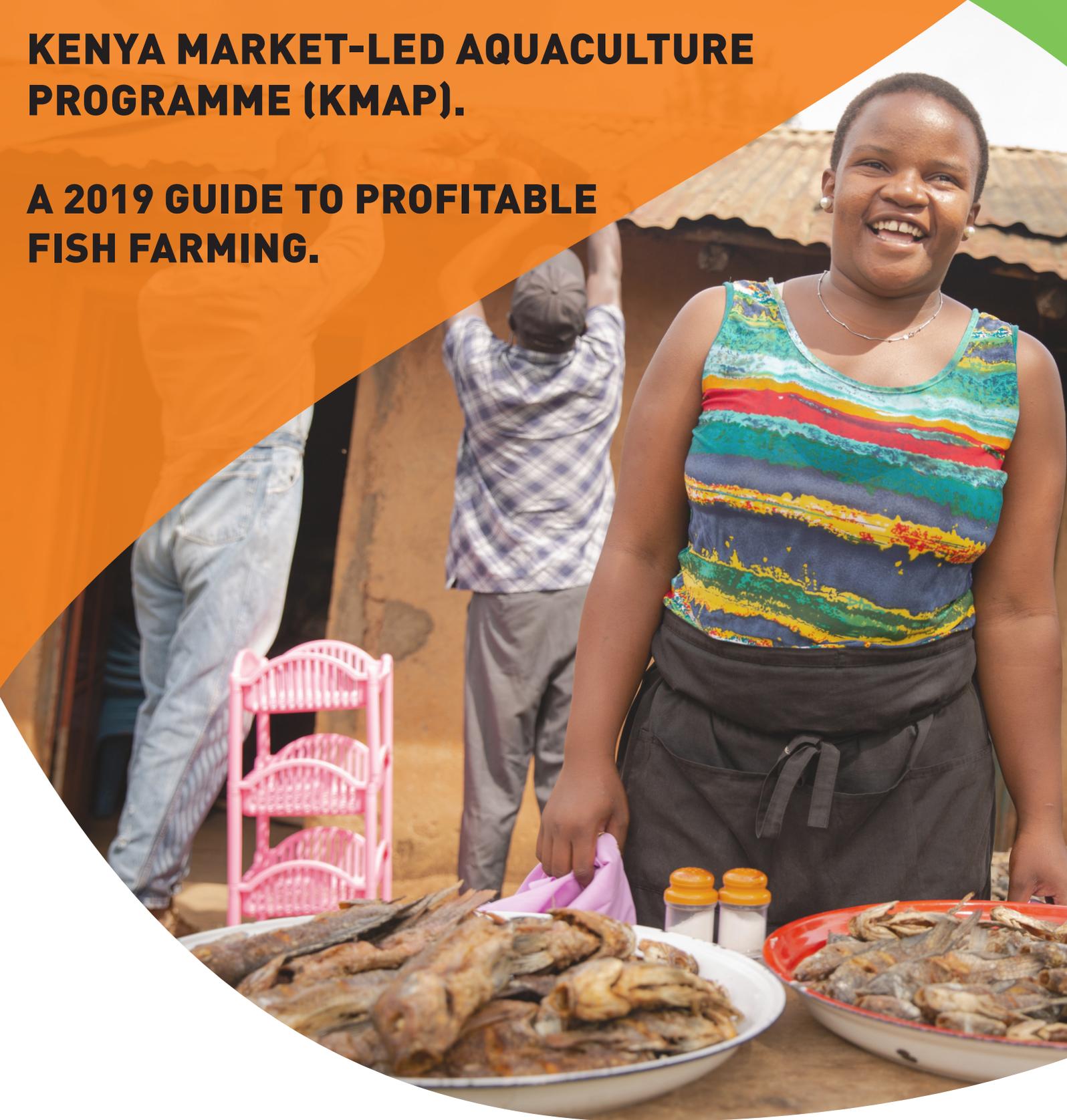


**KENYA MARKET-LED AQUACULTURE
PROGRAMME (KMAP).**

**A 2019 GUIDE TO PROFITABLE
FISH FARMING.**



Project funded by:



Embassy of the
Kingdom of the Netherlands



An aquaculture expert explains the attributes of catfish to a trainee in West Kenya. Photo/ Farm Africa.

