023** |
| /atrho31 | .2891 | .2340 | 1.24 | 0.217 |
| /atrho41 | -.5951 | .2529 | -2.35 | 0.019** |
| /atrho32 | -.1642 | .1982 | -0.83 | 0.408 |
| /atrho42 | -.5990 | .2424 | -2.47 | 0.013** |
| /atrho43 | .3225 | .1947 | 1.66 | 0.098* |
| Rho21 | .4573 | .1712 | 2.67 | 0.008*** |
| Rho31 | .2813 | .2155 | 1.31 | 0.192 |
| Rho41 | -.5335 | .1810 | -2.95 | 0.003*** |
| Rho32 | -.1627 | .1930 | -0.84 | 0.399 |
| Rho42 | -5363 | .1727 | -3.11 | 0.002*** |
| Rho43 | .3117 | .1758 | 1.77 | 0.076* |

*Likelihood ration test of rho21 = rho31 = rho41 = rho32 = rho42 = rho43= 0 where 1, 2, 3 and 4 stands for wholesaler, collector, retailer and consumer, respectively, Chi2 (6) = 16.0803, Prob>chi2 = 0.013, ***, ** and * are statistically significant at 1%, 5% and 10% level, respectively.*

*Source: Survey result (2015)*

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# Insects as an Option to Conventional Protein Sources in Animal Feed: A Review Paper

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*Abstract-* Intensification of Livestock production and the growing world population poses heavy pressure on limited resources which requires urgent attention to reduce its effect on climate change and feed scarcity. Protein-rich insects are one of the options to conventional protein sources. Africa is one of the most important hotspots of edible insects' biodiversity comprising 524 species. The most widely used insects in animal feeds are the larvae of the black soldier fly, the maggot and pupae of common housefly, the yellow mealworm or larvae of the beetle as well as blue bottle, termites, blow flies and insect families belonging to the order Orthoptera including, grasshoppers, crickets and katydids. The chemical composition of insects vary between species, growth stage and management conditions. The Crude protein (CP %) ranges from 41.1-76.1, crude fiber (CF %) from 3.8- 15.7, ether extract (EE %) from 5.4- 37.2, ash% from 2.2-26.6 and gross energy (GE) from 19.8- 27.2. Based on the nutritive values, Insect meal is an excellent and important substitute of poultry diet replacing wide range of feed stuffs.

*Keywords:* *insects, feed, inclusion, constituents, animal feed.*

*GJSFR-D Classification:* *FOR Code: 860304*


*Strictly as per the compliance and regulations of :*

# Insects as an Option to Conventional Protein Sources in Animal Feed: A Review Paper

Nazif Amza [α] & Metekia Tamiru [σ]

*Abstract-* Intensification of Livestock production and the growing world population posed heavy pressure on limited resources which requires urgent attention to reduce its effect on climate change and feed scarcity. Protein-rich insects are one of the options to conventional protein sources. Africa is one of the most important hotspots of edible insects' biodiversity comprising 524 species. The most widely used insects in animal feeds are the larvae of the black soldier fly, the maggot and pupae of common housefly, the yellow mealworm or larvae of the beetle as well as blue bottle, termites, blow flies and insect families belonging to the order Orthoptera including, grasshoppers, crickets and katydids. The chemical composition of insects varies between species, growth stage and management conditions. The Crude protein (CP %) ranges from 41.1-76.1, crude fiber (CF %) from 3.8-15.7, the extract (EE %) from 5.4- 37.2, ash% from 2.2-26.6 and gross energy (GE) from 19.8- 27.2. Based on the nutritive values, Insect meal is an excellent and important substitute of poultry diet replacing wide range of feed stuffs. Insect protein as supplement or substitute on aquaculture production improves fish productivity which could replace 50 % fish meal without adverse effect on weight gain, Specific growth rate and feed conversion ratio. Utilization of insect as a substitute or supplement in Pig has no adverse effect on growth performance and carcass quality. Despite the above benefits, all insects are not safe to use in animal feed. Just as it applies for plant and animal food Products some insects cause allergic reactions, botulism, parasitizes and food poisoning. All these health risks can be prevented by the utilization of scientifically recommended insect species reared on pollutant-free feed either harvested in the wild or on farms with proper processing, handling, and storage. Although utilization of insects as animal feed have been given due attention, insects are being reared at a small scale. So that there is a need for establishing cost-effective well-optimized mass insect rearing facilities up on utilization of bio-waste and organic side stream for a defined quality of animal product.

*Keywords: insects, feed, inclusion, constituents and animal feed.*

## I. Introduction

World's population will grow to around 9 billion people in 2050 resulting in a higher consumption of food from animal origin and an increased demand for protein to feed livestock(Alexandratos and Bruinsma, 2012). Livestock production which accounts 70% of agricultural land and world population increase place heavy pressure on limited resources which require urgent attention in causing climate change and feed scarcity (Fao, 2009a). The livestock sector contributes approximately 14.5% of all anthropogenic greenhouse gas (GHG) emissions (7.1 Gigatons of $CO_2$-equivalent per year) (Gerber *et a*l., 2013) and animal products have a much higher water footprint than plant-based foods(Mekonnen and Hoekstra, 2012). Making better use of low-impact feed sources such as grasses, insects or worms can lower global footprint due to animal products (Soil Association, 2013). To reduce the environmental impact for Production of protein from animal sources and diet costs, protein-rich insects are one of the options to conventional protein sources (Khusro *et al*., 2012).

Feed-to-meat and milk conversion varies widely depending on the feed type, class of the animal and the production practices used (Pimentel and Pimentel 2003). Typically, 1 kg of live animal weight requires 2.5 kg for chicken, 5 kg for pork and 10 kg for beef in a typical United States production system(Smil, 2002).However, the production of 1 kg of live animal weight of crickets requires as little as 1.7 kg of feed(Collavo *et al.*, 2005). The growing of fish product importing in world requires a more interesting solution to benefit the producers on the use of insect meal to substitute fish and soybean meal at low costs (Van Huis, 2013). Fortunately, increasing demand for food (particularly meat, fish and eggs) has led to an urgent need for new and safe supplies of protein from insect which provides a potential alternative to animal feed protein from plant sources(Charlton *et al*, 2015).The important role of insects in assuring food and feed security is due to; their short life spans compared to most vertebrates, capacity to colonize new niches, ability to feed on nearly all species of plants with animals, easily reared on organic side streams (e.g. manure, pig slurry, industrial by product and compost), independency of arable land resources and non-competing with human nutrition(Cassidy *et al*., 2011, Veldkamp *et al.*, 2012).

Insects are a class of animals within the arthropod group that have a Chitin exoskeleton and a three-part body (head, thorax and abdomen) (Harpe and McCormack, 2001). They are the most diverse groups of organisms in the history of life (Scaraffia and Miesfeld, 2012). Although, insects are the least studied

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of forest organisms (Johnson, 2010), they provide essential ecosystem services such as pollination, composting, wildfire protection, pest control, as human consumption and feed for animals(Losey and Vaughan, 2006). Scientists consider the insect meals a valid alternative source of animal protein and have studied the nutritional features, in terms of protein, mineral, energy value and composition of fatty acid for different livestock classes. Consequently, their conservation and the habitats they occupy are of an enormous benefit (Belluko, *et al.,* 2013, DeFoliart, 2005, Samways, 2007).

