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SOYBEAN: A Major Component of Livestock Feed (Fish)

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Abstract
Soybean is a vegetable which belongs to the legume family and is known worldwide for its high protein nutrient values and also important raw material the feed industry of livestock (fish inclusive). The numerous use and importance of soybean cannot be over emphasized. So therefore, in this review, emphasis were laid on the soybean as a major component of livestock feed and how to encourage the further usage of soybean meal to replace the fish meal, as this will in turn boost fish production and supply in the country Nigeria and the world at large. Furthermore, soybean also effectively reduce the high cost of aquaculture production through lowering the price fish feed. This is because soybean is way cheaper and also easily available all year round when compared to fish meal.

Keywords*: Soybean, Fish, Fish meal, Aquaculture.*

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I. Introduction:

Soybean

Soybean (*Glycine max* (L.) Merr) is one of the important oilseed crop and grown all over the world. It contained maximum amount of protein and other important essentials vitamins that play important role in our daily life. It is also an important cash crop for our industry and also used as a biofuels (Hartman *et. al.,* 2011). It is an important and well recognized oil seed and grain legume crop of the world. Soybean called "Golden bean" or "Miracle bean" or "Protein hope of future" (Hossain *et. al.*, 2004 and Hari 2010)

Soybean is a legume that grows in tropical, subtropical, and temperate climates. Soybean is not an indigenous crop in Nigeria, although, it is gaining popularity in the country because of its numerous potentials that rank it even better than cowpea in the supply of high quality protein (Akande*et. al.,* 2007) . Soybean grains contain about 40% protein, 20% oil, an optimal supply of essential amino acids and nutrients, and a high calorie value [Singh*et. al.*, 2008].

It is one of the important sources of oil and protein in the world and it is commonly used in both human and animal diets (Onwueme and Sinha, 1991; Ariyo 1995).

North America is the largest producer of soybean in the world. Countries producing soybean in Africa are Kenya, Nigeria, Zimbabwe, Egypt, South Africa, Zambia, Malawi and Uganda (Nassiuma and Wasike, 2002).

Fish

Fish are cold-blooded gill breathing aquatic dwelling vertebrates and body covered with dermal scales. Recognizing this diversity, one can define a fish as a poikilothermic, aquatic chordate with appendages (when present) developed as fins, whose chief respiratory organs are gills and whose body is usually covered with scales (Berra 2001), or more simply, a fish is an aquatic vertebrate with gills and with limbs in the shape of fins (Nelson 2006).

Evolution of fish

Fishes have an ancestry that goes back at least 500 million years.The first fishes to fossilize occurred during the Early Cambrian and lived into the Devonian. They lacked jaws but possessed bony armor and had a muscular feeding pump. However, the ancestry of jawed fishes is unclear because no intermediate fossils between jawed and jawless forms have been found (Gene*et. al.*, 2009). Bony fishes, or teleost, are thought to have evolved during the Mesozoic era (70-155 million years ago) alongside birds and mammals (Wootton 1998).

Fish Ecology

Fish occupy almost every conceivable aquatic habitat (salt and fresh water). These habitats are defined by the critters that live in each.Fish are very different in appearance, size and shape. This all depends on the environment that it lives in (Greely 1998). Fish could either be jawed or jawless. The jawed fishes can be categorized into one of two groups according to their skeleton-type: cartilaginous fishes (Superclass Chondrichthyes), which possess cartilage that is more flexible than bone, but strong enough to support the body. Or bony fishes (Superclass Osteichthyes), which has jaws that are well developed, formed by true bone rather than cartilage. Fishes also include the jawless vertebrates such as the lamprey and hagfish; and the shark, ray, chimaera, and lungfish. The bony fish are the most common (Bond 1979).

Production Estimate of Soybean in Nigeria

The world production of the soybean seeds in 2009/2010 season carried out about 260.6mlnton (Rynek rzepaku, 2010). According to the United States Department of Agriculture (**USDA**), Soybean Production in 2019 was 358.65 million tons. As the soybean demand increases, the supply is challenged, the stocks reduce, and the market prices rise. In order to meet the demand, there are two alternatives: increase planted hectares or increase yield (tons/ha) (Masuda *et al*., 2009). Soybean is one of the major crops that are grown for both food and industrial purposes. The crop is grown in many states of Nigeria. Estimates for land are showed that 1174.83million hectares was cultivated in 2018 as against 1119.70 million hectares cultivated in 2019; an increase of 4.69%. The crop output forecast for the year 2018 was 1053.56 million tons which is higher than 993.78 million tons in 2017 (NEARLS 2018) (Table 1).

Table 1: Estimate of cultivated land area, production output and yield forecast for soybean.