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PROJECT OVERVIEW

A flourishing aquaculture industry creates employment opportunities, boosts incomes and provides families with an affordable and sustainable source of protein. More investment in fish farming will enable farmers to lower their costs of production and increase their profitability.

With funding from the Embassy of the Kingdom of the Netherlands in Kenya, the Kenya Market-led Aquaculture Programme (KMAP) has worked across the entire fish farming value chain in 14 counties. The project aims to increase productivity, strengthen market systems and make the policy environment conducive so that farmers can turn their ponds into thriving businesses.

KMAP has intervened in 14 counties:

West Kenya

- 1. Bungoma
- 2. Kakamega
- 3. Vihiga
- 4. Siaya
- 5. Homa Bay
- 6. Kisumu
- 7. Migori
- 8. Nyamira

- 9. Kisii
- 10. Busia

Central Kenya

- 11. Nairobi
- 12. Kiambu
- 13. Muranga
- 14. Machakos

Implementing partners





Farm Africa supports smallholder farmers to improve production and make the most of their land. We help rural communities make a decent living from farming, while protecting the environment for years to come.

PROJECT ACHIEVEMENTS (2016-2019):

- Provided technical and market engagement training to 1,114 fish farmers (June 2016 - December 2018).
- Reached over 6,713 fish farmers through trade fairs, e-learning platforms and peer-to-peer learning (August 2016 – December 2019).
- Increased the productivity of tilapia farmers by 97%, from 0.31Kg/M² at baseline (2016) to 0.61Kg/M² at end term (2019).
- Increased the productivity of catfish farmers from only 0.14Kg/M² (2016) at baseline to 0.82Kg/M² at end term (2019).
- Increased annual production of fish (both catfish and tilapia) from 249MT per year in 2016 to 912MT annually (2019).
- Overall revenue of fish farm enterprises has grown by 16% since 2016 with 62% of the farmers reporting increase in fish farming revenue since engagement with KMAP.
- As at November 2019, 77% of KMAP farms were profitable with a gross margin of over 70%.
- KMAP farms are now employing a total of 2,794 people per production cycle.
- The project contributed to the discussions that led the removal of the 5% fisheries levy on imported feeds.
- Successfully lobbied and led to the enactment of a bill on an inputs cost sharing system instead of free hand-outs in Kakamega County.

KMAP RESULT AREAS



WIDENING MARKET ACCESS

Increasing access to markets for medium to large scale fish farmers and input suppliers.



INCREASING PRODUCTION AND PRODUCTIVITY

Improved production and productivity of 1,100 medium to large scale fish farmers, hatcheries and fish feed producers in the aquaculture sub-sector in west & central Kenya.



POLICY INFLUENCING

To increase private sector participation in creating an enabling environment for aquaculture development.

PROFITABLE POND FARMING

The success of fish farming highly depends on farmers’ access to markets and closely monitored expenses through effective record keeping. Before embarking on the venture, farmers should consult an expert whose references have been carefully checked.

Pond construction

- If the soil has more than 30% clay, farmers can construct an earthen pond. If the clay content is below 30%, a liner is needed.
- A well constructed pond has compacted soil, good slopes of the dykes and a lifetime of at least 10 years with minimum maintenance.
- Ponds should be at least one meter deep.
- It is highly recommended for farmers to consult an expert for identification of the site and pond (s) construction.

Semi-intensive versus extensive farming

- **Extensive fish farming** is the rearing of tilapia in green water by applying fertiliser or manure to encourage the growth of algae which tilapia feed on.
- To succeed, farmers should stock half the pond density and wait for one to two extra months for the fish to reach market size. Extensive farming is not recommended for liner ponds.
- **Semi intensive fish farming** is the growing of fish in green water with additional feeding, thus the fish feed on algae and supplementary feeds. This allows the farmer to stock 1,000 fingerlings growing up to 350 grams.
- Earthen ponds are generally more productive than liner ponds.
- **Catfish in earthen ponds:** to prevent catfish from drilling holes in the dykes, a well compacted gentle slope (1:2) is needed. Catfish require additional feeding.

- Farmers should only invest in liners if the soil has less than 30 % clay.