In recent years much attention has been devoted to antimicrobial peptides (AMPs) present in insects called natural antibiotics due to the increasing global problem of bacterial, fungal, certain parasitic and viral resistance to antibiotics. AMPs mechanism of insect doesn't induce bacterial resistance and involves the destruction of the bacterial cell envelope (Park *et a*l., 2015). However, there are possibilities of using in agriculture including animal nutrition as well as the pharmaceutical industry (Yi *et al*., 2014). Moreover, insects from the Diptera order, e.g. the larvae of the housefly and black soldier fly have a great ability to utilize organic waste material that contain moisture (60–80%) converting it to valuable insect protein in such a way that they reduce the accumulation of poultry manure by 50% and reduce bacterial growth in the manure that results in a reduced odor development and the growth suppression of significant pathogens (Čičkova *et al*., 2015, Diener et al., 2011). In addition, if insects are fed as alternative food sources, they may add value to other agricultural industries and contribute to mitigating the impact of climate (Khusro *et a*l., 2012, Saxe *et a*l., 2013).

Various insect species have a higher proportion of protein content compared to conventional fish and soybean meals and also have efficient food conversion factor (Anand *et al.*, 2008).Animal feeding studies across insect species and animal production have shown that palatability of insects is good and they can replace 25-100% of soy meal or fishmeal depending on the animal and insect species (Makkar *et al*., 2014). Insects contain between 30% and 70% of protein on DM basis and rich in fats, minerals and vitamins (Veldkamp *et al*., 2012). Some insects can accumulate high levels of lipids and the extracted oil can be used for various applications including biodiesel production (Makkar et al., 2014). The nutritional contribution of more than 2,000 recorded edible insect species as food and feed is highly variable between species and morphological stages (eggs, larvae, pupae and adults) (Van Huis, 2013).

Insects such as the black soldier fly (*Hermeticaillucens* Linnaeus), common housefly (*Muscadomestica),* Linnaeus, (termites) and yellow mealworm (*Tenebriomolitor)* can play dual roles of recycling of organic by-products into high quality compost-fertilizers as well as utilization of the maggots directly as animal feed (Čičkováet *al.*, 2015).The objective of this paper is to review utilization of insects as protein source in animal feed.

## II. Potential Insect Species as Animal Feed

Insects are the most popular species comprising 70% of animal species and their biomass can be very high in some ecosystems (Chapman, 2009). Most insects are native from the tropical and subtropical of the world. However, insects are now wide spreading in tropical and warmer temperate regions between about 45°N and 40°S (Dienere*t al*., 2011). There are insect species that are extremely resistant capable of dealing with demanding environmental conditions such as drought, food shortage or oxygen deficiency like black solder flies larvae ( Dienere*t al*., 2011).

In recent assessment Van Huise*t al.* (2013) reported 246 species of edible insects from 27 countries in Africa. Later, Ramos-Elorduy (2005) noted that Africa is one of the most important hotspots of edible insects biodiversity in the world with 524 species reported from 34 African countries. In Kenya, Nigeria, Tanzania, South Africa and Uganda, researchers are testing the feasibility of using insects rather than soybeans and fish meal for raising poultry and fish.

The most promising insects in animal feeds are the larvae of the black soldier fly (Hermetiaillucens), the maggot and pupae of common housefly (Muscadomestica), the yellow mealworm or larvae of the beetle (Tenebriomolitor) as well as blue bottle (Calliphoravomitoria), termites, blow flies and insect families belonging to the order Orthoptera including grasshoppers, crickets and katylids(Ghaly and Alkoaik, 2009). However, insects of the order Blattodea like American (Periplaneta Americana), German (Blattellagermanica) and Asian (Blattellaasahinai) cockroaches are also interesting candidates (Charlton *et al*, 2015).

*Table 1:* Distribution of insects in some parts of the world

| Insect | Distribution |
|---|---|
| Black soldier fly | Tropical, subtropical and warm temperate of the world |
| Housefly | Word wide |
| Mealworm | Indigenous to Europe and now distributed worldwide |
| Grasshoppers and crickets | Africa, South America and Asia. |
| Silkworm | Worldwide, mostly Asia and silk producing countries(China, India, Uzbekistan, Brazil, Thailand and Vietnam) |

*Sources; (Longview al., 2011 and FAO, 2012).*

## III. Chemical Constituents of Insects at Different Developmental Stages

Most insects have a high-value feed source rich in protein, mineral, vitamin and fat. The amount of fat is extremely variable and depends on the type of diet which is 15-25% for larvae fed on poultry manure (Arango Gutierrez *et al*., 2004), 28% on swine manure (Newton *et al*., 2005), and 35% on cattle manure and 42-49% on oil-rich food waste for black solder fly larvae (Barry, 2004).

*Table 2:* Chemical constituents of insects in DM% reported by different authors

| Types of insect | Chemical Composition | | | | | Reference |
|---|---|---|---|---|---|---|
| | CP | CF | EE | Ash | GE (MJ/kg) | |
| Black solder Fly larvae | 42.1±1 | 7 | 26.0 ±8.3 | 20.6 ± 6 | 22.1 | St-Hilaire*et al*. 2007 |
| Housefly maggot meal | 50.4 ± 5.3 | 5.7 ± 2.4 | 18.9 ± 5.6 | 10.1 ± 3.3 | 22.9 ± 1.4 | Adesina*et al*. 2011 |
| Housefly pupae meal | 70.8 ± 5.3 | 15.7 | 15.5 ± 1 | 7.7 ± 2.1 | 24.3 | Pretorius (2011 |
| Mealworm | 52.8 ± 4.2 | - | 36.1 ± 4.1 | 3.1 ± 0.9 | 26.8 ± 0.4 | Finke, 2002 |
| locust or grasshopper meal | 57.3 ± 11.8 | 8.5 ± 4.1 | 8.5 ± 3.1 | 6.6 ± 2.5 | 21.8 ± 2 | Alegbeleye *et al*., 2012 |
| House cricket | 63.3 ± 5.7 | - | 17.3 ± 6.3 | 5.6 ± 2.4 | - | Finke, 2002 |
| silkworm pupae meal (non-defatted) | 60.7 ± 7 | 3.9 ± 1.1 | 25.7 ± 9 | 5.8 ± 2.4 | 25.8 | Jintasataporn, 2012 |

*Note that DM is dry matter. Values are mean ± standard deviation and values without SE is when =1*

According to St-Hilaire*et al*.2007, Adesina*et al* 2011, Pretorius 2011, Finke, 2002 and Jintasataporn, 2012, the chemical composition of insects varies between species, growth stage and management conditions and the crude protein (CP %) ranges from 41.1-76.1, crude fiber (CF %) from 3.8- 15.7, Ether extract (EE%) from 5.4- 37.2, ash% from 2.2-26.6 and gross energy(GE) from 19.8- 27.2 (Table2).

The protein content of insect meals varies considerably from around 41.1- 76.1 even when the meals are based on the same insect species (Table2). The same holds true for the fat content. However, it is important to note that insect meals compared to fishmeal contain lower concentration of Methionine and Calcium which has to be considered when formulating diets based on insect proteins (Van Broekhoven*et al*., 2015, De Marco et al., 2015, Makkar*et al*., 2014).The fat content of mealworms fed low protein diets was significantly lower as compared to high protein diets (18.9 vs. 26.3 %) (VanBroekhoven*et al*., 2015).

