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Analysis of market demand for alternative poultry feeds in Uganda

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Abstract

Feeds constitute 70% of the cost of poultry production and of this, proteins constitute the highest cost. Finding cheaper alternatives to existing protein sources would improve efficiency and profitability of poultry production. The *Acrida cinerea* Project was implemented to foster development and promotion of insect protein- based poultry feeds. It was hypothesized that insect-based protein sources could significantly supplement or even replace fish meal which is the predominant source of feed protein currently. The market for conventional protein was expected to gradually switch from silver fish through partial to complete substitution with insect sources. The major objective of the study was to analyse demand, market size and trends of current conventional and proposed sources of poultry feed proteins in Uganda and make projections. The study was conducted in Mukono, Wakiso and Jinja districts. The bulk of data were captured from secondary sources and primary data from formal survey of farmers and poultry value chain actors. Aggregate demand for insect feed ingredients for poultry feed was estimated at 5,853 metric tons on dry matter basis at 50% rate of substitution of conventional animal protein. Projected demand for poultry insect feed proteins was 35,201 metric tons in the next 5 years. Insects had a strong potential for incorporation into poultry feeds.

Key words: Consumer Tastes, Edible Insects, Protein Feed Substitutability, Silver fish, Soya beans

Introduction

Louw *et al.* (2011), revealed that intensively managed chickens heavily consume manufactured feeds as compound concentrates or protein enriched value-added cereal bran or oil seed by-products on a daily basis. According to Byarugaba (2007), Graffham *et al.* (2003) and Osongo *et al*. (2018) feeds constitute over 70% of the cost of production in such enterprises. However, Frame (2008) noted that chicken will only grow and perform to the extent they receive proper nutrition. If compromised, feed quality will affect feed consumption and can cause disease or nutritional deficiencies as well. A Project on *Acrida cinerea* - was engaged to develop and promote insect protein-based poultry feeds. Protein constituted the highest cost item in poultry feeds (https://doi.org/10.1093/jee//toy118), thus finding alternatives would promote greater poultry production for both large scale commercial and small-scale producers. Reduction in cost of production of such feed will make cheaper protein rich food more available to an increasing human population. Under natural traditional free ranging chicken production systems, insects within the ecosystems are a key feed resource for many poultry species. Extensively managed village chickens move around courtyards, gardens, green fields, open up top

soils and litter to search for grasshoppers, crickets, cockroaches, termites, worms and their larvae that they feed on. According to Khusro *et al.* (2012), such insects could be safe to feed to chicken and the quality and palatability of the chicken meat remains good. More insects such as lice, cicadas, desert locusts (*Schistocercagregaria*), aphids, common housefly maggots (*Muscadomestica*), flies, bees, stink bugs, scale insects, psyllids, beetles, fleas, wasps, domesticated silkworm (*Bombyxmori*), caterpillars and ants could be considered as animal protein feed ingredients for specific intensive commercial poultry production systems. Edible insects have protein content ranging from 30% to 80% for wood worms and wasp species, respectively (Khusro *et al*, 2012) and these could be good substitutes for the conventional sources of proteins in the poultry feeds. Past studies revealed that, changing from use of Soymeal and fish meal to feeding insect- based meals to chicken lowered emissions of greenhouse gases and led to efficient use of natural resources (Van Zanten *et al*. 2018 and Khan, 2018). According to Osongo *et al.* (2018), when birds were reared on the highest concentration of black soldier fly, the Cost Benefit Ratio and the returns to investment in broiler production increased by 16% and 25%, respectively. Poultry farmers interviewed in a survey in Australia, accepted to feed insects to poultry, so long as it was economical (Khusro *et al.* (2012). As such, a number of poultry insect protein-based feed formulations are to be developed and these require a well-targeted market. This study was geared towards assessing the potential market for insect protein in commercially produced poultry feeds.

It was hypothesized that insect-based protein sources for poultry feed could significantly supplement or even replace fish meal which is the predominant source of feed protein currently being used. The market for conventional protein - haplochromis fish species (Silver fish) locally called Omena or mukene- was expected partially to be substituted with insect feed. When the location, time period and marketing effort of a product are defined, market demand of the product would constitute the total volume of that product or service that would be bought by a consumer group. Market demand can depend on environmental factors as well as the sales of a related product (complements and substitutes) or service and the existing economic conditions. Market demand is divided into two categories, primary and selective demand. Primary demand is the total demand of a given product or services, whereas selective demand is the demand for a given brand of product or services. In order to assess its business potential, a business should estimate what its share of the market could be. Insect protein-based feed for poultry is a new feed product being researched on with the aim of producing low - cost poultry feeds which will help farmers to lower their cost of production. Being a new product, a market demand analysis is necessary to understand its market potential. To determine the market demand of insect protein-based poultry feed, the market demand of the current poultry feed was analysed. According to UBOS, (2020), there are 47.6 million chickens in Uganda and of these 85% are indigenous totalling to 41.726 million chicken while the exotic are 5.852 million chickens.