State	Production ("000" MT)			Land ("000" Ha)			Yield (tons/Ha)	
	2017	2018	%change	2017	2018	%change	2017	2018
Bauchi	23.42	25.12	6.77	34.95	36.79	5.00	0.67	0.68
Gombe	52.59	57.68	8.82	60.88	66.77	8.82	0.86	0.86
Adamawa	44.13	46.78	5.66	50.30	53.04	5.17	0.88	0.88
Taraba	52.44	54.01	2.91	57.37	55.26	-3.82	0.91	0.98
Jigawa	35.36	34.22	-3.33	43.97	42.16	-4.29	0.80	0.81
Katsina	29.10	37.22	21.82	39.73	43.70	9.08	0.73	0.85
Sokoto	15.66	22.00	28.82	28.14	32.47	13.34	0.56	0.68
Kebbi	32.64	35.70	8.57	43.18	43.91	1.66	0.76	0.81
Zamfara	23.97	21.73	-10.31	43.50	43.25	-0.58	0.55	0.50
Kano	70.24	66.07	-6.31	71.53	65.88	-8.54	0.98	1.00
Kaduna	94.63	97.48	2.92	100.44	101.44	0.99	0.94	0.96
Plateau	23.42	24.12	2.90	45.87	46.55	1.46	0.51	0.52
Nassarawa	29.17	27.20	-7.24	38.60	35.90	-7.52	0.76	0.76
Fct	34.37	34.40	0.09	60.10	60.70	0.99	0.57	0.57
Niger	34.87	42.73	18.39	49.83	80.37	38.00	0.70	0.53
Kwara	47.59	50.69	6.12	53.11	56.57	6.12	0.90	0.90
Kogi	30.98	34.18	9.36	56.69	57.14	0.79	0.55	0.60
Benue	219.26	241.19	9.09	87.95	92.35	4.76	2.49	2.61
Osun	19.15	20.11	4.77	34.50	34.72	0.36	0.56	0.58
Oyo	21.03	21.72	3.18	35.00	35.14	0.40	0.60	0.62
Ekiti	8.94	9.08	1.54	24.74	26.06	5.07	0.36	0.35
Ondo	31.26	26.56	-17.70	28.78	28.07	-2.53	1.09	0.95
Ogun	18.65	22.53	17.22	24.51	29.85	17.89	0.76	0.75
Lagos	0.91	1.05	13.33	6.03	6.75	10.67	0.15	0.16
National	993.78	1053.56	5.67	1119.70	1174.83	4.69	0.89	0.90

SOURCE: National Report NEARLS and FDAE December, 2018

Production estimate of fish in Nigeria

There is now little doubt that the world's fisheries are in crisis. Mounting scientific evidence points to dramatic declines in global catches (Pauly *et. al*., 2002). Increasingly, many are making the case that farming fish offers a solution to meeting the growing demand for seafood that catching fish cannot provide. Aquaculture now accounts for roughly one-third of the world's total supply of food fish and undoubtedly the contribution of aquaculture to seafood supplies will increase in the future. Aquaculture has the potential to become a sustainable practice that can supplement capture fisheries and significantly contribute to feeding the world's growing population. However, instead of helping to ease the crisis in wild fisheries, unsustainable aquaculture development could exacerbate the problems and create new ones, damaging our important and already-stressed coastal areas (Meyers *et al*., 2003).

Below is a data on fish production estimate of fish production for the year 2017 and 2018 based on fish culture (Table 2).

Table 2: Aquaculture production in 2017 and 2018

State	Production in 2017(MT)	Production in 2018(MT)
North-East		
Bauchi	14.3	14.4
Gombe	47,863.2	52,436.6
North-West		
Katsina	936.6	982.2
Zamfara	1,083	1,324
North Central		
Fct	-	541.5
Taraba	-	18,013
Niger	39.6	37.2
South-West		
Ekiti	2,591	2,290
Osun	512	530
Oyo	39,780	42,634
South-East		
Ebonyi	800	900
Imo	71.2	43.65
Abia	-	2.5
South-South		
Akwa-ibom	40,632	15,467

SOURCE: National Report NEARLS and FDAE December, 2018

Aquaculture

Fish in modern day have been made feasible through aquaculture. Aquaculture is the world's fastest-growing sector of agriculture, chiefly dominated by fish farming for production both in fresh and salt-water environments for food-production (Ravi *et. al*., 2007). Aquaculture is also known as aqua-farming. Aquaculture is can be described as the farming or rearing of economically important aqua-plant and animals under controlled condition. It a popularized bio-technic involving the control of growth (through feeding) and reproduction (through breeding) of culture organism as well as the culture water and other culture input.(Bluwey *et al*., 2018) As defined by the United Nations Food and Agriculture Organization (FAO), aquaculture is the "farming of aquatic organisms including fish, mollusks, crustaceans and aquatic plants.Aquaculture is a form of agriculture that involves the propagation, cultivation, and marketing of aquatic animals and plants in a controlled environment (Swann 1992).

