

The Kenyan Aquaculture subsector: Perspectives on potential Impacts on Food and Nutrition Security and Poverty Alleviation

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Role of Fish in Food & Nutrition Security

- World wide, over 800 million people suffer from malnutrition, majority being in Africa
- Fish can play a critical role in tackling malnutrition
- Global demand for fish will continue to grow over next decade due to popn growth, urbanization and wealth (FAO 2014)



Malnutrition



Nutritional Aspects of fish

- Fish is nutrient dense; an excellent source of high quality **animal protein, fatty acids**, and **micronutrients**

Fish as source of Proteins – highly digestible proteins containing high conc of **ALL the 10 EAAs**

Fish as a source of PUFAs – rich in LC-PUFAs (w3 fatty acids) **EPA,DHA**

Fish as a source of micronutrients – rich in Vits **A,D,K; Calcium, Iron, Zinc** (Small fish rich in Vit A, calcium, Iron and zinc. Micronutrients conc in head, bones and viscera (Vit A conc in eyes and viscera, calcium conc in bones 8times higher than in milk /same bioavailability)

Contrasting development of capture fisheries and aquaculture

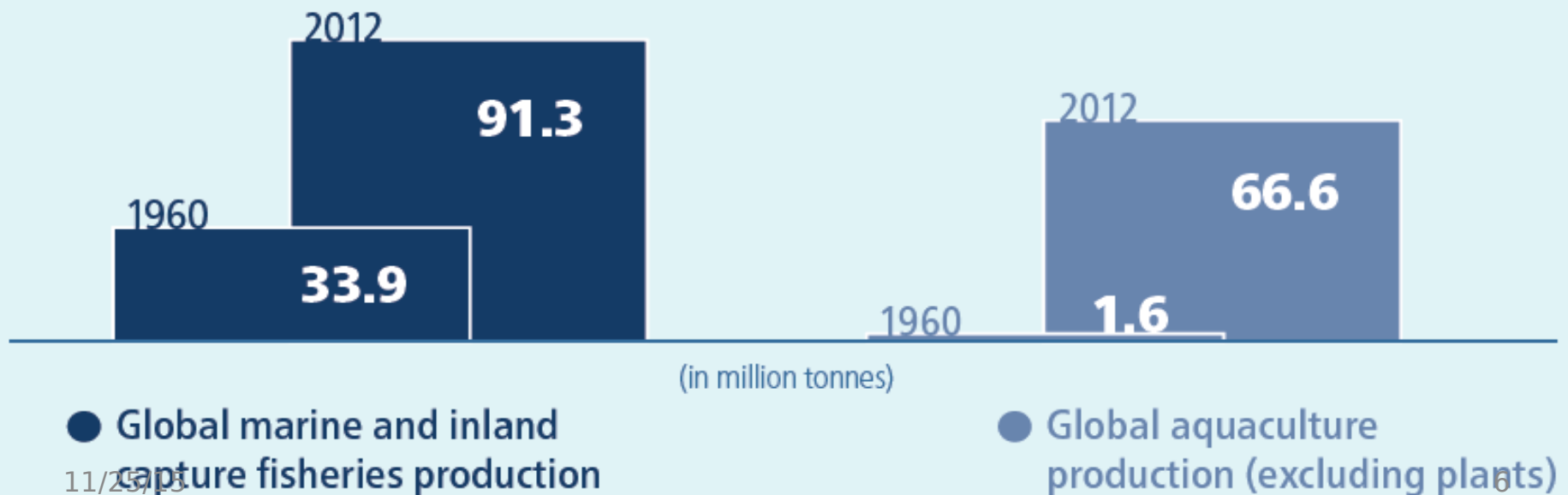
- Global fish supplies from capture sector increased rapidly throughout the 1950s and 1960s (growing at some 6%) leveled off by 1970s (max. potential of fishing areas, overexploitation, catch restrictions)
- Over the same period **Aquaculture has grown consistently**; now accounts for about 50% of total world fish supply
- Much of seafood is traded internationally; underlines importance of aquaculture as a generator of foreign exchange and a driver of economic growth

Global Fish Production (FAO 2014)

