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A Review of Production Protocols Used in Producing Economically Viable Monosex Tilapia

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ABSTRACT
In the culture of tilapia seed various issues come into play tilapia when stocked in pond multiply excessively resulting in unhealthy competition for food and natural resources leading to a large number of stunted growths and a large number of mini fish that is not economically viable sexual diamophisim which means that the male fish grow bigger than the female in a mixed culture production, this results in culturists wanting only the seed of the male fish or ways that the sex of fish seed produced is skewed towards masculine fish. Culturist and farmers acknowledged the use of single sex fish also known as monosex fish as solution to the problem. The production of single sex fish which in the case of tilapia all male fish also has its own setback based on the production methods used in this case farmers ability to use the available resources in achieving the basic aim of production is a necessity. Monosex fish has the ability to tolerate sever environmental conditions including temperature, salinity low dissolve oxygen, greater uniformity of size is achieved at harvest because none of the fish is wasting energy in gonadal development. The various method used in producing monosex is based on the ability of the culturist to manage the structures (Pond, tanks) consumables (Hormones), systems (Water re-use, stagnant water) and skilled personal in producing and managing the production processes. In every step of production care is required because the production is gender specific pure breed most be used and strain confirm using current method of identification.

Key words: Monosex, sorting hybridization

INTRODUCTION
The life history of the fish tilapia is made up of two distinct ability: Reproduction in captivity a virtue that has a positive and negative aspect (Nwachi, 2013). This characteristics of tilapia makes it a fish, farmers want to culture because of the fact that there will not be need for them to continually go back to procure fish seed after each circle of production at the same time this ability also results in production issue during culture. Tilapia, when stocked in pond multiply excessively resulting in unhealthy competition for food and natural resources leading to a large number of stunted growths and a large number of mini fish that is not economically viable (Campos-Mendoza *et al*., 2004), sexual diamophisim which means that the male fish grow bigger than the female, this results in culturists wanting only the seed of the male fish or ways that the sex of fish seed produced is skewed towards masculine fish. Monosex fish has the ability to tolerate

sever environmental conditions including temperature, salinity low dissolve oxygen, greater uniformity of size is achieved at harvest because none of the fish is wasting energy in gonadal development (Ng and Wang, 2011). All male fish is also known for their better flesh quality resistance to prevailing deceases the process of developing gonad spawning and caring come with stress this normal predisposed mixed culture fish to diseases and reduce affect the quality of their skin (Megbowo, 2013; Beardmore *et al*., 2001). An important aim of the culturist is to produce fish that is economically viable so the stunting of the whole crop due to the ability of tilapia to reproduce in captivity will act negatively on his main objective (De Graaf and Huisman, 1999; Little and Edwards, 2004).

In every culture challenges or issues that makes it difficult for farmers to produce at his optimal level, a lot of solution were sought out to solve the challenges, however, the type of answers also depend on the person looking for the solution: Individual scientist, group of stake holders (farmers), research institute and even countries. The type of solution that this people search for also depend on the technology at their disposal, a number of time third world countries will embark on solution based on the resources on their disposal or the limit of their technology.

This research will examine the problem faced by culturist that farm tilapia and the various ways in which researchers and farmers has being trying to produce tilapia at the optimal level despite the production challenges that is mainly due to the characteristic of fish and production problem based on limited technology and skilled man power among other things.

Manual sorting: The first reaction that the farmer and even the researcher line of action when they discovered that tilapia exhibits sexual diamophisim might have been to manually separate the male fish from the female fish (Hulata *et al*., 1983). This process of separation also poses some un-for seen problem as opined by Rad *et al*. (2006). The separation process has to be done when the fish is at young adult stage or when their secondary sexual characteristics is well developed as shown in Fig. 1-3, Fig. 1 shows the male and female reproductive organ when placed side by side, Fig. 2 shows how the male fish looks like and Fig. 3 the female fish, armed with a mental diagram like this skilled personal embark on the task of separating the sexes from each other so that a required all mall proportion will be made available. The culturist will bear the cost of feeding this