The study had the following objectives:

1. Analyse the demand, market size and trends for conventional sources of poultry feed proteins in Uganda at present, and providing a current situation and make projections into the future.
2. Analyse the opportunities and threats for transfer and adoption of insects as protein sources in feeds.

Methodology

The study was conducted in the districts where there were high concentrations of commercial poultry (small, medium and large scale). Under the study several data types based on different approaches were collected. These included secondary data from the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), Sector and sub-sector statistics from UBOS, formal survey of farmers and manufacturers/suppliers of ingredients and feeds of poultry, and key informant interviews. Secondary data consisted of reports and articles on works done on poultry feed in Uganda and in regions of similar circumstances. Key informant interviews were done with stakeholders knowledgeable in the poultry feed industry. Data were captured using semi-formal, structured formal standard and check lists. Major data sources were chairpersons of poultry farmers' associations, prominent poultry feed processors and farmers like Ugachick, Biyinzika Poultry International Ltd, MAAIF and District Veterinary Officers in the study area.

Household Survey Sampling Procedures

Multi-stage, stratified and purposive sampling techniques were used to identify respondent firms. In poultry farming sub-sectors data were triangulated and complemented using the data collection techniques shown below (Table 1).

Table 1: Data collection techniques

Technique	Information source
Formal Surveys - Commercial chicken Standard Questionnaire	Sixty respondents from commercial layers, broilers and kroilers (Mukono, Wakiso and Jinja districts)
Key informant Interviews	NARO – NaLIRRI, Ugachick, Biyinzika, District Veterinary Office (DVOs) and prominent farmers, feed Manufacturers and wholesalers, fish landing sites
Secondary data and Information	MAAIF, UBOS National Census of Livestock
Physical verification and direct observation	Poultry farms, feed Manufacturers and wholesalers, fish landing sites

Estimation of Demand and Market Size of Poultry Feeds

Demand of poultry feed is determined by existing poultry populations multiplied by their feed intake in a production cycle. In Uganda, in 2008, the national flock was 34.8 million, when the livestock census was done, the bulk (87.7 per cent were indigenous chickens). The rest 6.6 per cent (2.5 million) were commercial layers and 4.1 per cent (1.5 million) were commercial broilers (MAAIF-UBOS 2008). According to UBOS (2020), the national chicken flock was 47.6 million in 2017, the bulk (85 percent were indigenous chickens). There were approximately 41, 726,000 indigenous chickens and 5,852,000 exotic chickens by 2017 (UBOS, 2020). In 2020, chicken population was estimated at 53.4 million birds, of these 45.4 million birds were indigenous and 8.0 million were exotic. The exotic birds were composed of 3.0 million broilers and 5.0 million layers. Of the remaining flock that includes Kroilers and indigenous, it is estimated that 2.5 per cent of such birds are managed under semi-intensive systems and therefore use commercial feeds.

Annual poultry feed demand = (No. of commercial layers x annual feed intake/layer) + (No. commercial broilers x annual feed intake/broiler) + (No. of intensively managed indigenous/crosses/Kroilers x annual feed intake/Kroiler). Effective market demand of poultry feed in a year was calculated using the formula below:

$$\sum L_{ij} x_{ij} + \sum B_{ij} xj + \sum Cr_{ij} x_{ij} \cong F_i$$

.....(1)

Where:

L_{ij} = National Layer feed consumption level in the j[th] year

x_{ij} = National layer/broiler/kroiler flock in the j[th] year

B_{ik} = National broiler feed consumption level in the j[th] year

Cr_{ij} = National kroiler feed consumption level in the j[th] year

F_i = Total chicken feed demand in tons

It is understood that both the number of farmers who mix their own feed and those who do not mix feed obtain their animal protein sources from the open market. Data capture focused on key animal protein ingredients used to mix the feed.