People have never consumed so much fish or depended so greatly on the sector for their well-being as they do today

PRODUCTION

World fisheries produced 158 million tonnes of fish in 2012



Global Fish Production from capture fisheries and Aquaculture (FAO 2014)

- Globally **158** m tones of fish produced in 2012 (11.6m inland fisheries, 79.7m marine capture fisheries, 41.9m tones inland aquaculture, 24.7m tones marine aquaculture) i.e. **Total production from aquaculture was 66.6m t !**
- **Out of the 158m t, 136m t** was used for human consumption i.e. about 50% of all fish consumed in 2012 was produced through fish farming

TRADE

Fish is among the world's most traded food commodities

Worth almost US\$130 billion (2012)

**Developing
economies
account for**

54%

**of total fishery
exports by value**



**Developed
economies
account for**

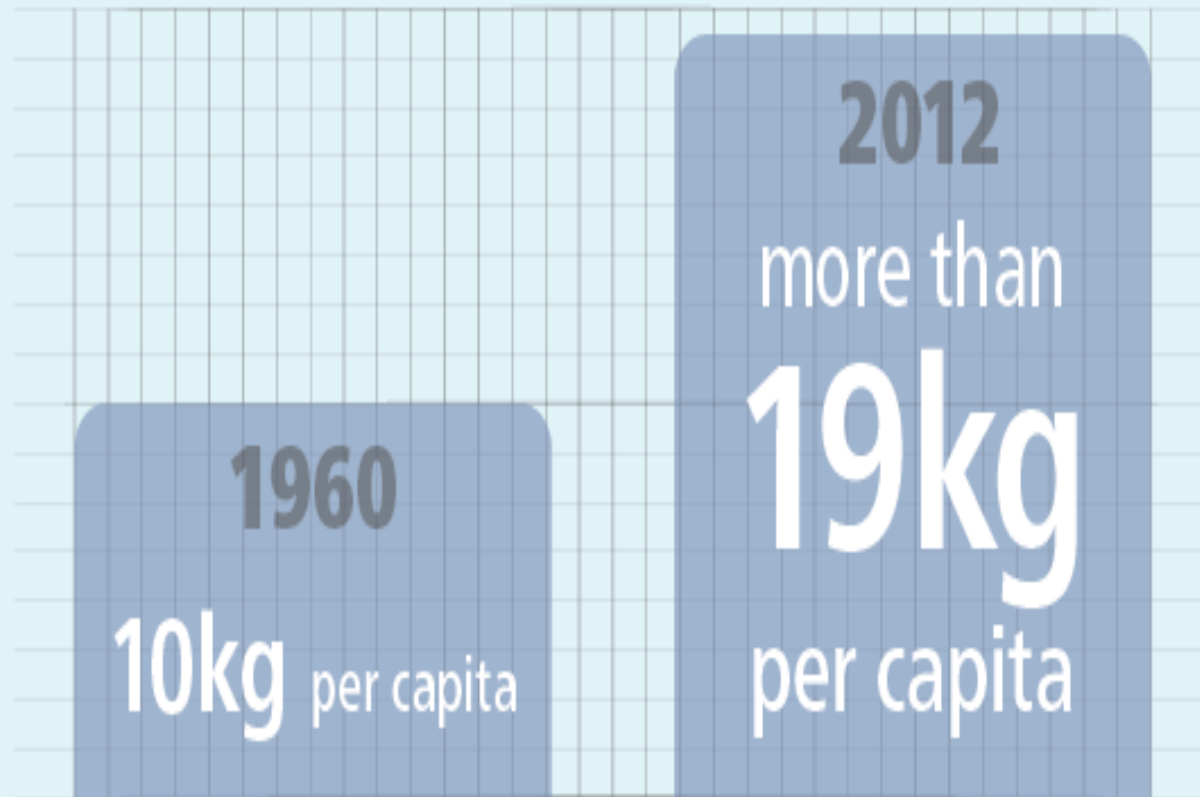
46%

**of total fishery
exports by value**

CONSUMPTION AND NUTRITION

The amount of fish that people are eating continues to rise.

Fish makes up **17%** of the global population's intake of **animal protein**, and provides **essential nutrients, vitamins** and **omega-3 fatty acids**.