Farming in liner ponds

- Being a big investment, liners increase the cost of production thus eating into profits. With extensive farming, it is improbable to make profits in liner ponds due to the low production per square meter.

Tilapia or catfish?

- Before deciding which species to grow, farmers should understand the market requirements. What sizes and which species sell?
- Catfish can produce 6 kg per square meter whereas tilapia can produce up to 1.2 kg per square meter.
- Catfish grow faster, are more tolerant to low water quality and do well in both warmer and cooler areas unlike tilapia which grow very slowly in temperatures below 25 degrees Celsius.

Aquaculture tips

- 5 grams tilapia fingerlings have a higher survival rate and shorten the production cycle by one to two months especially in colder regions. Bigger fingerlings are a good investment to boost farmers’ profits.
- The production cycle of farmers ranges between 8 to 12 months for tilapia on the semi-intensive system and 6 to 8 months for catfish under intensive system in central Kenya.
- Estimated mortality of fingerlings from stocking to harvesting is 10% for both tilapia and catfish.
- To be profitable, management of costs is key. Good records help farmers to know their production costs.
- Uniform sized catfish fingerlings should be bought to prevent cannibalism.
- Farmers should identify a market for both smaller and bigger fish sizes and strive to sell all at once so as to start the next production cycle promptly.
- Growing tilapia in liner ponds takes three times longer (compared to earthen ponds) to repay the investment.



The optimum pond water temperature ranges between 28 to 30 degrees Celsius.

From a November 2019 KMAP market study, the prevailing selling price of fresh fish per kilogram is:

	West Kenya	Central Kenya
Tilapia	Ksh 225 to 400	Ksh 270 to 400
Catfish	Ksh 215-350	Ksh 280-550



Table 1: Fish pond income and expenditure statement

Below is a breakdown of the income and expenditure by a farmer who has invested in three 300m² earthen ponds.

Assumptions

1. Species: tilapia.
2. Food Conversion Ratio (FCR): 1.25.
3. Pond construction costs: Ksh 130 per m².
4. Price of fish: Ksh 300.
5. Worker is involved in other farm duties and allocates one hour per day to tend to fish ponds.
6. Production cycle length: 8 months.

Item	Quantity (Kg)	Unit price (Ksh)	Total Revenue (Ksh)
Revenue from sale of tilapia	600 kg	300	180,000
EXPENSES incurred in a cycle			
FIXED COSTS (incurred per month)			
Item	Quantity	Unit price (Ksh)	Total costs (Ksh)
Pond construction total costs	900m ²	130	117,000
Salaries	8 months	1,130	9,040
Depreciation costs (ponds + materials)	8 months	650	5,200
VARIABLE COSTS (one off costs per cycle)			
5 gram tilapia fingerlings (Pieces)	3,000 pieces	10	30,000
Fertiliser and lime	8 kg	200	1,600
Fish feeds (kg)	750 kg	110	82,500
Miscellaneous		12,000	12,000
Total variable costs			140,340
GROSS PROFIT (For 3 ponds, 8 months cycle)			39,660

Source: Fish farmer from Kakamega County, West Kenya, 2019.

FEEDING

The daily amount of feed needed is determined by the size of fish, the pond temperature and the number of fish in the pond. Fish can eat up to 10% of their body weight during the pre-fingerling stage which reduces to 1.5% when they attain a weight of 400 grams.



Table 2: Types of fish feeds

Feed type	Remarks
Algae (green water)	Algae can be used as supplementary feed. Use of fertiliser and manure encourages the growth of algae.
	Despite being a complete diet, fish grow slowly with only algae.
	The quantity of algae cannot be directly controlled by the farmer (except through fertilisation).
Floating pellets (extruded)	Less wastage.
	Feed is easier to digest since it is pre-cooked.
	Best (low) FCR.
	It is not a must have.
Home-made pellets	Not recommended, it is very difficult to get it right.
	Not a complete diet.
	Not for professional farmers.
	A lot of work for little feed, accumulates at the pond bottom and lowers oxygen levels in the long run.

Source: Quick guide to farming tilapia in ponds- Ministry of livestock, fisheries and irrigation (2014).