Trends in Poultry Feed Availability

Information on seasonal availability of feed ingredient and price trends was obtained from feed processors, farmers and silver fish bulkers and bulk breakers at fish landing sites. Information captured reviewed annual trends and seasonal trajectory in availability and prices observed over the past 5 year's period. Information captured centred on annual sales, seasonal changes in sales, volumes/ quantities of different ingredients used seasonally and annually. This was supplemented by information from time series historical data on poultry feeds from the Ugandan bureau of statistics (UBOS) and from specific organizations like Ministry of Agriculture, Animal industry and fisheries (MAAIF). The data were analysed to determine the trends and the progression of the silver fish market and insect's substitutes over time as well as the size of the market. In addition, farmers interviewed provided information on most popular poultry feed brands as well as the matching retail prices. The feed price information combined with feed volume estimates provides an approximation of the current and potential demand of the poultry feeds markets in the country.

Sampling Frame of Poultry Farmers

Sampling of poultry feed market demand analysis study was done using two strata- sampling frame with focus being placed on two categories: Poultry farmers and Feed processors /suppliers. These were selected from Wakiso, Mukono and Jinja districts. In this study, statistical rigour was not the key driver of the analysis but rather demand and cost of production structures. This implied that representativeness rather statistically large samples prevailed.

Prospects for Transfer and Adoption of Insects as Protein Sources in Feeds

Key informant interviews were conducted in the study area to explore Strengths, Weaknesses, Opportunities and Threats (SWOT) for transfer and adoption of insects as protein sources in feeds. Key informants included District Veterinary Offices (DVOs), District Production Offices (DPOs), farmer leaders, Community Development Offices (CDOs) and representatives of feed processors and feed ingredient suppliers.

Results and Discussion

Demand Estimation for Poultry Feed

Demand estimation was calculated at annual basis. The key parameters used in its estimation are presented in table 2.

Table 2: Key Poultry Production Indices and Statistics in Uganda

Poultry farming	Value
National layer flock (Million birds)	5.0
National broiler flock (Million birds)	3.0
Feed requirement per bird from day one to 8 weeks market weight broiler (Kilograms)	4.50
Feed requirement of layers from day one to 70 weeks of market send- off (Kilograms)	59
Protein feed requirement for broilers (Per cent)	18 -20
Layer protein requirement (Per cent)	15 – 20

Source: MAAIF (2019) and UBOS (2020)

Protein sources used in manufacture of poultry feeds include full fat soya, solvent extracted soya and silver fish (mukene). The total quantity of protein used ranged from 2,950 tons to 10,570 tons between 2012 and 2020. Of this the proportion of silver fish ranged from 7 per cent to 28 per cent (Figure 1). It is therefore estimated that the proportion of silver fish in the protein source for feeds is about 18 per cent.

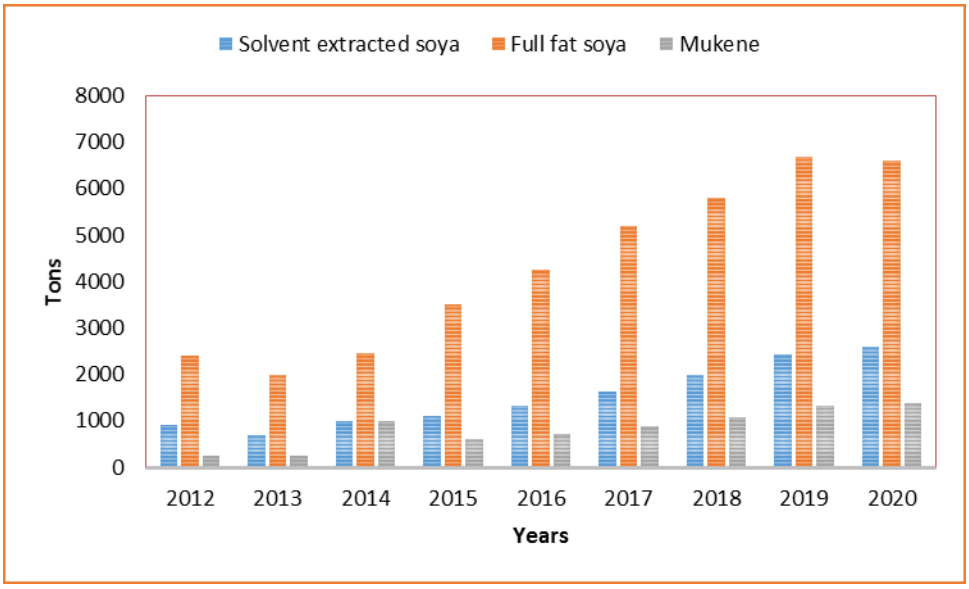

Figure 1: Protein Ingredients in Tons Used in Manufacture of Poultry Feeds from 2012 to 2020
Source: Ugachick Poultry Breeders Ltd

Computation of National Demand for Animal Protein in Chicken Feed

Technical coefficients used in the computation of broiler and layer feeds are outlined in tables 3 and 4.