Definition of Aquaculture

- FAO 1988 “The farming of aquatic organisms, including fish, molluscs, crustaceans, and aquatic plants. Farming implies some form of intervention in the rearing process to enhance production such as regular stocking, feeding, protection from predators etc. Farming also implies individual or corporate ownership of the stock being cultivated”
- **Key features: Husbandry and Ownership**
- **Agriculture = farming on land(animals & plants)**
- **Aquaculture = farming in water(animals & plants)**
- **Fisheries = Hunting**

Aquaculture (History, Production systems, Feed, Seed)

- Aquaculture has origins in 2 geographical areas : **North Africa (Egypt)** about 3200 BC and **China**(recreational pursuit)about 2000 BC
- Aquaculture Production carried out in **Inland** (fresh water environments) **Marine** environments (fw, brackishwater, seawater)
- Over the past 3 decades, Aquaculture has become the fastest growing food production sector in the world.
- Asian countries dominated aquaculture production; 9 of the top 10 producers are from Asia with China alone responsible for over 90%

Systems and Grow-out units

Systems classified as

- **Extensive** (use of natural feeds)
- **semi-intensive** (natural food enhancement, supplementation), and
- **Intensive** (use of complete diets)

Grow-out units : ponds, cages, pens, tanks, raceways, rafts and longlines, hapas etc)

- Feed (spp, growth stage, size, FCR, Growth rate, water fouling etc)

Grow-out units (ponds, hapas in pond)