Feeding tips

- Feeding should be done at least twice a day between 11 am and 4 pm, always at the same time and spot outside the pond.
- The feed pellets should not be bigger than the eyes of the fish.
- Floating pellets reduce wastage of feeds as the farmer can tell whether the feeds have been consumed.
- Mash feeds have a high FCR hence more feeds are needed to grow fish.
- Feeding should be stopped when the fish are not responding. This could be as a result of low oxygen levels and cloudy weather.
- Overfeeding is a waste of money and affects the water quality negatively.
- Fish should never be fed when they are not healthy. Signs of ill health should be checked during sampling.
- Feeding should be stopped at least 24 hours before transport and harvest.
- Feeds should always be stored on pallets (never directly on the soil) and off the walls cool and dry area.
- Should feeds get wet, fish should be fed on it immediately as moist feeds gather mold quickly. Moldy feed should never be fed on fish as it is poisonous.

Food Conversion Ratio (FCR) = Kg of feeds / kg of gain in body weight.

Example: An FCR of 2 means that 2 kg of feed was used to produce 1 Kg of fish.

A lower FCR is better.



The feed versus strain growth trials

World Fish and Farm Africa conducted a growth trial in Kisumu and Karatina between 2017 and 2018 to establish the best combinations needed to achieve maximum aquaculture productivity and profitability using three different strains of fingerlings and four different types of feeds available in the Kenyan market, both locally produced and imported.

Recommendations from the study

- Despite the overall low costs (Ksh 85 per kg, the use of mash feeds for grow-out (fish almost ready for the market) did not result to cost-effective production as the FCR was high.
- At 20°C, quality feeds resulted to slightly higher fish weight gain, but at high costs leading to the conclusion that cheaper pellets should be used in cooler areas.
- Feeds and genetics (strain of brood stock) are critical to optimise aquaculture production.
- At 28 °C, production costs are lower due to lower (better) FCR, reduced feed costs due to less feeds used and faster growth.
- At 20 °C, fish were not able to fully metabolise feed and express optimal growth, therefore feed with lower protein levels (affordable feed) is more economical.

HATCHERY SET-UP

Since hatchery operations are very technical, hatchery operators should have a good grasp of the venture and a ready market to succeed in the business. Getting good quality brood-stock which is fast growing and disease free is key.

Hatchery activities

- It is advisable for hatchery operators to get an expert to design their hatchery.
- From the expert's referrals, hatchery operators should ascertain that the systems in place are functional.
- The survival rate of fingerlings in the hatchery is approximately 75%, but can decline to 5% in the event of a disease or system failure.

Before starting, farmers should check:

- Which species and size does the market want and at what price?
- Who are the competitors and where are they located?
- What is the market size and which percentage can the hatchery operator take?

Hatchery design

- A poorly designed hatchery will not produce the desired results and will instead create technical problems.
- Water quality and quantity is key for hatchery operations.
- The water should be tested on pH, pollution, bacteria e.g E. coli and fluorine (for a borehole) before setting up a hatchery.
- Constructing ponds on clay soil will not require a liner, while loam soil will require one due to low water retention.
- The site should have water temperatures of between 28° to 30° C for optimum growth.
- Water coming in by gravity saves on energy costs compared to pumping thus boosting profits.
- Stringent hygiene rules should be implemented to prevent contamination and spread of diseases.

Tilapia or catfish?

- A tilapia hatchery has a different set up from that of catfish.
- For a tilapia hatchery, more space is needed for the broodstock, fry and fingerlings.
- Catfish require darkness in the first few weeks to reduce stress for optimum growth.
- Managing an optimum temperature is necessary for sex-reversal of tilapia
- Farmers should choose between YY broodstock (all male without hormones) and other selected brood stock based on performance.
- Using special broodstock feeds improves the performance of the broodstock and accelerates the growth of the fry, thus reducing the time the fish spend in the hatchery.
- Good records of the results achieved from using different feeds should be kept to help the farmer know what works best.

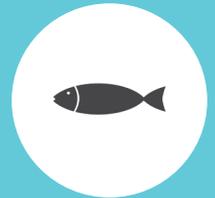
Recirculation Aquaculture Systems (RAS)

- Recirculation systems have been developed to culture tilapia year round under controlled conditions.
- Most recirculation systems are designed to replace 5 to 10 percent of the system volume each day with new water.
- This amount of exchange is used to flush out the solids that accumulate in the bio-filter.
- The system however requires power throughout which increases the operational costs.