*Table 3:* Mineral content of some insects reported by different authors

| Types of insect | Ca | P | K | Na | Mg | Fe | Mn | Zn | Cu | Reference |
|---|---|---|---|---|---|---|---|---|---|---|
| Black solder Fly larvae | 75.6 ± 17.1 | 9 ± 4 | 6.9 | 1.3 | 3.90 | 1.37 | 246 | 108 | 6 | ArangoGutierrezetal.2004 |
| Housefly maggot meal | 4.7 ± 1.7 | 16± 5.5 | 5.7 ± 3.5 | 5.2 ± 2.4 | 3.4 ± 4 | 1± 0.44 | 114±91 | 27±6 | 119±118 | Odesanya*et al*. 2011 |
| Mealworm | 2.7 ± 1.9 | 7.8 ± 3.7 | 8.9 | 0.9 | 2.3 ± 0.4 | 57 ± 32 | 9.0 ± 4.0 | 116 ± 24 | 16 ± 1 | Klasing*et al*., 2000 |
| House cricket | 10.1 ± 5.3 | 7.8± 7.9 | - | - | 1.6 ± 0.8 | 116 ± 58 | 40.0 ± 10 | 215 ± 60 | 15± 7 | Finke, 2002 |
| silkworm pupae (non-defatted) | 3.8 ± 3 | 6 ± 2.3 | | | 3.7 ± 2.5 | 326± 67 | 28± 9 | 224 ± 126 | 15 ± 12 | Jintasataporn, 2012 |

*Note that values are mean± standard deviation except at n=1, DM, dry matter and all values in g/kg DM except Mn, Zn, and Cu are in mg/kg DM.*

The major mineral content of studied insect were 0.8-92.7, 3.7-22.5, 2.2-9.2, 0.9-7.6 and 0.8-6.2 for Ca, P, k, Na and Mg in g/kg DM and also the micro was 0.56-393, 5-246, 19-275, and 1-237, for Fe, Mn, Zn and Cu mg/kg DM respectively. The mineral content of insects reviewed indicates that there is a need to think about feed of plant origin substitution by insects for animal at low cost .It is important that insect meals compared to fishmeal contain have lower concentration of ca which has to be considered when formulating diets based on insect proteins (Table3).

## IV. Nutritional Value of Insects for Different Animal Species

Numerous studies have been conducted on the nutritive value and nutrient composition of different species insects confirming that insects are good sources of proteins, fat, energy, vitamins and minerals. The consumption of 100 g of caterpillars, for example, provides 76% of the daily required amount of proteins and almost 100% of the daily required amount of vitamins for humans and animals. And also Dried silkworm pupae are composed of about 50% proteins and 30% lipids ( Mitsuhashi, 2010, Agbidye et al, 2009).

*a) Insect protein in poultry production*

The poultry industry is one of the fastest-growing agro-businesses but the use of expensive maize as a feed ingredient is threatening the survival of farmers. Feeding poultry with insect based is the best option for the survival (Krishnan *et al*. 2011).The insects were able to transform the low-nutritive waste products into a high-protein diet in particular as a replacement of soybean meal in poultry feed. Research conducted by Ramos Elorduy *et al.*, 2002 confirmed that insects could be utilized as protein source in poultry feed. More specifically, the amino acids derived from most insects'are superior compared to those from plant supplements in poultry feed formulations (Bukkens, 2005). They are usually fed live but are also sold canned, dried or in powder form (Aguilar-Miranda et al., 2002, Hardouin and Mahoux, 2003, Veldkampet *a*l., 2012).

*Table 4(a):* The role of insect in growing chicks and laying hens reported by different authors

| Class of Animal | Insect Type | Feeding purpose | Result | Recommendation | Reference |
|---|---|---|---|---|---|
| In Chicks | Black solder fly larvae | As component of diet and substitute of soybean meal | Good growth and High feed conversion efficiency | Concentration up to 93% has significance / above 93% isn't recommended | Newton *et al*., 2005 |
| Ruralchicken (Ghana and Togo) | Housefly maggot (larvae) meal | Supplementation | Higher growth rate, increased hatchability and clutch size | 30-50g/d/bird | Dankwa *et al* .2002, Ekoue and Hadzi,2000 |
| Laying hens | Mealworm | To replace fishmeal | Higher egg-laying ratio than that obtained with good quality feed. | 2.4% and There is limited information | Giannone, 2003 |

*Table 4(b):* The Role of Insects in Broilers reported by different authors

| Class of Animal | Insect Type | Feeding purpose | Result obtained | Recommendation | Reference |
|---|---|---|---|---|---|
| Broilers | Housefly maggot meal | Replacement for conventional protein sources and fishmeal | Have no distinctive organoleptic qualities and to be acceptable by consumers | Inclusion rate is ≤10% in the diet >10% result lower intake due to darker color of the meal | (Awoniyi, 2007). |
| 120-day broilers (in Nigeria) | Maggot meal | Mixture of dried cassava peels and maggot meal for replacing 0-100% maize grain | Cassava peels-maggots' mixture could replace 50% maize (29% diet as fed) into save cost | With 4:1 ratio | Adesina *et al*., 2011 |

*Table 4(c):* The role of Insects in Broilers reported by different authors

| Class of Animal | Insect Type | Feeding purpose | Result obtained | Recommendation | Reference |
|---|---|---|---|---|---|
| Broilers | Mealworm | For replacing soy meal or fishmeal. | Protein quality is like that of soy meal based broilers. But, low methionine and Ca content for poultry. | The addition of 8% $CaCO_3$ was found to be suitable to increase Ca. | Klasing*et al*., 2000. Anderson, 2000 |
| | Dried Mealworm | Inclusion of broiler starter diet based on sorghum and soybean | Without negative effects on feed consumption, weight gain, feed efficiency, texture, palatability or inclusion level | Inclusion level is 25% mealworm, as a substitution of the basal diet | RamosElorduy*et al*., 2002 Schiavone *etal*., 2014 |
| Broilers 1-28 days | grasshopper | As a substitute for fishmeal | Resulted in higher body weight gain, feed intake and feed conversion | Replace50% fishmeal protein with locust meal 1.7% in the diet. | Adeyemo *et al*., 2008 |

According to different studies conducted in the above (table4), insect meal is an interesting and important substitute of poultry diet potentially substituting wide range of feed staff like cassava peels, sorghum, fish meal, maize and soy meal. However, some insect species have no distinctive organoleptic quality which leads lack of consumer acceptance. Generally, when insects were included in poultry feed, the carcass quality, breast muscle portions, feed consumption, weight gain, feed efficiency, texture, palatability and higher egg-laying ratio was found to be better at a recommended levels of inclusion than other conventional good quality feed.

*b) Insect protein in Aquaculture production*

Recent high demand and consequent prices for fishmeal together with increasing production pressure on aquaculture has led to undertaking research into the development of insect proteins for aquaculture and making insects more cost-effective dietary fishmeal substitutes (Fao, 2012b).