Grow-
out /
breeding
units



•tanks

•cages

raceway



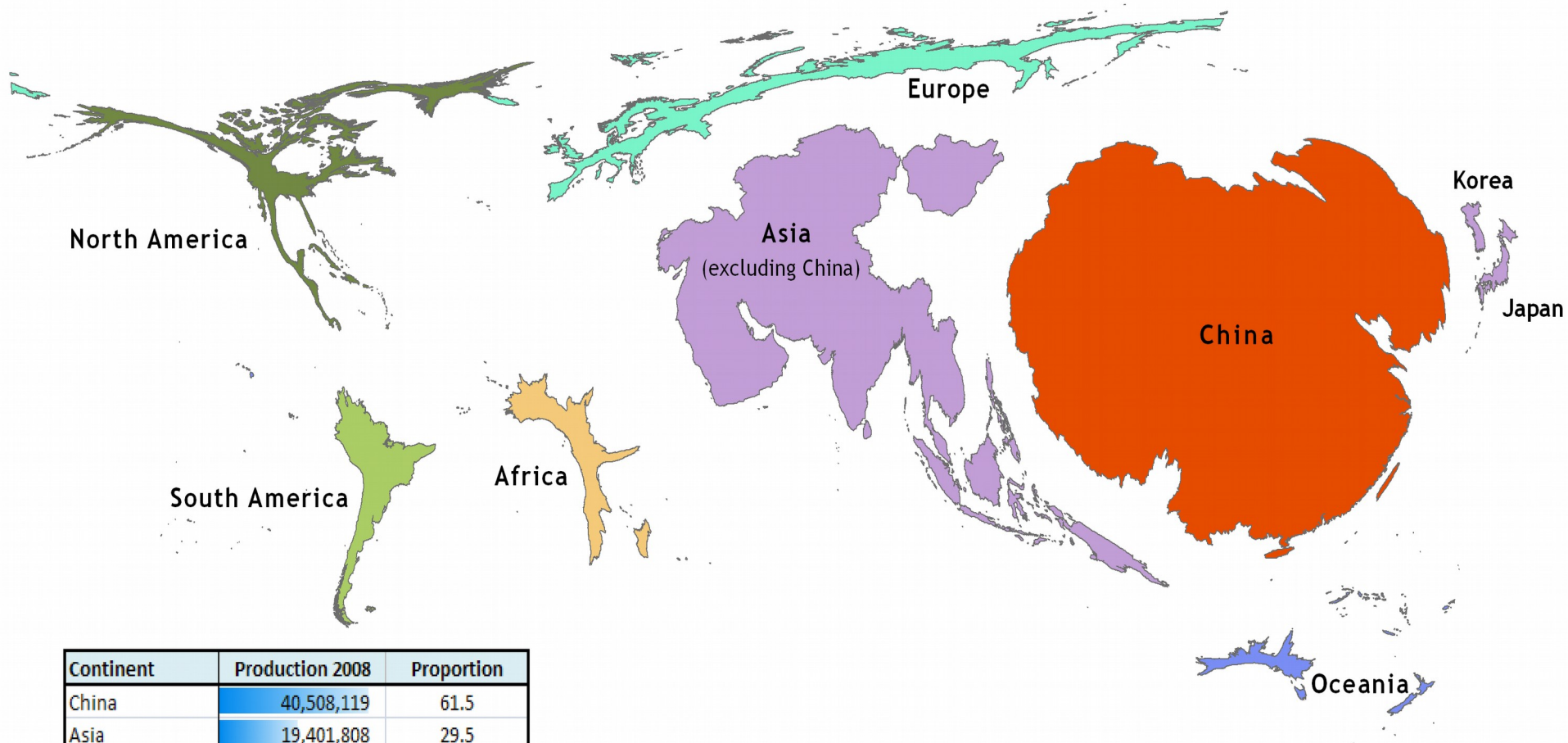
CAGE CULTURE



Grow-out units

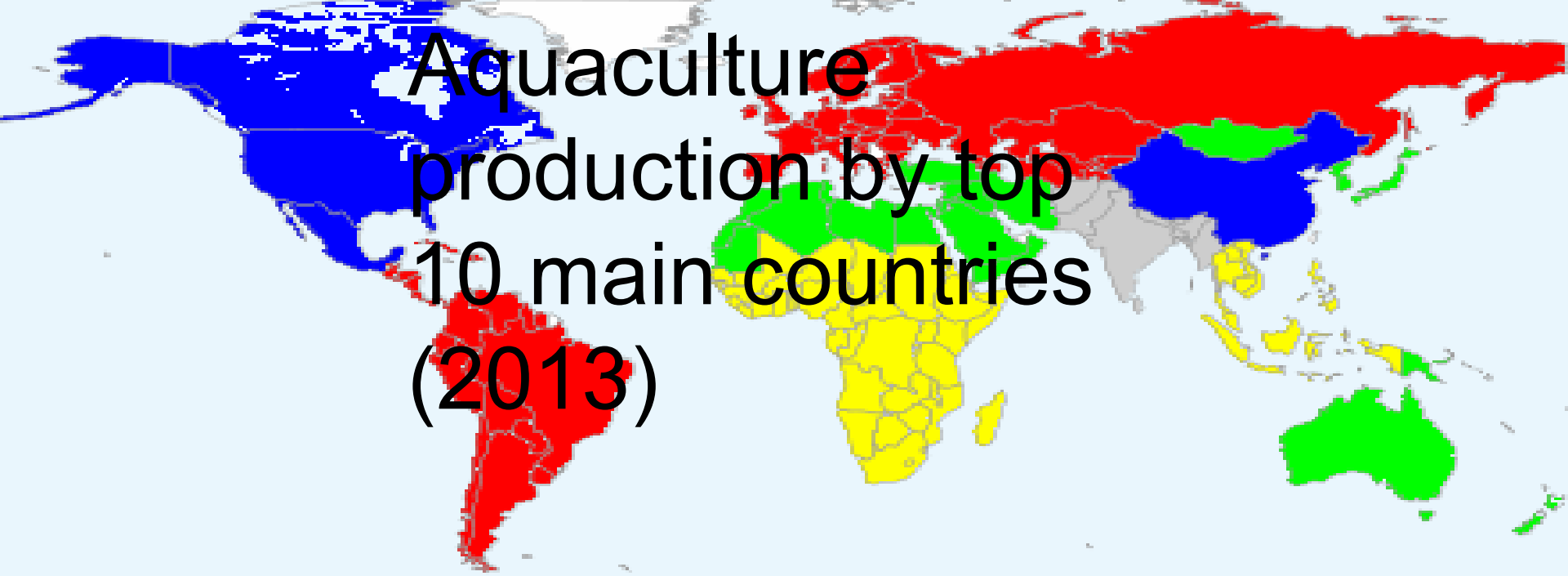


Who is Growing the fish ?