Table 3: Technical Coefficients and Demand Estimation for Commercial Broiler Feeds

Commercial broiler characteristic	Value
National broiler flock '000' million birds	3.0
Broiler feed requirement from day one to 8 weeks (Kilograms)	4.50
Protein requirement (Per cent)	19.0
Proportion of animal protein in protein ingredients (Per cent)	18.0
Potential aggregate national whole meal feed requirements (tons)	13,500
Aggregate national protein ingredient feed requirements (tons)	2,565
Aggregate animal protein feed requirement (tons)	461.7
Effective demand for insect ingredient at 50 % substitution rate (tons) for broilers	230.9

Source: UBOS (2020), MAAIF (2019) and own calculations

Table 4: Technical Coefficients and Demand for Commercial Layer Feeds

Commercial layer characteristic	Value
National layer flock '000' (million birds)	5.0
Feed requirement from day one to 70 weeks of market send-off (Kilograms) for layers	59
Protein requirement (Per cent)	17.5
Proportion of animal protein in protein ingredients (Per cent)	18.0
Potential aggregate national whole meal feed requirements (tons)	295,000
Aggregate national protein ingredient feed requirements (tons)	51,625
Aggregate animal protein feed requirement (tons)	9,293
Effective demand for insect ingredient at 50 % substitution rate (tons) for layers	4646.3

Source: UBOS (2020), MAAIF (2019) and own calculations

The total poultry protein annual requirement is estimated at 54,190 metric tons for commercial broilers and layers. It is estimated that considering the feed requirements for existing Kroilers and semi-intensively managed poultry this figure would increase by about 20 per cent to 65,022 metric tons and -annual animal protein requirement is 11,706 metric tons. If rate of substitution of 50 per cent is anticipated the demand for insect feed ingredients would be 5,853 metric tons on dry matter basis.

Current and Projected Poultry Feed Proteins (Tons) in Uganda

The bulk of protein is obtained from soya bean and Silver fish. Some feed plants such as IG Invest have tried blood meal. Ugachick currently uses 8,900 tons of feed proteins in the manufacture of livestock and fish feeds proteins (Figure 2). Uganda's current annual demand for poultry feed proteins and animal protein for poultry feeds are 65,022 metric tons and 11,706 metric tons respectively. Projections in the next five years indicates a demand for animal protein for poultry feed totalling to 70,402 metric tons (table 5). At 50% substitution, insect protein demand for poultry feed will be 35,201 metric tons in the next 5 years.

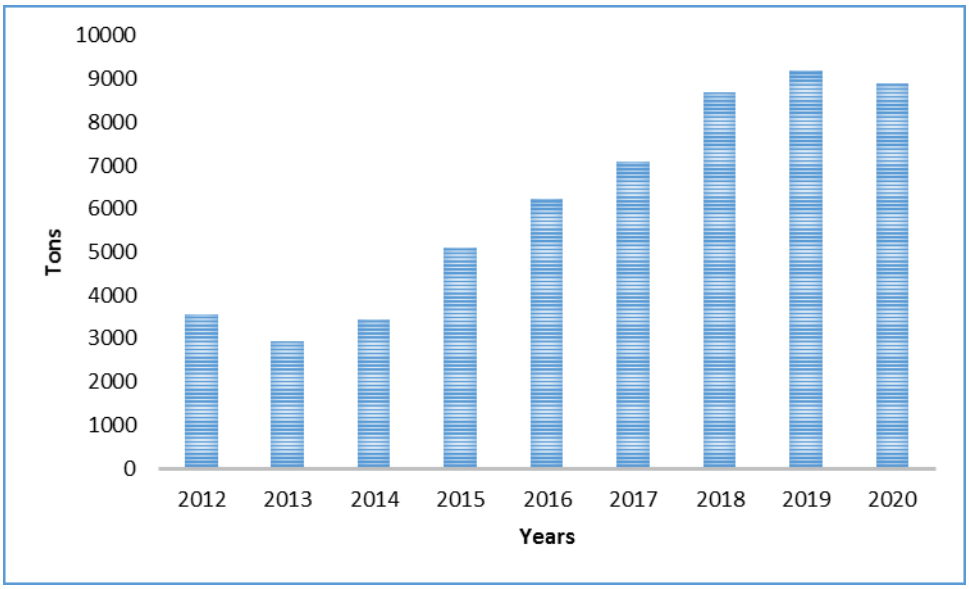

Figure 2: Current Poultry and Fish Feed Proteins in Metric Tons at Ugachick
Source: Ugachick Poultry Breeders Ltd