*Table 5(a):* The role of insect in Aquaculture production reported by different authors

| Fish species | Insect Type | Feeding purpose | Result obtained | Recommendation | Reference |
|---|---|---|---|---|---|
| Blue tilapia | Chopped black solder fly larva | Alone or in combination with commercial feed | Improve weight gain higher by 140% and 28%feed conversion | Not the same as tilapia in another fish(reduction of performance is observed) | Sealey*et al*.,2011 |
| Rainbow trout fishes | Mealworm | As replacement of fishmeal in a diet containing 45% Cp | Without a growth performance reduction, leading to a saving of fishmeal. | Inclusion level at 25% and can be used up to 50% | Gasco*et al*., 2014a |
| African catfish | Meal of adultgrassho pper | To replace fishmeal (weight basis | Resulted without any adverse effect on growth and nutrient utilization at the same protein level in the diet. | Inclusion>25%decreased digestibility, performance, a little shrinkage in gills, reduction in ovarian steroid genesis which may reduce fertility | Alegbeleye *et al*., 2012, Johri*et al*., 2010;Johri *et al*., 2011a, b |

*Table 5 (b):* The role of Insects in Aquaculture Production

| Fish species | Insect Type | Feeding purpose | Result obtained | Recommendation | Reference |
|---|---|---|---|---|---|
| Blue tilapia | Chopped black solder fly larva | Alone or in combination with commercial feed | Improve weight gain higher by 140% and 28%feed conversion | Not the same as tilapia in another fish(reduction of performance is observed) | Sealey*et al.*,2011 |
| Rainbow trout fishes | Mealworm | As replacement of fishmeal in a diet containing 45% Cp | Without a growth performance reduction, leading to a saving of fishmeal. | Inclusion level at 25% and can be used up to 50% | Gasco*et al.*, 2014a |
| African catfish | Meal of adultgrassho pper | To replace fishmeal (weight basis | Resulted without any adverse effect on growth and nutrient utilization at the same protein level in the diet. | Inclusion>25%decreased digestibility, performance, a little shrinkage in gills, reduction in ovarian steroid genesis which may reduce fertility | Alegbeleye *et al*., 2012, Johri*et al*., 2010;Johri *et al*., 2011a, b |

In aquaculture production for better economic benefit at low cost and quick returns, inclusion of insect meal is one of the alternative feed sources that can substitute Fishmeal, Soybean alone or in combination with commercial feed like cattle brain meal, feather meal and chicken offal meal at different level of inclusion for different fish species (Table5b).

Insect protein as supplement or substitute on aquaculture production improves fish productivity which could replace 50 % fish meal without adverse effect on weight gain, specific growth rate and feed conversion varying between fish species and inclusion level. However, inclusion rate ≤7.5% is unnecessary and chopping is recommended in channel fish. Maggot meal gave better performance than soy meal and lower performance than cattle brains in African catfish (Table5 b).

*c) Insect protein in Swine production*

According to (Adenji, 2008, Medhi et al., 2009a, b) insects were able to transform the low-Nutritive waste products into a high-protein diet as a replacement of soybean meal in swine feed.

*Table 6:* Pig performance evaluation under diet inclusion with insect meal

| Class of Animal | Insect Type | Feeding purpose | Result obtained | Recommendation | Reference |
|---|---|---|---|---|---|
| Growing pigs | Black solder fly larvae | As replacement of soy meal | Good performance without supplementation of Ca and P | High ash content, require attention | Newton *et.al*,2005 |
| Weaned Pig | Black solder fly larvae | Without Amino acid supplement | Gave better performance at 50% mix | Cuticle removal and rendering is necessary | Newton *et.al*,2005 |
| | House fly larvae | Processed and as replacement of wheat offal | No adverse effect on performance | At ratio of 3;1 or at 10% inclusion | Adenji,2008 |
| Finishing pigs | Silkworm pupae non-defatted silkworm | To replace up to 100% of soy meal | no adverse effect on growth performance, carcass characteristics and blood parameters | ≥50% have negative effect on intake | Medhi*et al*., 2009a, b Medhi, 2011. |
| | | To replace up to 100% fish meal | no adverse effect on growth performance, carcass characteristics and blood parameters | Could fully replace fishmeal | |
| | Silkworm litter | To replace fish meal | no adverse effect on growth performance, carcass characteristics and blood | inclusion rate is about 7% but, shouldn't ≥ 10% | Wang *et al*., 2007 |

In different classes of pigs' utilization of insect as a substitute or supplement have no adverse effect on growth performance, carcass quality and interest of consumers within recommended inclusion level for specified species of insects (Table6).

## V. Insect Meals vis-à-vis Fishmeal and Soy Meal in Animal Feed

Insect meals are the important dietary substitutes of plant origin. Because plant production competes with human food and expensive compared with insect production and have environmental impact. Moreover, chemical constituent of fish meal and soy meal is less or equal to insects.

*Table 7:* Comparison of some insect's meal with soy meal and fish meal

| Constituents % in DM) | Housefly maggot meal | Silkworm pupae meal | Fishmeal | Soy meal |
|---|---|---|---|---|
| Crude protein | 50.4 - 62.1 | 60.7 -81.7 | 70.6 | 51.8 |
| Lipid | 18.9 | 25.7 | 9.9 | 2.0 |
| Calcium | 0.47 | 0.38 | 4.34 | 0.39 |
| Phosphorus | 1.60 | 0.60 | 2.79 | 0.69 |

*Source FAO, 2011 and 2013*

## VI. Barriers for Inclusion of Insect Protein in Animal Feed

Not all insects are safe to use in animal feed. Just as it applies for plant and animal food Products some insects cause allergic reactions, botulism, parasitizes and food poisoning (Yen, 2010). For example, the pupae of the African silkworm (Anaphevenata) contains a thiaminase and can cause thiamine deficiency and responsible for a seasonal ataxic syndrome (Okazaki & Akai, 2000).

However, all these health risks can be prevented by utilization of scientifically recommended insect species reared on pollutant-free feed either harvested in the wild or on farms with proper processing, handling and storage facilities (Schabel, 2010).

## VII. The Role of Insects in Reducing the Environmental Impact of Livestock Intensification

About 20 percent of the world's pastures and rangeland have been degraded to some extent and the proportion may be as high as 73 percent in dry areas (UNEP, 2004). To reduce the environmental impact (through deforestation) due to intensification of livestock production, the protein-rich insects are one of the options which are being considered as an alternative to conventional protein sources (Khusro*et al*., 2012).

Among insect species only cockroaches, termites and beetles produce CH4 which originates from bacterial fermentation by Methanobacteriaceae in the hindgut (Egert *et al*., 2003). More importantly insect's species such as mealworm larvae, crickets and locusts which are favorably lower by a factor of about 100 with pigs and beef cattle in their GHG emissions (Oonincx *et al*., 2010) suggesting that they are the inevitable option in reducing GHG emission.

*Table 8:* Production of GHG and Ammonia in three insect species, pig and beef

| Emission | Meal worm | Cricket | Locust | Pig | Beef |
|---|---|---|---|---|---|
| GHG | 50 (insignificant) | 50(insignificant) | 100 | 200-1000 | 2500-2800 |
| Ammonia | 10 (insignificant) | 100 | 50 | 1100 | Not specified |

*NB.The unit used in measuring emission was; for GHG=g/kg mass gain and mg/day/kg mass gain.*

*Source (Ooninck. et al., 2010)*

## VIII. Summary and Conclusion

- Based on the comprehensive research finding obtained from different researchers, it is possible to come up with concrete conclusion that insect meals are a valid, cost effective and highly nutritive alternative source of animal protein potentially utilized as a supplement and or sole source of nutrients particularly protein meeting the overall nutrient requirements of various animal species.
- According to the current reviews, various insect species have 30% -70% of protein on DM basis and rich in fats, minerals and vitamins content and have efficient food conversion factor compared to conventional fish and soybean meals which are reported to be very expensive and unaffordable for small scale farmers engaged in livestock rearing.
- The palatability of the diets containing insect meals is good and can replace soybean and fishmeal in the diets of poultry, fish and pig based on feeding studies conducted by different researchers. However, in the future further availability of different species of insect meals should be conducted to provide impetus for upcoming detailed research on evaluation of insects as alternative feed resources in ruminant livestock as well.
- In laying hens maggots could replace up to 50% of fishmeal at inclusion 5% in diet without any adverse effects. However 100% replacement produced negative effects on egg production. For broilers, the optimum level of their inclusion is generally ≤ 10% like meal worm without any adverse effects; however it is important to note that insect meals compared to fishmeal contain lower concentration

of Methionine and Ca which has to be considered when formulating diets based on insect proteins. It appears that grasshopper meal could be added into the diets of broilers at 2.5% (as a substitute for fishmeal). Mormon cricket can be up to 30% without any adverse effects.