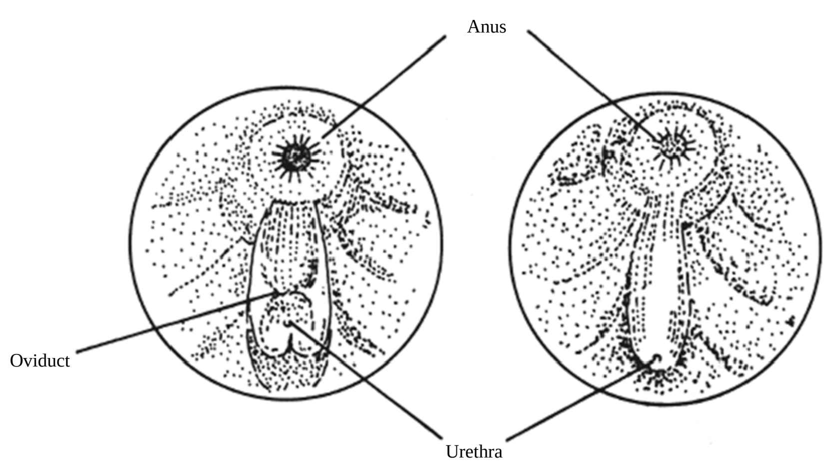

Fig. 1: Reproductive organ of male and female tilapia fish (FAO., 1976)

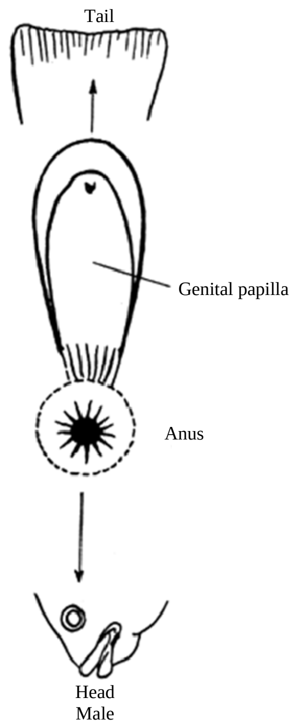

Fig. 2: Male tilapia (FAO., 1976)

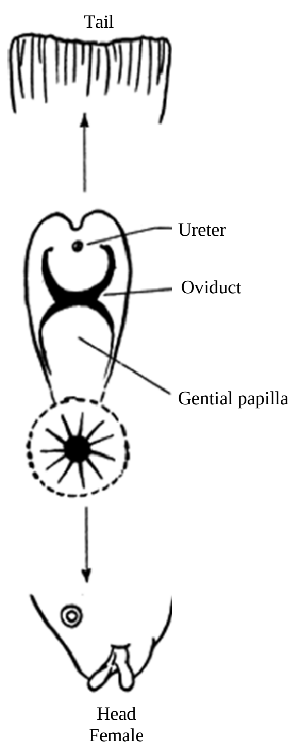

Fig. 3: Female tilapia (FAO., 1976)

fish until it get to a stage where they can be easily identified by skilled personal as either a male or female fish and the required sorting carried out.

It is reported that feed cost take up large proportion of the total input required in fish feeding (Bhujel *et al*., 2001; Canonico *et al*., 2005; Iluyemi *et al*., 2010) the implication to tilapia farmers is that they will use their scares resources in feeding fish that might not bring needed economic value. In fish farming profit making depend so much on the way in which the resources like feed is effectively used there is a great need to maximize available resources which has cost implication (Nwachi and Toritseju, 2014). Manual selection of sexes cannot give hundred percent results, there have been a number cases where by females were found in the presumably all male population and this has effect on the size of the final output because of recruitments or total amount of wild spawning (Hulata *et al*., 1983; Rackocy and McGinty, 1989). Also selecting one particular sex in this case male fish will lead to a glut in the female fish that is not wanted by the farmer a situation in which the farmer may not know what to do with the large number of female fish that is sorted out from the mixed population of fish might arise where selection is mostly skewed towards the production of the male fish. Manual selection is labour intensive and uneconomical in the long run because of a number of resources that will be tied down during the process, skilled personal are needed to carry out a number of specialised jobs on the farm making them spend a lot of valuable time sexing fish for a long period is not in the interest of the farmer. A number of times the farm maybe filled with the unwanted female as reported by Beardmore *et al*. (2001) and Gupta and Acosta (2004). This female occupy useful space consumed feed that might be used for feeding fish that can be economically viable and can even cost money for disposal purposes. Even with all this the farmer cannot be rest assured that one or two female will not be taken as male in the culture tank. A single female in an all-male tank can result in poor output.