Continent	Production 2008	Proportion
China	40,508,119	61.5
Asia	19,401,808	29.5
Europe	2,341,646	3.6
South America	1,461,061	2.2
North America	965,792	1.5
Africa	952,133	1.4
Oceania	176,181	0.3

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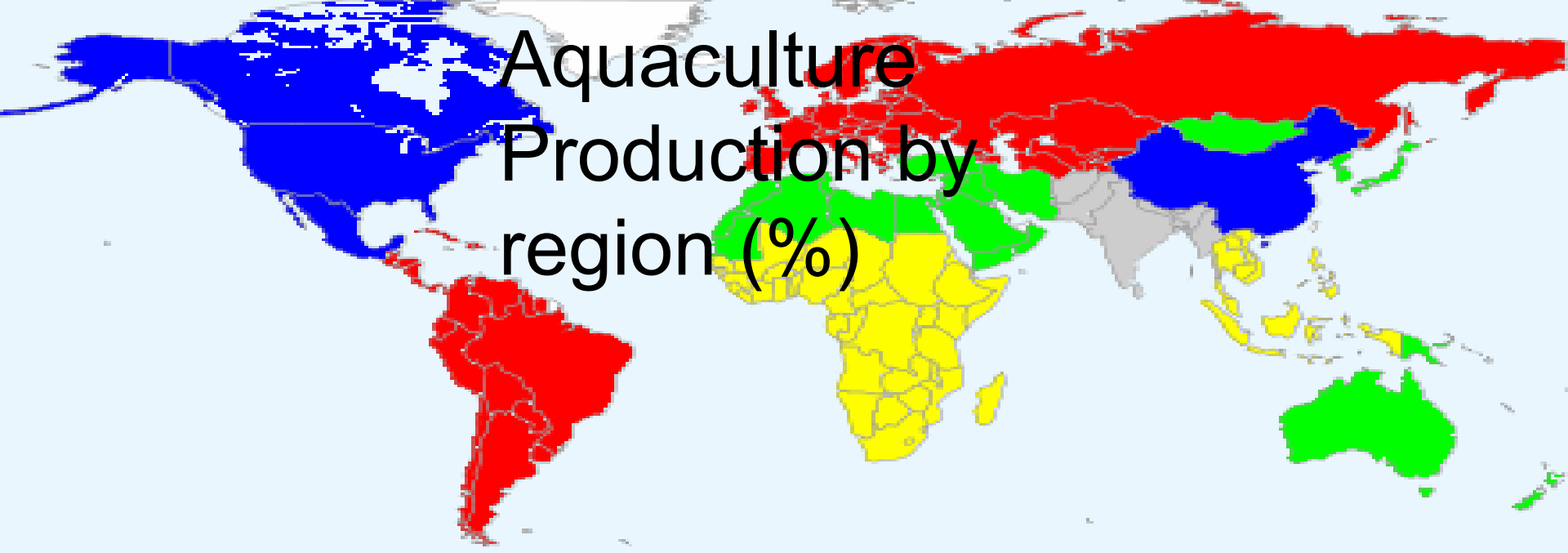


Aquaculture production by top 10 main countries (2013)

	Million tones	Billion USD	Quantity Share	Value Share
China	41.1	66.2	61.7%	48.2%
India	4.2	9.2	6.3%	6.7%
Vietnam	3.1	5.8	4.6%	4.2%
Indonesia	3.1	6.7	4.6%	4.9%
Bangladesh	1.7	3.9	2.6%	2.8%
Norway	1.3	5.2	2.0%	3.8%
Thailand	1.2	3.3	1.9%	2.4%
Chile	1.1	6.0	1.6%	4.4%
Egypt	1.0	2.0	1.5%	1.5%
Myanmar	0.9	1.5	1.3%	1.1%
Total	66.6	137.3		

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Region	1990	1995	2000	2005	2010	2012
Africa	0.62	0.45	1.23	1.46	2.18	2.23
Americas	4.19	3.77	4.39	4.91	4.37	4.78
Asia	82.61	88.90	87.67	88.46	88.82	88.39
China	49.58	65.03	66.39	63.48	62.22	61.69
Europe	12.25	6.49	6.33	4.83	4.32	4.32
Oceania	0.32	0.39	0.37	0.34	0.31	0.28
World (tonnes)	13.1m	24.4m	32.4m	44.3m	59.0m	66.6m

Fisheries sector in Kenya

- The sector comprises **capture** and **culture**-based fisheries
- Kenya has vast marine & inland water resources hence huge potential for fish production i.e.