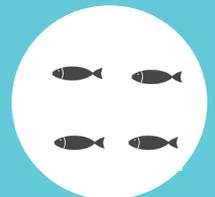
FISH BREEDING



The female incubates the eggs in her mouth and broods the fry after hatching.



Egg number is proportional to the size of the female.



Swim up fry gather at the edge of a tank or pond and can be collected with fine mesh nets. Fry collection can begin 10 to 15 days after introducing the broodstock.



Multiple harvests (six times per day at 5 day intervals) are conducted up to a maximum of 8 to 10 weeks before pond drainage and a complete harvest is necessary.



Table 3: Cashflow statement showing the total income and expenditure in fingerlings nursing.

Fingerlings produced per quarter: 300,000

Price per fingerling: Ksh 10

	Year 1				Year 2				Year 3
	1 quarter	2 quarter	3 quarter	4 quarter	1 quarter	2 quarter	3 quarter	4 quarter	1 - 4 quarter
REVENUE									
Sales	0	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	12,000,000
EXPENSES									
Fixed costs									
Opportunity cost	52,500	52,500	52,500	52,500	52,500	52,500	52,500	52,500	105,000
Depreciation: machinery					200,000				200,000
Depreciation: infrastructure					100,000				100,000
Variable costs									
Fingerlings	720,000	720,000	720,000	720,000	720,000	720,000	720,000	720,000	2,880,000
Feed	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	2,400,000
Labor	73,000	73,000	73,000	73,000	73,000	73,000	73,000	73,000	292,000
Power	65,700	65,700	65,700	65,700	65,700	65,700	65,700	65,700	262,800
Oxygen (rent cylinder + Oxygen)	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	24,000
Administration costs	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	600,000
Total costs	1,667,200	1,667,200	1,667,200	1,667,200	1,967,200	1,667,200	1,667,200	1,667,200	6,863,800
Gross profit	-1,667,200	1,332,800	1,332,800	1,332,800	1,032,800	1,332,800	1,332,800	1,332,800	5,136,200
Cumulative cash flows	-1,667,200	-334,400	998,400	2,331,200	3,364,000	4,696,800	6,029,600	7,362,400	12,498,600

Source: Vihiga County, West Kenya, 2019.



A hatchery with a RAS system in Homa Bay County
Photo: Farm Africa.

ROUTE TO MARKET

Market-led aquaculture production is very crucial for an aquaculture enterprise to be profitable. Selling all fish at once is best for the business. This calls for the farmer to identify a few off-takers coming on the same day.

1. Complete harvest with partial selling to farm gate and partially to trader

Complete harvesting followed by selling partially to the farm gate and partially to traders enables the farmer to sell all the fish quickly, allowing for timely pond stocking to ensure consistency in production. This calls for the farmer to be aggressive in marketing the fish.

2. Complete harvest for sale to traders

With complete harvesting, the labour cost for harvesting is incurred once since all the fish from the pond are harvested. Traders pay lower prices compared to the farm gate.

Complete harvesting targeting traders is encouraged when the farm gate market lacks the capacity to consume the whole pond capacity of 200 kg from a 300m² pond at a go.

Farmers should only harvest fish once the market is assured, and accurate information on the size of ready fish should be shared to build confidence with the trader(s).

The farmer should sample the fish and possibly carry a few to the trader 1-2 weeks before harvesting so that the trader can know the expected size.

3. Complete harvest for sale to the farm gate

Selling fish at the farm gate (to neighbours) fetches the best prices but it is difficult to sell all the fish at once.

Despite the good prices, the costs involved such as hiring casual labourers and equipment e.g. fishing net increase the expenses thus eating into the profits.