Aquaculture has become an important economic activity in many countries and it plays a vital role in a nation's economy. According to a recent report published by the United Nations Food and Agriculture Organization (FAO), world aquaculture has grown significantly in the past 50 years. The world's total production of fish and shellfish was 99 mt in 1990 and it increased to 122 mt in 1997 (www.agriculture.de/acms1/conf6/ws9fish.htm). Production has increased from less than 1×10^6 tons in the early 1950s to approximately 5.94×10^7 million tons by 2004 (FAO, 2006). According to FAO (2009), the global aquaculture production has increased from about 28.3 million tons to 40 mt in 2009. Total global fish production in 2016: 171 million tonnes - Share of that from marine capture fisheries: 79.3 million tonnes - From freshwater capture fisheries: 11.6 million tonnes - From aquaculture: 80 million tonnes (FAO, 2018).

History of Aquaculture

Aquaculture was developed more than 2,000 years ago in countries such as China, Italy and Egypt. Not long after, aquaculture practices in Europe, China, and Japan commonly involved stocking wild-caught fingerlings — for example, carp fingerlings (juvenile fish) captured from rivers — in ponds or other bodies of water for further growth (Adedeji 2011).

Aquaculture is believed to originate from Asia thou, it can be said to be relatively recent sub-sahara Africa, Nigeria inclusive. Fresh water aquaculture developed empirically 1000 years earlier in china. The cold water culture of tract limited to the higher altitude area was introduced into Kenya and Malaysia in the late 1920. From the 1940s to date, fish farming technology have continued to be introduced from Europe into various African countries and development in this sector have been spreading rapidly. In Nigeria the first recorded side of fish culture can be traced to the first northern Nigeria with the construction of a pilot fish farm at Panyan near Jos for the culture of common carp in 1951 (Bluwey *et al*., 2018).

Importance of Soybean in Fish Production

Aquaculture is the fastest growing segment of livestock production worldwide, growing in large part because production is switching to more intensive, higher input systems. The main input is feed, which offers tremendous opportunities for aqua feed manufacturers and associated product suppliers. It also presents significant challenges to all sectors of the industry (Lourens, 2007).

Traditionally, fish is the main dietary protein source in fish feed formulation. In general, fish feed contain 5-50 percent of fish meal. The rapid development of aquaculture will result in the high demand and the shortage of supply for fish meal. Besides being limited in supply, fish meal is relatively an expensive ingredient in aqua feed. Furthermore, the quality of fishmeal can vary to a large extent, concerning to nutritional composition, pathogen and contamination of biogenic amines. Many researches, therefore, have been conducted to search alternative protein sources as replacement of fishmeal in aquafeeds (Dersjant, 2002). The high cost and competing demand for fish meal in fish diet has made the search for alternative ingredient very expedient. Finding an alternative protein source has become a major focus of research from the view point of producing a stable supply of commercial aqua feed at a reduced price (Ajani *et al*., 2016).

Farmers and feed stuff producers value fish meal mainly because of it high protein content and health enhancing nutrient. These characteristics are however not only found in fish meal, but to different degree also in vegetable based product like rapeseed, soybean, corn and gluten. It is also possible to use terrestrial products like meal from meat, bone, blood and feathers. Alternatively marine based substitutes from crustaceans, krill and algae are also usable as substitutes. The common denominator of all these organic substances is that the they have a high content of protein and some contain omega-3-acids (Tacon *et al*., 2008).

Animal proteins such as poultry by products, meats and bone meal have been used to replace fish meal. Animal proteins are good source of protein with low price which can be used to partially replace fish meal. However, due to the occurrence of BSE (bovine spongiform encephalopathy), consumers are questioning feeding practices based on the use of animal protein in animal feed. In some countries, animal proteins are banned in animal feed. Therefore, development of animal feed goes towards a vegetable based formulation. Plant ingredient which contain high protein content such as oil seeds, are alternative protein sources for fish meal. These ingredients are readily available worldwide with a low cost. However, plant proteins in general are low in some essential amino acid and containing anti-nutritional factors. Therefore the levels of raw or under processed plant materials containing high protein content and it high digestibility of crude protein and low anti-nutritional component are potential alternative protein sources for replace of fish meal in fish diet (Dersjant, 2002).