Lakes: **Turkana** 6405km², **Victoria** 4,128km², **Naivasha** 210km², **Baringo** 129km², **Jipe** 39km²

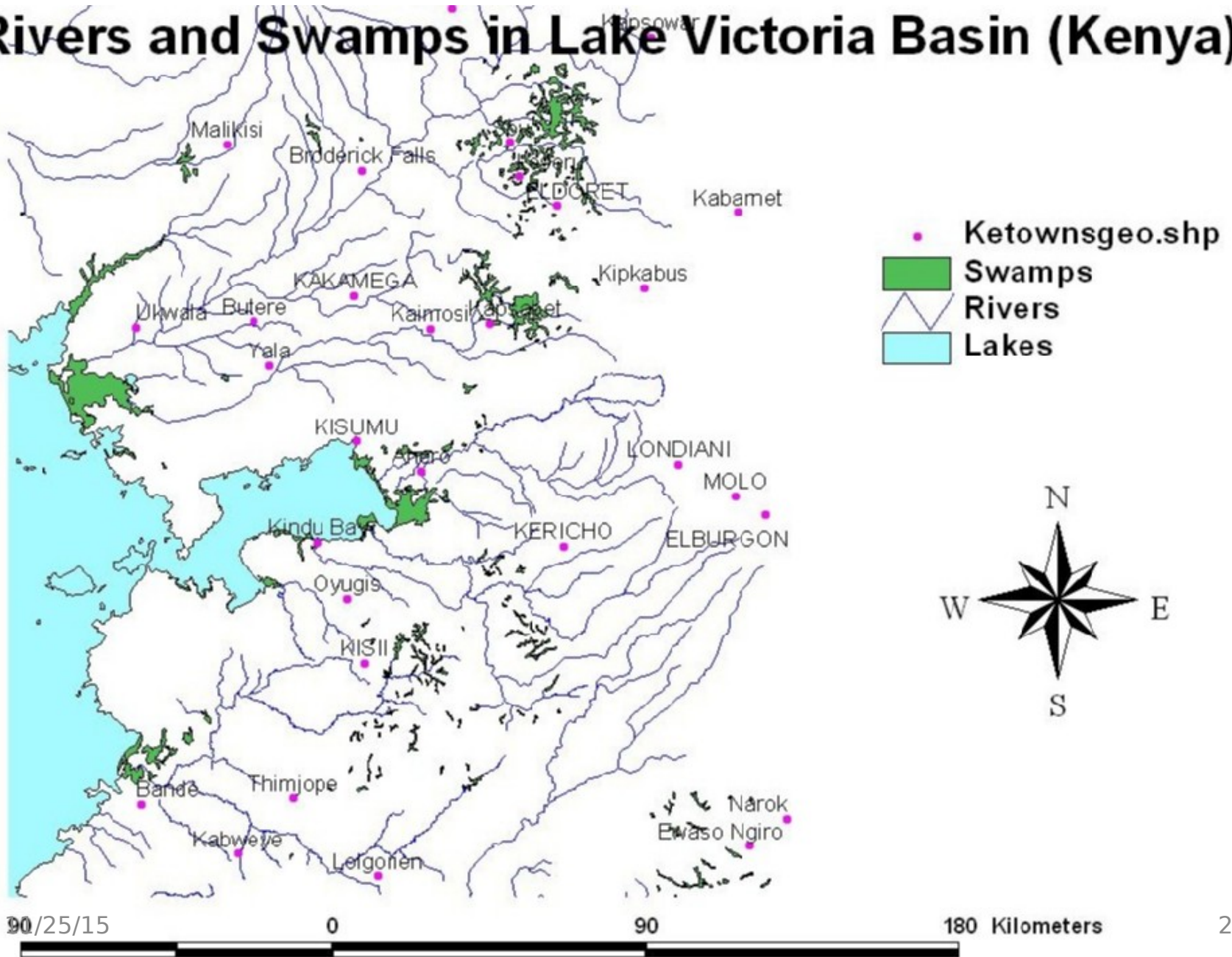
Rivers: **Tana** 700km, **Athi/Galana/Sabaki** 530km, Ewaso-Ngiro North 520km, Ewaso-Ngiro south 140km, **Kerio** 240km, **Suam-Turkwel** 350km, **Mara** 280km, Nzoia 240, Yala 170, **Sondu-Miriu** 105km, **Malewa** 105, **Kuja** 80km