Hybridisation: Hybridisation is the process of combining different varieties of organism to create a hybrid the crossing of interspecific strains to produce hybrids and the mating of genetically differentiated individuals or groups which may involve crosses within a species (also known as line crossing or strain crossing) or crosses between separate species (Bartley *et al*., 2000). Unlike in most aquaculture species the production and the use of hybrids in tilapia has been a success story (Rahman *et al*., 2013, Gupta and Acosta, 2004; Lozano *et al*., 2014). This success story of the various type of hybrid of tilapia is associated with the following factors as reported by Scribner *et al*. (2000). Because tilapia fertilized its egg externally making it possible to carry out manipulation of the egg and milt of the strain of intended couple to reducing the problem of either fish not wanting to cross each other either because they look a bit different from or they have different ways in which they court before eggs and milt could be released. Tilapia has the ability to accept strains that are not close relatives this single act makes it easy for breeders to cross different type strains and examine their suitability either as culture fish or for astatic value. The short maturation time of tilapia also reduce the waiting period for scientist and farmer whenever a new hybrid is to be produced (Lozano *et al*., 2013). Rad *et al*. (2006) infer that procedure such as increasing or reducing the photoperiod of which *Oreochromis* is exposed to increase their ability to reproduce and shorten the production circle all this point to the fact that the result of any crosses made can be available for commercial assessment in the shortest possible time and are likely to fit with most tilapia. The significant of this aquaculture discovery help in solving the sexual diamophisim in tilapia, a significant number of crosses carried out in other to produced male skewed population on monosex involved the maternal mouth brooders mouth brooders (Beardmore *et al*., 2001; Hulata *et al*., 1983).

It is reported that a good number of the crosses carried out to produce monosex fish were made from a combination of the pure breed of the mouth brooding tilapia; this crosses results in producing fish whose sex orientation skewed towards all male. A number of dedicated crosses were made specifically to produce all male fish this include male *Oreochromis aureus*×female *Oreochromis niloticus* (Wohlfarth, 1994), male *O. hornorum*×female *O. mossambicus* (Hickling, 1960), male *O. mossambicus*×female *O. aureus* (Pierce, 1980) and male *O. mossambicus*×female *O. spilurus niger* (Pruginnin, 1967). Some other crosses produce fishes that have their sexuality skewed towards all male fish but were not up to the targeted 100% results ranges from 20-98%. It is important to note that most of the characteristics that made tilapia a good candidate for hybridization also in a way stand as a challenge because most of the failures can be attributed to the use of hybrid at a time that pure breed of the required strain is needed and because any mistake in segregating tilapia broodstock lead to uncontrolled and unwarranted breeding and pollution of the needed pure stain in some cases the hybrid of the required strain mistakenly introduced into the broodstock pond are eventually selected during hybridization this hybrid because of its impure nature cannot and would not produce 100% all male (Coward and Bromage, 2000). A report by Marengoni *et al*. (1998) shows that some tilapia strains do not normally produce 100% all male when they are hybridized because of differences in their strain a cross between Stirling Nile tilapia female and blue tilapia males would produce 100% male whereas the Japan Nile tilapia can only manage 91%. A list of success recorded in known crosses of tilapia is recorded in Table 1.