Soybeans have particularly high protein content and also contain favorable acids which have made it a very common substitute and complement to fish meal. Soy is the most fitting and wide spread vegetable alternative to fish meal. Soybean is considered to be one of the most suitable and economical candidate for replacing fish meal in commercial aqua feeds. It is been identified as having the best amino acid profile of all protein rich plant feed stuffs for meeting the essential amino acid requirements of fish. On the negative side, the Sulphur containing amino acid methionine and cysteine are generally considered to be the most limiting in soybean products compared to the quantitave amino acid requirement of most fish species (NRC, 1993). Notwithstanding, it is however the presence of anti-nutritional factors (ANF) that limits its use in crude and processed forms in aqua feeds. Raw or unheated soybean contain a number of heat liable ANFs that inhibit some digestive processes of fish when replacing high dietary levels of fish meal with soybean meal (Refstie *et al*., 1998)

Proper heat treatment of the soybean is important to inactivate the anti-nutritional factors without affecting their nutritional quality to optimally be used in aqua feed.

Nutrient Composition of Soybean

Soybean seeds contain to 40% of crude protein and about 20% of fat, and soybean meal characterized higher content of crude protein- about 40-49%. Soybean meal standardized on 44 and 49% of protein there is on the feed market. The protein of soybean contains the Cons iderable quantity of lysine (6.2g/16gN), but value of protein is limited by methionine and cystine content (2.9g/16gN). With regard on high protein content, the soybean meal is mainly use in poultry and pigs nutrition. In mixtures for poultry content of soybean meal can approximate to 40%. (Banaszkiewicz, 2011)

Generally soybean seeds content 5.6-11.5% of water, ranges for crude protein is from 32 to 43.6%, for fat from 15.5 to 24.7%, for crude ash from 4.5 to 6.4%, for neutral detergent fiber(NDF) from 10 to14.9%, acid detergent fiber (ADF) from 9 to 11,1%, carbohydrates content from 31.7 to 31.85% on a dry matter basis. The soybean contain very little of starch (4.66-7%) and quite a lot of hemicellulose and pectins. Protein of soybean products characterized much quantity of lysine, tryptophane, isoleucine, valine and threonine however sulphuric amino acids are less than in protein of rape products. (Ensminger *et al.,* 1990; NRC, 1998; Poultry Feeding Standards, 2005).

Table 3: Basic nutrients in soybean seeds and products.

Nutrient	Soybean seeds % of DM	Soybean meal	
		44% CP, % of DM	49% CP, % of DM
Crude protein	37.08	43.8-49.9	52.8-56.3
Crude ash	4.86	5.6-7.2	5.2-9.1
Crude fat	18.38	0.55-3.0	1.0-3.3
Crude fiber	5.12	4.3-7.2	3.1-4.1
NDF	12.98	12.3-18.9	7.4-12.2
ADF	7.22	8.9-11.9	5.2-6.7
N-free-extractive	24.00	34.3	33.2
Starch	4.66	5.51	5.46

Source:(Van Eys *et al.,* 2004; ENV/JM/MONO (2001)15)

Soybean is characterized the highest digestibility of protein, lysine and methionine. The amino acids content in soybean protein are good supplemented of grain protein and covered requirement of animals. (Ravindran *et al.,* 2005)

Soy Products Relevant For Aquaculture Feeds Can Be Divided Into Four Categories.

- Soybean meals
- Soy protein products
- Oil
- Lecithin

However, soybean meal (SBM) is the most conventionally used.
Below are the nutrient compositions of soybean products commonly used in aquafeed

Table4: Nutrient Composition Of Soybean Products Commonly Used In Aquafeeds

Nutrients	Full fat soybean Meal (%)	SBM mechanically Extracted (%)	SBM Solvent Extracted (%)	Soyprotein concentrates (%)
Moisture	10.0	10.0	11.0	8.0
Protein	38.0	42.9	44.6	84.0
Lipid	18.0	4.8	1.4	0.5
Fiber	5.0	5.9	6.2	0.1
Ash	4.1	6.0	6.5	3.5

Source:(**National Research Council, 1993).**

II. Conclusion

Soybean meal is considered as the most nutritive plant ingredients widely used in livestock and fish feed production. In fish feed production, it is d most suitable ingredient that can replace the role of fish meal. More production of soybean needs to be encouraged among farmers so that it's production will in turn increase and provide adequate soybean meal that will be used in fish feed production. Soybean is a cheap commodity that is readily available. So therefore, its production will lower the cost of production in aquaculture because the major input and capital requirement in aquaculture is spent on feed. This way many other can engage in aquaculture so as to increase the amounts of fisheries produce in the country.

Furthermore, the discrepancy among researchers regarding the use of SBM in aquafeeds related to the quality and processing of SBM, variation in diet formulation and differences in fish species, size and culture systems make it difficult to draw clear conclusion with regard to the partial or total replacement of fish meal with soybean meal in aquafeeds. But however is overruled because of is high protein quality and also the most suitable with least disadvantages.

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