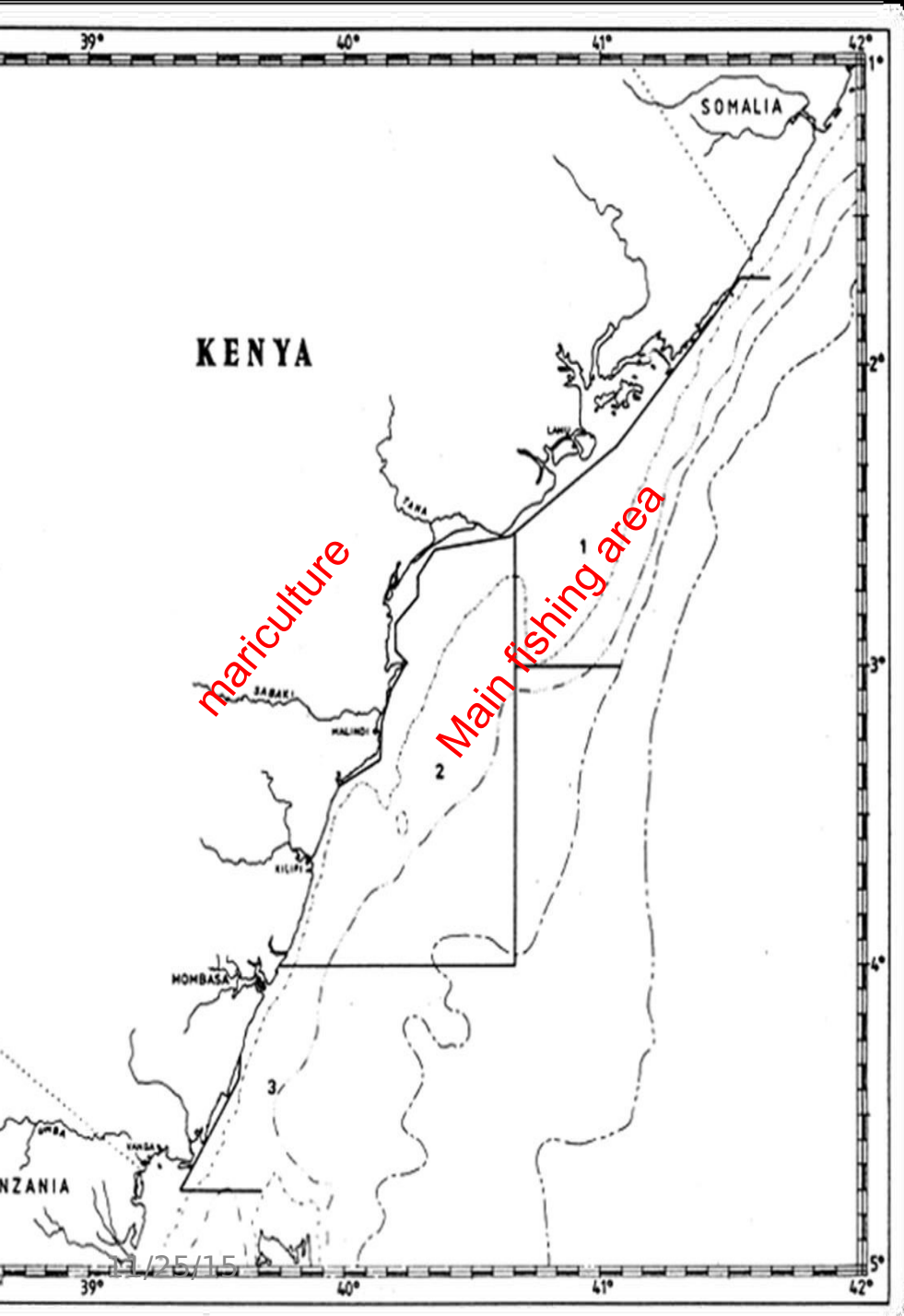
Ocean: coastline 640km (rugged 880km), EEZ 200 nautical miles. Located within the richest tuna belt SW Indian ocean