Hormonal sex reversal: Solving the problem of insufficient food in the world can only be a success if more food is produced at any given time the use of hormones in food fish production has being in the fur front in the way to increase production. Tilapia production has its own share on how hormones can be used to improve production, with good increase in size at the shortest possible time. Among ways adopted in tilapia production for either producing single sex fish or sterile fish is the use of hormone when the fish has not differentiated into male or female (Totipotent) (Baroiller and D'Cotta, 2001; Singh and Pandey, 1995; Sukmanomon *et al*., 2012). The use of hormone is not without its criticism by the consumers based on the fact that many believe the residual effect of such hormone has harmful side effect (El-Sayed *et al*., 2012; Guillen *et al*., 1999). Steroid hormones as well as non-steroid compounds are commonly used in the production of monosex tilapia the techniques used in administering ranges from oral to immersion. A number of authors (Hulata, 2001; Nwachi and Zeliber, 2013) used hormones on various fishes with no known resultant side effect. Table 2 shows steroid and non-steroid used in masculinization of tilapia, the most commonly used hormone in aquaculture is the 17α-methelyltestosterone (MT) this can be link to the fact that it is easily available and most literature on the production of monosex

Table 1: Hybridization of different tilapia species to produce all male populations

Species hybrid			
Male	Female	Male (%)	Reference
Oreochromis niloticus	*Oreochromis aureus*	75-95	Pruginin (1967)
O. aureus	*O. niloticus*	50-100	Lee (1979) and Wohlfarth (1994)
O. aureus	*O. niloticus* (*Stirling strain*)	100	Marengoni *et al*. (1998)
Oreochromis mossambicus	*O. aureus*	89	Pierce (1980)
Oreochromis hornorum	*O. mossambicus*	100	Hickling (1960)
Oreochromis marcrochir	*O. mossambicus*	100	Majumder *et al*. (1983)
O. macrochir	*O. niloticus*	100	Pruyinin (1967)

Table 2: List of successful use of different type of hormones in producing monosex tilapia

Species	Hormone	Duration	Male (%)	Reference
Oreochromis niloticus	Fadrozole	30 days	92.5-96	Kwon *et al*. (2000)
O. niloticus	17 α-ethynyltestosterone	25-28 days	91-99.4	Afonso *et al*. (2001)
O. niloticus	17 α-methyltestosterone	21 days	99	Guerrero and Guerror (1988)
O. niloticus	17 α methyldihydrotestosterone	4 h	100	Wassermann and Afonso (2003)
O. mossambicus	17 α-ethynyltestosterone	18 days	100	Guerrero (1975)
O. mossambicus	17 α-methyltestosterone	18 days	98	Guerrero (1975)
Oreochromis aureus	17 α-methyltestosterone	42 days	100	Hines and Watts (1995)
O. aureus	17 α-ethynyltestosterone	25-28 days	83-97	Melard *et al*. (1994)

and a number of successes achieved with the use of the hormone. The dose use when administered orally varies from 30-60 mg kg^{-1} of feed for total of 25-30 days depending on the intended result (Beaven and Muposhi, 2012; Campos-Ramos *et al*., 2003; Little *et al*., 2003). However (Guerrero, 1975) opined that the use of 30 mg kg^{-1} of 17 α-ethynyltestosterone (ET) for 18 days will produce about 98% of male fish while it will take the use of the full recommended dose 60 mg kg^{-1} of feed to produce 100% male in *O. mossambicus*. The MT will give 98 and 85% at 30 and 60 mg kg^{-1} this is an indication that the use of more than the recommended dose will not add any value to the stock but serve a waste of available resources and can even lead to fish mortality fish the rate of failure in the use of basic protocols in masculinization can be reduce if the process of feeding and preparing hormone laced feed is well adhered to (Green *et al*., 1997). The use of steroid has being under public criticism for so long to the extent that efforts were made to use non-steroid in masculinization (Singh, 2013; Ruksana *et al*., 2010). A study by Hines and Watts (1995) shows that when the hybrids of *O. niloticus* and *O. aureus* were fed with tamoxifen-treated 100% male were produced at a dose of 100 mg kg^{-1}, the use of acriflavine at 50 mg kg^{-1} diet however gave 89 and 85% males. Oral administration of both steroid and non-steroid sex reversal hormone is considered to be a safe and secured method; however, traces from effluent water and uneaten food can be a source of concern especially in the developing nation where effluent water come into contact with edible food and water for farm animals. Immersing fry in hormone solution seem a way out (Arslan and Phelps, 2004) immersion reduce the treatment time and enable the culturist to treat the fry at a time they are most sensitive and receptive to the chemical increasing the success rate of masculinization to a great extent.