- In fish species 25-40% replacement of insect meal as substitute of fishmeal does not affect growth performance in catfish. In various fish species (African catfish, walking fish and Nile tilapia) the studies suggested that 25% of fishmeal can be replaced with grasshopper meal without any adverse effects and for some species inclusion up to 40% is recommended. From the output of experiments conducted in growing and finishing pigs, it could be concluded that defatted silkworm meal could replace 100% of soy meal or fishmeal.
- Some insect meals, for example (black soldier fly larvae, housefly maggot meal, mealworm and silkworm) contain as high as 36% oil which can be used for the preparation of biodiesel. However, high content of oil could decrease fiber digestion in the rumen in such a way that it creates unfavorable condition for optimum rumen fermentation. Therefore, such species of insects should be defatted to ensure normal rumen fermentation.
- Insect meals (e.g. black soldier fly larvae) contain high levels of ash and hence their higher levels of inclusion in the diet, especially of mono-gastric, can decrease its intake and cause other adverse effects. Furthermore, black solder fly larvae has high content of Ca which is around (7.5%) and other insects containing low content of Ca which need be supplemented with Ca in the ration.

## IX. The Way Forward

- Currently, insect rearing is done at a small scale. So that, there is a need for establishing cost-effective well-optimized mass insect rearing facilities for a defined quality of animal product.
- To use insects as alternative sustainable protein rich ingredient in poultry, Fish and pig diets, it requires production of insect at large scale up on undertaking utilization of bio-waste and organic side stream.
- There is a need in developing countries to establish intensive insect rearing to enhance livestock productivity ultimately ensuring food security. This can be achieved when different stakeholders share
- Coordinated responsibilities. First the Government should create awareness on how to establish insect rearing farms up on utilizing of locally available insects species, biowates and organic side streams to different stakeholders engaged in livestock rearing and collaborately working with various governmental and nongovernmental such those working in agriculture, livestock resource, fishery developments, health and environment.
- For obtaining safe insect meals in animal feed, setting up of sanitation procedures on bio-wastes, disease management, application of heavy metals and pesticides needs to be considered.
- While feeding insects' meal to livestock, we should also consider its impacts on animal and human health point of view.
- To reduce environmental effect of protein rich animal feed derived from plant and animal sources, insect should be encouraged as substitute or supplementation.

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# Assessment of Farmers' Perception on Performance of Different Disseminated Breeding Ram and their Cross to Damot Sore and Merab Badewacho Worda, Southern Ethiopia

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*Abstract-* Near to 99.99 percent of sheep breeds in southern region is in the traditional way, in which indigenous breeds and types predominate. Indigenous sheep genetic improvement via 50% Dorper crossed ram introduction and community based sheep breed improvement, are found mostly under taken by southern agricultural research centre.50% Dorper crossed ram, Bonga and doygena ram were widely distributed to different agroecology of the region. The objective of this paper is to assess the productive performance of introduced ram based farmer perceptions and to analyze performance of the introduced breeding ram in Damot sore and Merab Badewacho worda southern Ethiopia. Community based improved Doygena ram were preferred for their ability to produce multiple birth, for its attractive coat color, its resistance to health problem in Damot sore while in Merab Badewacho the breed perform less significant.

*Keywords:* *breeding sheep, farmer perception, damot sore, merab badewacho.*

*GJSFR-D Classification:* *FOR Code: 079999*

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Kebede H/giorgis [α] & Zekarias Bassa [σ]

*Abstract-* Near to 99.99 percent of sheep breeds in southern region is in the traditional way, in which indigenous breeds and types predominate. Indigenous sheep genetic improvement via 50% Dorper crossed ram introduction and community based sheep breed improvement, are found mostly under taken by southern agricultural research centre.50% Dorper crossed ram, Bonga and doygena ram were widely distributed to different agroecology of the region. The objective of this paper is to assess the productive performance of introduced ram based farmer perceptions and to analyze performance of the introduced breeding ram in Damot sore and Merab Badewacho worda southern Ethiopia. Community based improved Doygena ram were preferred for their ability to produce multiple birth, for its attractive coat color, its resistance to health problem in Damot sore while in Merab Badewacho the breed perform less significant. Bonga ram and its f1 appreciated for fast growth and good adaptability in Merab Badewacho whereas in Damot Sore it could not perform at it is expected. Comparative performances based on farmer view show that Dorper cross were preferred for its docile behavior in Damot sore Worda. Farmer in Damot Sore Worda appreciated the doygena ram for its sexual performance/libido. Most of the respondents reported Dorper and its cross is not easily marketable. It is suggested that in Damot Sore worda more opportunity were existed to introduce improved Doygena, Bonga and Dorper ram while in Merab Badewacho efforts should be directed to develop local sheep selection or introduced Bonga ram to smallholder farmer.

*Keywords: breeding sheep, farmer perception, damot sore, merab badewacho.*

## I. Introduction

To improve productivity of indigenous sheep Southern agricultural research Centre has applies its effort in many directions. one of the option was CBBI through natural selection and distribution of first best ranked ram to different agroecology of the region. Bonga and Areka agricultural research Centre established a cooperative for continuous supply of Bonga and DoyoenaCBBI improved ram. For the last 4 consecutive years near breeding ram were distributed across different agroecology. Most documented work on the productive performance of indigenous sheep were at station rearing condition in the region is from research stations BED sit. Based on operational research and technology dissemination programs Merab Badewacho and Damot sore worda was selected as ORTD site and in both worda doygena and Bonga ram were distributed for genetic improvement purpose In animal genetic improvement, during technology diffusion the question of technology adaptability is the most important one. Also the rate of adoption of a new technology is subject to its profitability and the degree of risk and uncertainty associated with it, agricultural policies, and the socio-economic characteristics of farmer's acceptances is the most important. Intensity of animal adoption and farmer preference is actually the most critical criterion in animal technology diffusion process. Smallholder sheep producer use different phenotypic features including adaptive attributes to identify and select their breeds, for centuries. Study indicate that farmers may be rejected the crossbreds F1 lamb produced from introduced ram if the progeny have phenotypic feature is dissimilarity with their local breeds. Even introduced ram and its F1 have larger body size and higher body weighted sheep it may not prefer by farmer. A study conducted for exotic sheep X local sheep cross breeding indicates except Awassi most distributed crossbreds neglected by farmer because they did not meet farmer phenotypic preference (etal T. Getachew, 2016).in a similar case among regional sheep breed across agroecology adaptability and farmer preference variation were observed. Thus during introduction and adaption new improved breed considering acceptance among farmers and understanding of adaption of the technology were important point. This was analyzed by examining introduced breeding sheep, their production performance and farmer acceptance relative to home-grown sheep in various phenotypic reasons. Therefore the objective of this paper is to assess interest farmer based introduction of improved sheep in Damot Soreand Merab Badewacho.

### a) Objective

To evaluate performances of disseminated rams and their progenies based on farmer view.

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To identify constraints and opportunities for future improvements and interventions.