Market scenarios

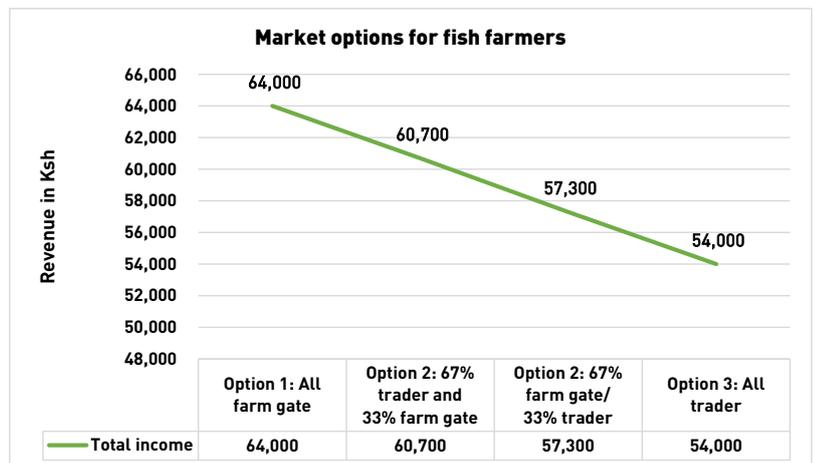
Option 1: After a complete harvest, the farmer sells fish at the farm gate. This fetches the best income although the off-take is slower.

Option 2: After a complete harvest, the farmer sells partly to farm gate and partly to trader(s). Combining the two markets ensures that what is not consumed by one is taken up by the other.

Option 3: After a complete harvest, farmer sells all the fish to trader (s). Although the buying price is lower, the off-take is faster which enables quick return on cash flow for the business.



Figure 1: Market options after a complete harvest of 200 kg of tilapia from one 300m² pond.



Market	Tilapia price in Ksh/kg (as per KMAP market study in Kakamega)
1. Farm gate	320
2. Trader	270

Value addition

Farmers are encouraged to increase fish marketability and revenue by adopting various value addition methods to boost their revenue.

Below are fish products ranked in order of consumer preference based on KMAP market studies:

- Samosas (from catfish fillet)
- Fried whole tilapia
- Filleting (done to catfish but not recommended on tilapia because of high costs)
- Fish fingers (from catfish fillet)
- Sausages (from catfish fillet although the processing machinery required is expensive).

 **Table 4: Prices of value added tilapia and catfish.**

Product	Kg	Pieces	Price/piece in Ksh	Total revenue in Ksh	Cost per kg in Ksh	Profit in Ksh	% profit margin
Catfish samosas	1	35	30	1050	600	450	43%
Fried whole tilapia 200 g	1	5	100	500	300	200	40%
Catfish fillet	1	10	70	700	600	100	14%
Catfish fish fingers	1	50	10	500	600	-100	-14%

Source: Central Kenya cluster, 2019.

Benefits of value addition

- It increases the marketability of the product.
- Farmers are able to keep up with the dynamic consumer needs.
- The demand for value added products is on the rise.
- Value added fish products, except fish fingers, fetch better market prices leading to increased profits.
- To be profitable, fish fingers should be sold to a target market.



To achieve 1 kg of catfish fillet, 2 kg of whole catfish are needed.

THE CLUSTER APPROACH

Clusters should ensure synchronisation of fish production through the development of production plans for continuous and consistent supply to the market.

Farmer clusters should aim to:

- Supply the market continuously with fish at a good price.
- Cut transport costs for farmers by purchasing inputs from distributors collectively.
- Increase access to finance through group savings.
- Foster peer learning to encourage adoption of best aquaculture practices.
- Consistently supply fish to the market.
- The appraisal system of a credible financier can easily single out outlets that are well structured and profitable, making it easy for them to offer loans when approached with practical cluster business plans.

Building strong clusters

- Farmers should continuously and aggressively look for a market long before the fish mature. Joint marketing of the cluster business activities by farmers increases market access.
- Implementing a synchronised production plan for farmers within the cluster is the only way to ensure consistent supply of fish to sell all year round.
- Selling fish during market days instead of opening an outlet could be a better alternative as it cuts on the operational and running costs. Targeting market days enables farmers to sell the fish in volumes and at good prices.
- Farmers should concentrate on increasing profitability by optimising production and productivity.
- Incorporating savings and loan associations (SLAs) to clusters allows farmers to save and borrow funds to invest in their businesses.
- Clusters with members who live within the same locality function better as full attendance of group meetings is made easier.
- Separating the various businesses that a cluster runs e.g. the self-help component from fish business allows the evaluation of profitability of each independently.
- Strengthening the relationship and accountability structure of the group to the fisheries department allows for regular evaluation and monitoring of the business to ensure that all members' interests are safeguarded.
- Members should understand their rights and responsibilities and the structure of the cluster to ensure smooth running.