Seed production systems: The potential of the various methods listed skewed to the production of the needed seed for the aquaculture industry the demand still remain high despite efforts made by scientists and even the culturist to produce fish of great potential a number of write up and studies has gone into this essential part of the tilapia industry in various region of the world (Sebti, 2010; El Gayar, 2003; NEF., 1999; RCF., 2009). Despite all this information based on the production protocols that deals with larva rearing, hatchability and the absorption of yolk sac still remain different from various regions. Production is a biological process that must remain one inspite of the region and procedure. In other to solve the problem of insufficient quality tilapia seed all this problem must be addressed.

Earthen pond: The use of dugout pond is one of the oldest system used in the production of fish seed, developing African and Asian countries still practice this form of tilapia farming in seed and grow out production (Trong *et al*., 2013; Qiuming and Yi, 2004; Bwanika *et al*., 2004). This based on the knowledge that tilapia can spawn in water bodies once the physic-chemical properties are satisfied. Although the size of pond and water depth affect harvest especially during seed production, dugout/earthen pond can be used with little modification in producing mixed sex and monosex tilapia. Eggs and fries are usually harvested at intervals to reduce density and to maintain growth rate. The use of dugout pond to produce fingerlings is practiced in extensive system of culture because of different spawning time associated with this method. This production methods is however, limited by the activities of older fish feeding on smaller once because of the fact that partial harvesting by the use of sine net is normally carried out without total draining living a whole lot of previous spawn inside the pond. There are also possibilities of predator fish entering the spawning pond preying on the fingerlings reducing the production capability of the dugout pond.

Concrete tanks: The use of tanks made from concrete of various forms and sizes, tanks are made from solid blocks and hollow blocks filled with concrete to make it water proof. Moderate fertilization with organic manure is applied while brood fish is raised and allowed to spawn in the tanks. Unconfirmed results by Duponchelle and Legendre (1997) infer that Nile tilapia prefer tanks without artificial shed the work was refer to as unconfirmed because of the short period at which the pairing was examined (two months). Baroiller *et al*. (1997) opined that the use of artificial shelters in seed production actually increases seed production astronomically. This report can be substantiated because of the way tilapias prefer to spawn in the wild. Tilapia nest made for the purpose spawning has being discovered in the natural water bodies.

Hapas: A number of countries in Asia Thailand, America and even Africa use hapas in producing tilapia seed. Hapas has the added advantage of being mobile they can be moved from one pond to another and even from a concrete based system to the earthen pond, they are easy to construct and manage. Hapas require almost daily maintenance to enable free flow of water (Bhujel, 2000). Various form of hapas has being used in seed production double hapa has the advantage of keeping the parent stock away from the fries but also has the disadvantage of getting polluted if careful monitoring is lacking. The stocking density is mainly based on the type management principles adopted by the culturist.

CONCLUSION

The process of producing any sex of fish start with the production of the fish seed the success recorded in seed production will determined the quantity of required fish produced. Tilapia has the added advantage of having short production circle so any process embark on by the researcher or even the culturist get completed in the shortest possible time. Most culturable tilapia species are prolific in nature, they can reproduce unrestricted in any suitable water body this characteristic seem like a great value can also be restricting because of the fact that the culture system end up having so many miniature fishes which is of little or no economic value. Producing fishes that will be of economic value is a major challenge faced by the culturist. Various methods has being adopted based on the nature of the fish (Male grow bigger than the females) and production protocols which the consumers will accept. The success of this methods depend on a number of factors and the level of technology that is available to the culturist, above all the main aim is to produce a fish that would be acceptable be the consumers.

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