## II. Material and Method

*a) Description of study site*

The studies were conducted at Damot Sore and Merab Badewach woredas. Damot Sore is located in between 7°35" North Longitude; and 38°1". Agro ecology of the areas is 58% highland (Dega), 42% midland (Weina Dega). The average temperature varies from minimum 13°C to maximum 21°C.The annual average rainfall of Damot Sore is 1200 mm. Merab Badewacho is situated at an altitude ranging from 1750 to 2100 m.a.s.land located in between 7°7" North Longitude; and 37°43". The average temperature varies from minimum 15°C to maximum 27°C.The annual average rainfall varies from minimum 900 to maximum 1200mm (Source Zonal agriculture and rural development department and the office of livestock and fishery of Damot Sore and Merab Badewacho Worda, 2016).

*b) Data collection*

Data were collected via field observation, group discussions and key informant interviews. Based on the questionnaire Individual interview (questionnaire) were held to generate socio-economic information and management practices Farmers included in this study were those who have detail information about the breed and use it so far. The selected farmers had, ram holder, and have comparative knowledge about the distributing breeding ram, i.e. Bonga, Doygena and indigenous additionally Dorper sheep were considered for Damot sore districts. In these study collaborative agency who carried out breeding sheep distribution were involved. This was determined through focus group discussions with Worda office of livestock and fishery development officials and breeding sheep holder within the target areas including local leaders, ministry and NGOs were involved.

In total of, 60 breeding ram beneficiary farmers and breeding ram service user were asked, from 25 from Merab Badewacho and 35 from Damot sore. Of the 60 beneficiary farmers, 35 for Damot sore worda respondents have satisfactory information for the three sheep breeds groups, whereas 25 for Merab Badewacho had only Bonga and Doygena and their cross. During data collection farmers were requested to classify the introduced sheep groups according to their preference and capability of adaptability. In addition farmers were requested to classify based on morphology and coat color, growth ability easiness to manage, feeding habit and mainly, when possible, use of their knowledge of the preference of each animal. Within each of the three breed groups. According to the farmer's opinion represented the rank1 (first best), rank2 (second best), rank3 (third best) and rank4 (fourth best), respectively. Distributing Breeding sheep were from CBBI improved sheep from Bonga agricultural research Centre and Areka agricultural research center Doygena CBBI. Thus, the origin of improved breeding sheep is from different agroecology of the region.

*c) Statistical analyses*

Data were analyzed using SPSS version 20.we used for the general linear model analyses for estimation of the least squares means. Effects of agroecology based on breed and interactions between Breed and Rank and between study area and Rank were tested in chi-square.

The following fixed linear model, including the main effects were significant, was finally used to explain the variation of the sheep traits prefer by farmer: $yijkl = \mu + Sitei + Farmerj(Sitei) + Breedk + Rankl + (Breed*Site)ki + eijkl$

where yijkl is the trait of interest, either rapid growth, good adaptability, easy to manage, attractive in color and feeding habit. $\mu$ is the overall mean for the trait; Sitei is the effect of the ith site (i = Merab Badewach, Damot Sore); Farmer j(Worda) is the effect of jth farmer within study sitei (j = 1–60); Breedk is the effect of the kth breed group (k =Bonga and its Cross, Doygena and its cross, and Dorper and its cross and indigenous); Rankl is the effect of the lth rank of the ram (l = first best, second best, third best, and fourth best); (Breed*Site)ki is the interaction effect between Breedk and Sitei; and eijkl is the random residual effect

## III. Result and Discussion

*Respondents and total household members*

For this study a total of 60 households were asked from the both study area where improved ram were distributed. Of the total households, the majority (66.67%) were female headed while the remaining 33.33 house hold was male households. The overall average family sizes of household's were4.45±0.383 (table 1). In this study, majority household respondents were married person who maintains and is running a household were above 85.71% whereas 14.29 percent headed household is widowed (table1).

*Table 1:* Household characteristic across the study area

| Parameter | Damot sore n=35 | Merab Badewacho n=25 | Overall N =60 |
|---|---|---|---|
| | Mean ±SE | mean ±SE | mean±SE |
| Respondent sex | | | |
| Male | 11 | 9 | 33.33 |
| Female | 24 | 16 | 66.67 |
| Age(years) | 49.00±20 | 36.82±1.08 | 42.91±1.11 |
| Marital status | | | |
| Married | 86.6 | 90 | 85.71 |
| Widowed | 13.4 | 10 | 14.29 |
| Total family size | 5.5±0.50 | 3.46±0.27 | 4.45±0.383 |

*N=number of respondents*

*a) Breeding ram preference*

For the success of indigenous sheep genetic improvement understanding the community breeding animal preference is important (Solomon etal, 2013) .the first issue is choice of breeds. Sheep producing communities commonly prefer to keep their own traditional breeds to meet their multiple breeding objectives. Farmer's preferences for breeds are influenced by their perceptions of their breeds and previous genetic improvement effort in the area. Farmer reported different preference for introduced breeding ram and their cross, for instance in Merab Badewacho Bonga ram and its cross were significantly preferred for its fast growth rate (ranking index 0.63),), its coat color (0.474) and for its best feeding habit (0.43). Doygena sheep is preferred for its ability to produce multiple births in both study area (table2). In both study area no encounter of market problem for introduced Doygena and Bonga ram cross. Generally in Merab Badewacho majority of the interviewed farmer have an interested for Bonga sheep than Doygena and indigenous sheep. On the other hand for Damot sore worda Doygena breeding ram and its cross were appreciated for its fast growth rate (0.33), for its best adaptability (0.33), for its attractive *Bula* and light red coat color (0.333) and for its ability to resist disease and parasite(0.36),for its ability to mate more ewe (0.52),and for its ability to produce multiple birth at one delivery(0.44), Dorper cross is preferred for its best feed habit(0.33),and its docile behavior. In both study area aggressive behavior of Doyogena ram is not preferred by farmer (table2).

*Table 2:* Ranking of introduced improved sheep and their cross by beneficiary farmers

| Respondents interest in choice of breeds | Ranking index | | | | | | |
|---|---|---|---|---|---|---|---|
| | Damot Sore | | | | Merab Badewacho | | |
| | Dorper | Bonga | Doygen | Indigenous | Bonga | Doygena | Indigenous |
| For its rapid growth | 0.30 | 0.30 | 0.33 | 0.07 | 0.63 | 0.21 | 0.16 |
| For its instantaneous adaptability | 0.21 | 0.24 | 0.33 | 0.18 | 0.27 | 0.20 | 0.53 |
| For its docile Behavior | 0.40 | 0.23 | 0.10 | 0.27 | 0.333 | 0.167 | 0.500 |
| For its attractive coat color | 0.212 | 0.242 | 0.333 | 0.212 | 0.474 | 0.369 | 0.158 |
| For its best feeding habit | 0.333 | 0.300 | 0.300 | 0.067 | 0.43 | 0.41 | 0.16 |
| For its ability to resist disease and parasite | 0.14 | 0.21 | 0.36 | 0.29 | 0.39 | 0.19 | 0.42 |
| For its ability to mate more ewe | 0.09 | 0.26 | 0.52 | 0.13 | 0.25 | 0.43 | 0.31 |
| For its ability to produce multiple birth | 0.15 | 0.26 | 0.44 | 0.15 | 0.37 | 0.47 | 0.17 |

*Index= ((4 for rank 1) + (3 for rank 2) + (2 for rank 3) + (1 for rank 4) divided by sum of parameter farmer interest list during breeding sheep preference mentioned by the respondents.*

*b) Possible opportunity to expand sheep production*

The greatest number of respondents' reason for expansion of sheep production in the study area is for their immediate return(ranking index for Damot Sore and Merab Badewach) were 0.29,0.31 respectively as shown in (Table3) .in addition high market demand availability(ranking index 0.28), and appropriate for slaughter(0.21)were reason) reported reason for Merab Baewacho farmer. For Damot sore easy to manage(0.27),high market demand(0.0.22)similarly for appropriate for slaughter were main raised reason .it is possible to say almost all of the interviewed farmer show the future interest to continue and /or expand sheep production. Among the reason of sheep

production expansions, immediate return and high market demand are the most appreciated issues currently for sheep production. These results are agreed with the report of Fsahatsion, 2013 Tsedeke (2007) and Belete (2009) in GamoGofa Zone, Halaba area and Jimma zone.