Table 5: Projections of poultry populations, poultry feed and feed protein

Year	Projected National flock ('000')	Projected Poultry feed demand (tons)	Projected Poultry feed protein (tons)	Projected animal protein requirements (tons)	Projected insect protein requirement for poultry feeds at 50% substitution (tons)
2021	55,446	301,431	72,343	13,024	6,512
2022	57,608	313,187	75,165	13,532	6,766
2023	59,855	325,401	78,096	14,060	7,030
2024	62,189	338,092	81,142	14,608	7,304
2025	64,615	351,277	84,307	15,178	7,589

Source: Own calculations based on annual rates of change per variable

Information on the major sources of protein and challenges with silver fish as animal protein revealed the following: There are seasons when silver fish is scarce on the market. This is attributed to two causes. Whenever

the moon light is strong it tends to cause interference with the lights flashed on the lake to attract silver fish at night. Besides, there are cases when demand for silver fish is high. This coincides with peak production cycles for layer and broiler production. This is mostly during the months of May to July and September to December. December to March and July - August are normally slack periods. During periods of scarcity a kilogram of silver fish goes for about shillings 4,000 yet during periods of surplus prices slump up to shillings 2,800 a kilogram with an annual average of shillings 3500 (USD $1.06). There is, however, an increase in price of silver fish of about 13 per cent per annum from the year 2012 to 2015 Price of silver fish (USD) until when price stabilised at $1.5 (Figure 3).

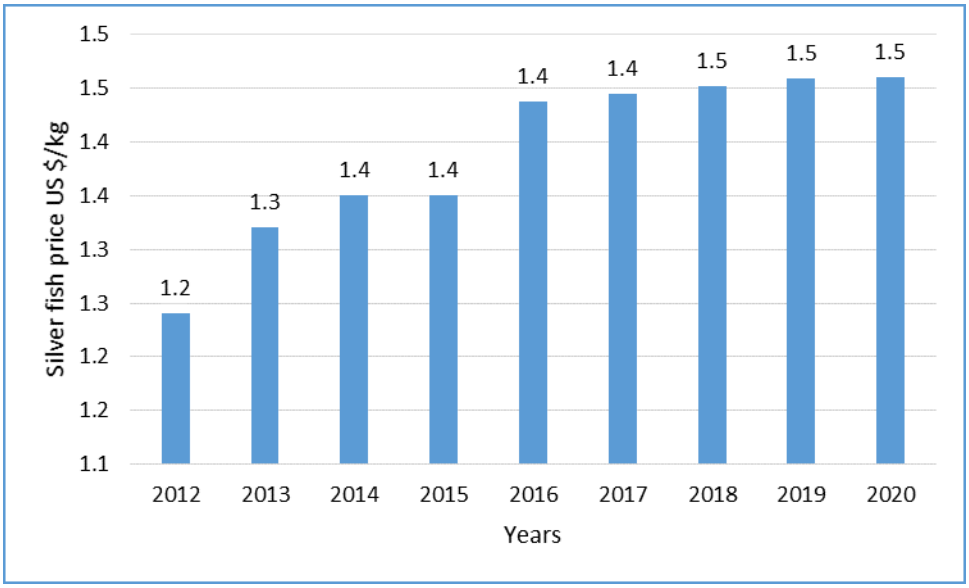

Figure 3: Purchase Price of Silver fish Fishmeal (USD[1]/Kg)
Source: Feed Ingredient Dealers: *One USD ($) is equivalent to Uganda Shillings (UGX 3500/=)*

Analysis of Strengths, Weaknesses, Opportunities and Threats (SWOT) for transfer and adoption of insects as protein sources in feeds