Leveraging on value addition

- Clusters can boost their earnings and offer various products to their clientele through value addition.
- For value addition to be profitable, the cost of inputs should be low so as to widen the profit margin.

A detailed cluster production plan shows the details of the active ponds including the total number of ponds owned by cluster members, number of fingerlings stocked and the stocking date so as to ensure consistent supply of fish to the market.



Table 5: Below is an example of a cluster production plan.

Assumptions:

- Farmers production cycle length: 8 months.
- With the first farmer stocking in January, the group should have consistent harvests from September.

1.STOCKING SCHEDULE			Pieces of fingerlings stocked											
Farmer's name	No. of ponds	Pond size (m ²)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
James	2	300	1,000		1,000									
Ken	1	300	1,000											
Peninah	2	300		1,000		1,000								
Christian	2	300				1,000		1,000						
Amos	3	300					1,000		1,000					
Ibrahim	2	300		1,000			1,000		1,000					
Total-Ponds and fingerlings	12	3600	2000	2000	1000	2000	2000	1000	2000	0	0	0	0	0
2.HARVEST AND SALES FORECASTS											Expected harvest in kg at 0.66 kg/m ²			
Farmer's name	No. of ponds	Pond size (m ²)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
James	2	300									200		200	
Ken	1	300									200			
Peninah	2	300										200		200
Christian	2	300												200
Amos	3	300												
Ibrahim	2	300										200		
3. PROJECTED KGS	12		0	0	0	0	0	0	0	0	400	400	200	400

Source: Central Kenya cluster, 2019.



Deep fried fish. Photo: Farm Africa.

YOUTH AQUACULTURE AGENT MODEL

Approximately 70% of Kenya's population is below 24 years of age. With the increasing demand for skilled youth, the aquaculture sector presents a myriad of employment opportunities for young people to tap into.

Opportunities for the youth in aquaculture

KMAP adopted a privatised extension model using youth Aquaculture Agents to increase access to technical and business advice needed to improve the production and market access of fish farmers. The agents have been resourceful in creating linkages between input providers, farmers and the market.

Out of the 45 agents that have been engaged during the KMAP project life time, 16 have secured permanent employment in the aquaculture sector.

The current 13 agents have capitalised on their existing network of farmers to generate an additional income by selling quality fingerlings, feeds and market size fish.

After successful implementation by KMAP, upscaling of the model is currently underway in West Kenya where two private sector players (Unga Farm Care EA and Pioneer Fish Farm) have adopted it.

Other possible sources of income include pond construction and rehabilitation, leasing of harvesting nets, management advice, sampling, aquarium building, e.t.c.

Table 6 shows how aquaculture extension services can help the youth to create employment and boost their incomes.

Why the limited youth engagement?

Findings from a 2016 study conducted by the Kenya Market-led Aquaculture Programme (KMAP) attributed this to low access to land and capital by the youth.



Impact of Aquaculture Agents engagement in KMAP

The engagement of Aquaculture Agents to train farmers in fish production, business management, creating market and inputs linkages has resulted in a 70% revenue increase from start of project in 2016 to 2019. This has grown the income to an average of Ksh 80,000. per farmer.

For successful integration of Aquaculture Agents in the value chain to be achieved, they should be equipped with:

- Technical, business and extension skills.
- Access to a network of farmers.
- Direct linkages to input providers and fish traders.
- Mobility to enhance efficiency.
- Coaching.
- Business plan development guidance.



Table 6: Estimated income per month from aquaculture extension services.

Revenue stream	Estimated commission per month in Ksh
1. Sale of fingerlings	20,000
2. Sale of fish	6,500
3. Training to farmers and farmer groups	3,500
4. Gross income	30,000
5. Monthly expenses (e.g. transport, maintenance)	3,000
6. Net income per month	27,000

Source: Central Kenya Aquaculture Agent, 2019.



A KMAP Aquaculture Agent explains the use of a secchi disk to a farmer.
Photo: Farm Africa.

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