*Table 3:* Possible opportunity to expand sheep production

| Reasons | Rank of reason | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Damot sore | | | | | Merab Badewacho | | | | |
| | R1 | R2 | R3 | R4 | index | R1 | R2 | R3 | R4 | Index |
| High market demand | 9 | 3 | 6 | 1 | 0.22 | 13 | 14 | 4 | 0 | 0.28 |
| Easy to manage and keep | 7 | 12 | 3 | 1 | 0.27 | 12 | 9 | 0 | 0 | 0.21 |
| Immediate returns | 12 | 3 | 8 | 1 | 0.29 | 15 | 7 | 15 | 0 | 0.31 |
| Appropriate for slaughter/consumption | 8 | 5 | 2 | 5 | 0.22 | 7 | 11 | 6 | 1 | 0.21 |

*Index= ((4 for rank 1) + (3 for rank 2) + (2 for rank 3) + (1 for rank 4) divided by sum of all reason mentioned by the respondents.*

c) *Selection criteria for breeding sheep*

The preferences of farmer to select best breeding rams are presented in Table 4. Regarding with animal sex majority of farmer show interest for both male and female animal (table4).farmer reported that Dorper with its F1 and Bonga with its F1 were susceptible with disease and parasite (table4). For Damot Sore worda, respondents show interest for Doygen(40%) and for Bonga (33.33) ram while in Merab Badewacho only Bonga was selected for breeding. The primary selection criteria were in the Damot Sore were based on the breed Physical appearance(length, color, height) of the ram (52.38%) while the introduced breed performance(47.61) was the primary selection criteria for Merab Badewacho. This finding is in agreement with the results of Fsahatsion, 2013).

*Table 4:* farmer perception breeding animal selection

| Respondents response for breeding sheep selection | Study site | | | |
|---|---|---|---|---|
| | Damot N | Sore % age | Merab N | Badewacho % age |
| By sex | | | | |
| Male | 7 | 29.16 | 3 | 7.5 |
| Female | 5 | 20.83 | 14 | 35 |
| Both types | 12 | 50 | 23 | 57.5 |
| Based on breed type | | | | |
| Dorper cross | 6 | 24 | | |
| Bonga | 8 | 33.33 | 17 | 62.96 |
| Doygena | 10 | 40 | 7 | 25.92 |
| Indigenous | 1 | 4 | 3 | 11.11 |
| Sheep breed susceptible with disease and parasite | | | | |
| Dorper(50%) and its F1 | 9 | 42.85 | | |
| Bonga and its F1 | 10 | 47.61 | 3 | 23.5 |
| Doyogena and its F1 | 1 | 4.7 | 6 | 8.8 |
| Indigenous sheep | 1 | 4.7 | 2 | 17.64 |
| Selection criteria for breeding sheep | | | | |
| Physical appearance(length, color, height) | 11 | 52.38 | 9 | 42.85 |
| Breed performance | 7 | 33.33 | 10 | 47.61 |
| Progeny performance | 3 | 14.28 | 2 | 9.5 |

d) *Major sheep production constraints*

The main sheep production constraints reported by the beneficiary for Damot Sore districts were disease and parasite (rank index 0.54 and feed shortage (0.28) and lack of extension support (0.24) were second and third constraint in the area table 5). For MerabBadewacho districts the primary reported problem was feed and grazing land shortage (rank index 0.301.health problem and labor shortage were the second and third problem reported by farmer index ranked 0.226, 0.092 respectively. The present study for extension support is disagreeing with the report of Ermias, etal 2015.

*Table 5:* Major sheep production constraints

| Major constraints | Rank of constraint | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Damot sore | | | | | Merab Badewacho | | | | |
| | R1 | R2 | R3 | R4 | Index | R1 | R2 | R3 | R4 | index |
| Disease and parasite | 21 | 6 | 1 | 0 | 0.469 | 14 | 17 | 2 | 2 | 0.36 |
| Feed and grazing land shortage | 4 | 12 | 1 | 0 | 0.244 | 27 | 14 | 0 | 0 | 0.48 |
| Labor shortage | 0 | 5 | 1 | 0 | 0.077 | 6 | 5 | 3 | 1 | 0.15 |
| Lack of extension support | 2 | 8 | 7 | 0 | 0.208 | 0 | 0 | 0 | 1 | 0.00 |
| Predators | 0 | 0 | 0 | 1 | 0.005 | 0 | 0 | 1 | 4 | 0.02 |

*Index= ((4 for rank 1) + (3 for rank 2) + (2 for rank 3) + (1 for rank 4) divided by sum of all listed constraints mentioned by the respondents.*

*e) Common types of diseases and parasites*

Major diseases and parasites were ranked by farmer according to the disease relative economic importance. These diseases were identified by the symptoms when asked for the respondents and the symptoms. Based on the survey results GIT parasites, ovine pasteurelosis/ respiratory problem and lung warm /Sheep couging are the most important diseases prevalent in the Damot sore worda and ranked first, second and third respectively. External parasite, blue tong and anthrax were prevalent and ranked fourth, fifth and sixth respectively. Pasteurellosis, blue tong and brucellosis are the most important diseases prevalent in the Merab Badewacho and ranked first, second and third, also the same incidences of lung warm, external parasite and GIT parasite were prevalent. Among the above mentioned diseases Pasteurellosis, blue tong and brucellosis causing the most serious/economic loss in Merab Badewacho. These study is agree with the report of Fsahatsion,2013 GIT parasite is cause of huge loss for huge amount of lambs, ewes and rams. Therefore it can be concluded that, ovinepasteurelosis/ respiratory problem the major problem in both study area.

*Table 6:* List of diseases reported by farmers in the study areas

| Local name | | | Ranking by location | | |
|---|---|---|---|---|---|
| (Amharic and Wollitta language) | Hydia language | Common name | Damot Sore | MerabBadewacho | symptoms |
| *Goreresa*,(Amharic), *Bochuwa* (Wollita) language | *Kutisojaboeye* | ovine pasteurelosis/ respiratory problem | 2 | 1 | Nasal discharge, emanation, death |
| Sugeta((Wollita) language | *Sugeta* | Blue tong | 5 | 2 | Tongue and Mouth swelling, stop eating |
| *Aba senga*(Amheric), *Telekeya(Wollitta language)* | | Anthrax | 6 | - | Sudden death, |
| *Sal*(Amharic), *Kofiya,*Wollitta language) | *Kutisojaboeye* | Lung warm /Sheep common cold | 3 | 4 | Frequent coughing, discharge |
| *Wureja*(Amheric language, *Awuchaya*Wollitta language) | *Kereqrema* | Abortion/brucellosis | - | 3 | Abortion |
| *Ayfiya*sahuwa(Wollitta language) | *Jeltilosoxile* | Pink eye | 7 | 7 | Eye redness, eye become cloudy and blindness |
| *Kezen*(Amheric), *Kera*(Wollitta language) | *Enishasha* | GIT parasite | 1 | 6 | Diarrhea, emaciation, rough hair coat, loss of appetite and death |
| *Odo*(Wollitta language *Alket*/mezger(Amharic) *Danko*(Wollitta language) | | Externa parasite like ovine foot rot leech, hard and soft tick, mange mite) | 4 | 5 | inflammation of the hooves and Lameness Itching, |
| *Nefate*(Amharic) *Pura*(Wollitta language) | | Bloat/Poisoning/non infectious | - | 8 | Discharge, stop eating, stop gastric circulations, bloating then death |

## IV. Conclusion and Recommendation

In both study worda respondents appreciate Bonga sheep for its ability to adapt and its progeny fast growth. In Damot Sore farmer like all three breeding ram. However their interests for Doygena breeding ram were much higher. In breeding sheep aspect Dorper sheep was not meet farmer interest because of black coat color. it is suggested that to achieve upsetting farmer breeding ram interest which is increasing time to time further increasing of breeding ram producer cooperative work should be considered.