As a result of managing the high cost and scarcity of protein sources more so the animal protein ingredients people have tried to substitute silver fish with lake flies, (nilotica), maggots, white ants, worms and grasshoppers. The biggest constraint has been mass rearing of these alternative sources. Besides, there is competition with humans for some of these alternative sources particularly the case of white ants and grasshoppers as food. In addition, some processors use blood meal but this one is also not readily available and is also expensive. Soya bean is considered to be next to silver fish as animal protein especially given that soya cake has high proteins. If it is used in large amounts the requirements for silver fish in the feed reduces. Other feed processors import animal protein to bridge the gap of not having enough silver fish. In order to get integrated in the process, feed value chains and poultry product food supply chains a range of demand, supply; cultural and socio-economic factors were considered. These included availabilities of insects; prices of insects' substitutes, and competing ingredients; potential for entry given existing market structure, conduct and performance; proportion of population taking poultry and their products, and consumer tastes and preferences; cultural norms and values. Whereas some of these accelerate uptake and adoption of insects as protein sources in feeds while others will discourage the process. Below is a set of strengths, weaknesses, opportunities and threats (SWOT) for transfer and adoption of insects to replace silver fish as protein sources in feeds.

Strengths

1. When used as ingredients in feed, insects can provide the necessary animal protein and have the potential to lower cost of feeds
2. These insects can be bred and bulked in large quantities (maggots, crickets, cockroaches) using low-cost substrates
3. Processors are positive to the use of the insects as they believe that many customers are indifferent about specific protein sources used as ingredients
4. Demand for poultry products in Uganda is very strong. Derived demand for feed ingredients is hence very high
5. Some companies have tried and gained necessary skills and interest in incorporating insects in poultry feeds

Weaknesses

1. Some farmers think, if insects used happen to be totems of some people such consumers may decline to eat the chicken produced. This is more so the grasshopper clan

2. Farmers are somewhat negative on use of maggots - an intermediate stage of houseflies – this may not go well with the customers
3. Mass production of required quantities of insects to substitute silver fish requires skill and technologies that many scientists and feed manufacturers do not have
4. The markets, distribution channels and consumption patterns and value chains for silver fish are already developed unlike those for insects
5. There is no Act of Parliament guiding stakeholder in the feed industry regulating conduct, standards and quality assurance

Opportunities

1. There is a wide range of naturally existing indigenous tropical insects that can be harnessed
2. Some insects (grasshopper – Nsenene and lake flies (essami) can seasonally be harvested from the wild in large quantities the same way silver fish is harvested on the lakes
3. Consumers are aware that free range chickens and capture fisheries normally feed on insects
4. Silver fish is generally scarce. Its availability is often seasonal and tends to become very expensive. This leaves a gap for substitutes like insects to enter the feed value chains

Threats

1. Price wars may not feature due to scarcity of silver fish but rivalry among competing producers will ride on consumer tastes regarding actual insect used (maggots – grasshopper misgivings)
2. Present attitude that silver fish is the best animal protein source will sustain competition from its substitute products namely the insects
3. Some insects such as grasshoppers and white ants are delicacies and widely eaten by human population. This will impose competition besides some cultural conflicts on their usage
4. Inclusion of insects may change the taste and flavour, texture and cooking qualities of poultry products

Conclusions

The following conclusions can be made from the study

1. Feed protein ingredients for poultry feed is largely based on soya and silver fish meals. The two feed sources have seasonal availability, highly priced leading to high feed costs
2. Poultry naturally incorporate insects in their rations. Besides, farmers use insects such as white ants and termites to feed chickens. In addition, processors have attempted to lower protein feed costs by incorporation of insects in their rations but are frustrated by mass bulking and sustainable production technologies
3. Based on the above arguments it can be inferred that insects have a strong potential for incorporation into poultry feeds provided consumer tastes and species dietary and digestibility of special feed needs are taken care of
4. Aggregate demand for insect feed ingredients for poultry feed was estimated to be 5,853 metric tons on dry matter basis at 50% rate of substitution of conventional animal protein by commercial feed manufacturers. Projected demand for poultry insect feed proteins was 35,201 metric tons in the next 5 years.
5. Lack of a livestock feeds Act hampers feed quality assurance

Recommendations

The following recommendations were made arising out of the conclusions

1. Insect species that match consumer tastes and poultry species dietary and digestibility of special feed needs and should be sustainably produced to meet the estimated national demand of insect protein.
2. Necessary and sufficient appropriate technologies should be developed/tested and promoted for commercial private feed ingredient production and distribution
3. Awareness and promotion of quality insect protein feed ingredients should be conducted hand in hand with concerted efforts of feed stakeholder and supporting legal and policy environments

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