## V. Acknowledgement

Both districts livestock and Fishery office professionals, key informant, are acknowledged for their valuable input during data collection. Also the authors thankful to small holder farmer in respective worda for their kind contribution in giving genuine information and expression of their interest openly.

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As changes to proofs are costly, we inquire that you only correct typesetting errors. All illustrations are retained by the publisher. Please note that the authors are responsible for all statements made in their work, including changes made by the copy editor.

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The Global Journals Inc. (US) are enclosed by our publishing's Early View service. Early View articles are complete full-text articles sent in advance of their publication. Early View articles are absolute and final. They have been completely reviewed, revised and edited for publication, and the authors' final corrections have been incorporated. Because they are in final form, no changes can be made after sending them. The nature of Early View articles means that they do not yet have volume, issue or page numbers, so Early View articles cannot be cited in the conventional way.

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Before start writing a good quality Computer Science Research Paper, let us first understand what is Computer Science Research Paper? So, Computer Science Research Paper is the paper which is written by professionals or scientists who are associated to Computer Science and Information Technology, or doing research study in these areas. If you are novel to this field then you can consult about this field from your supervisor or guide.

## TECHNIQUES FOR WRITING A GOOD QUALITY RESEARCH PAPER:

**1. Choosing the topic:** In most cases, the topic is searched by the interest of author but it can be also suggested by the guides. You can have several topics and then you can judge that in which topic or subject you are finding yourself most comfortable. This can be done by asking several questions to yourself, like Will I be able to carry our search in this area? Will I find all necessary recourses to accomplish the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

**2. Evaluators are human:** First thing to remember that evaluators are also human being. They are not only meant for rejecting a paper. They are here to evaluate your paper. So, present your Best.

**3. Think Like Evaluators:** If you are in a confusion or getting demotivated that your paper will be accepted by evaluators or not, then think and try to evaluate your paper like an Evaluator. Try to understand that what an evaluator wants in your research paper and automatically you will have your answer.

**4. Make blueprints of paper:** The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

**5. Ask your Guides:** If you are having any difficulty in your research, then do not hesitate to share your difficulty to your guide (if you have any). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work then ask the supervisor to help you with the alternative. He might also provide you the list of essential readings.

**6. Use of computer is recommended:** As you are doing research in the field of Computer Science, then this point is quite obvious.

**7. Use right software:** Always use good quality software packages. If you are not capable to judge good software then you can lose quality of your paper unknowingly. There are various software programs available to help you, which you can get through Internet.

**8. Use the Internet for help:** An excellent start for your paper can be by using the Google. It is an excellent search engine, where you can have your doubts resolved. You may also read some answers for the frequent question how to write my research paper or find model research paper. From the internet library you can download books. If you have all required books make important reading selecting and analyzing the specified information. Then put together research paper sketch out.

**9. Use and get big pictures:** Always use encyclopedias, Wikipedia to get pictures so that you can go into the depth.

**10. Bookmarks are useful:** When you read any book or magazine, you generally use bookmarks, right! It is a good habit, which helps to not to lose your continuity. You should always use bookmarks while searching on Internet also, which will make your search easier.

**11. Revise what you wrote:** When you write anything, always read it, summarize it and then finalize it.

**12. Make all efforts:** Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

**13. Have backups:** When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

**14. Produce good diagrams of your own:** Always try to include good charts or diagrams in your paper to improve quality. Using several and unnecessary diagrams will degrade the quality of your paper by creating "hotchpotch." So always, try to make and include those diagrams, which are made by your own to improve readability and understandability of your paper.

**15. Use of direct quotes:** When you do research relevant to literature, history or current affairs then use of quotes become essential but if study is relevant to science then use of quotes is not preferable.

**16. Use proper verb tense:** Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

**17. Never use online paper:** If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

**18. Pick a good study spot:** To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

**19. Know what you know:** Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

**20. Use good quality grammar:** Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

**21. Arrangement of information:** Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

**22. Never start in last minute:** Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

**23. Multitasking in research is not good:** Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

**24. Never copy others' work:** Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

**25. Take proper rest and food:** No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

**26. Go for seminars:** Attend seminars if the topic is relevant to your research area. Utilize all your resources.

**27. Refresh your mind after intervals:** Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

**28. Make colleagues:** Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

**29. Think technically:** Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

**30. Think and then print:** When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

**31. Adding unnecessary information:** Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

**32. Never oversimplify everything:** To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

**33. Report concluded results:** Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

**34. After conclusion:** Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

## Informal Guidelines of Research Paper Writing

**Key points to remember:**

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

**Final Points:**

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

**General style:**

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

**Title Page:**

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

**Abstract:**

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

**Introduction:**

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

**Procedures (Methods and Materials):**

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

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

Approach:

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

What to keep away from

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

**Results:**

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

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

Content

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

What to stay away from

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

Approach

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

Figures and tables

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

**Discussion:**

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

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

Approach:

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

Please carefully note down following rules and regulation before submitting your Research Paper to Global Journals Inc. (US):

**Segment Draft and Final Research Paper:** You have to strictly follow the template of research paper. If it is not done your paper may get rejected.

- The **major constraint** is that you must independently make all content, tables, graphs, and facts that are offered in the paper. You must write each part of the paper wholly on your own. The Peer-reviewers need to identify your own perceptive of the concepts in your own terms. NEVER extract straight from any foundation, and never rephrase someone else's analysis.

- Do not give permission to anyone else to "PROOFREAD" your manuscript.

- Methods to avoid Plagiarism is applied by us on every paper, if found guilty, you will be blacklisted by all of our collaborated research groups, your institution will be informed for this and strict legal actions will be taken immediately.)
- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

## Criterion for Grading a Research Paper (Compilation) by Global Journals Inc. (US)

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| Topics | Grades | | |
|---|---|---|---|
| | **A-B** | **C-D** | **E-F** |
| ***Abstract*** | Clear and concise with appropriate content, Correct format. 200 words or below | Unclear summary and no specific data, Incorrect form<br><br>Above 200 words | No specific data with ambiguous information<br><br>Above 250 words |
| ***Introduction*** | Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited | Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter | Out of place depth and content, hazy format |
| ***Methods and Procedures*** | Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads | Difficult to comprehend with embarrassed text, too much explanation but completed | Incorrect and unorganized structure with hazy meaning |
| ***Result*** | Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake | Complete and embarrassed text, difficult to comprehend | Irregular format with wrong facts and figures |
| ***Discussion*** | Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited | Wordy, unclear conclusion, spurious | Conclusion is not cited, unorganized, difficult to comprehend |
| ***References*** | Complete and correct format, well organized | Beside the point, Incomplete | Wrong format and structuring |

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