EASTERN AFRICA REGION SHOWING THE LOCATION OF LAKE VICTORIA AND ITS CATCHMENT



Rivers and Swamps in Lake Victoria Basin (Kenya)





KENYA'S MARINE ZONE

640Km (rugged 880 Km) coastline
EEZ of 200 nautical miles (a total area of about 230,000 Km²)

Estimated potential of Tuna fishery 150,000-350,000 MT

National Policy Priority

- Kenya's national development agenda is guided by the **Vision 2030** which aims at transforming Kenya into a newly industrializing, middle-income country providing a high quality of life to all its citizens in a clean and secure environment (GOK,2008)
- Fisheries to contribute to economic development in terms of food and nutrition security and industrialization. Targets to **use technology and innovation in fishing and aquaculture**, and product development to increase access and availability of fish and fish products

Policy Priorities for Fisheries

- **Increase production and productivity: Sustainable development of EEZ fisheries and mariculture**
- **Value Addition and new products**
- **Enhance market access for fish and fish products**
- **Enabling policies and frameworks**
- **Research**

Strategic Priorities in Fisheries

- Increase production and productivity
 - (i) sustainable development of the deep sea/EEZ fisheries through developing small-scale fisheries
 - (ii) aquaculture development through use of technology in aquaculture e.g. cage culture, new species and systems with greater profits and low impacts on environment
- Enhanced value addition and market access; reduced post-harvest losses, product development
- Support to fisheries/aquaculture research

Fisheries Legislations

- **Fish protection rules 1929 (Revised 1931)**
- **Fish Protection Act 1902**
- **Fish Protection (Oysters) Rules 1962**
- **Fish Protection (Registration of Fishing Craft, Sea fisheries Rules 0 1952**
- **Fish Industry Act 1968**
- **Fish Industry (Shells and live coral conservation) Regulation 1971**
- **Maritime Zones Act 1989**
- **Fisheries Act 1989 (Revised 2012)**

Fish production in Kenya

- Kenya is blessed with natural fisheries resources - fresh inland water bodies, marine waters (Indian Ocean) , and suitable climate
- Total fish production in **2013 was 186,969 MT** valued at about KES 24 billion (SDF,2014)

Inland capture fisheries 123,861 MT (**68%** of total national production) valued at KES 12 B

Marine capture fisheries was 8,865 MT (**5%** of national production) valued at KES 1B

Aquaculture was 48,790 MT (**27%**)valued at 18B

Fish production

- Fishery in Kenya **mainly artisanal** in both the inland and marine waters.

Few commercial /industrial vessels in the marine waters (mainly owned by **Distant Water Fishing Nations** operating under Kenyan license in the EEZ),target mainly shrimp and tuna with catch destined for export.

- Inland fishery accounted for 68% of the total with **L. Victoria producing 76% of the total catch from inland capture fisheries.**

Kenyan Aquaculture sub-sector

- Fish farming began by colonialists early 1990s – Rainbow trout for sport fishing, static water pond aquaculture (tilapia, carp, bass).
- Sagana and Kiganjo Fish farms 1948 (restocking rivers, dams, ponds). Mariculture 1970s (Ngomeni Prawn Farm)
- Potential for fish production is considered favorable – Lakes, Rivers, & Dams give surface water cover of 13,400 km², Territorial ocean water cover is 14,300km². In addition Kenya has 1.4m hectares of land suitable for aquaculture of which only 0.014 % is currently used for fish farming

Low Production Levels!

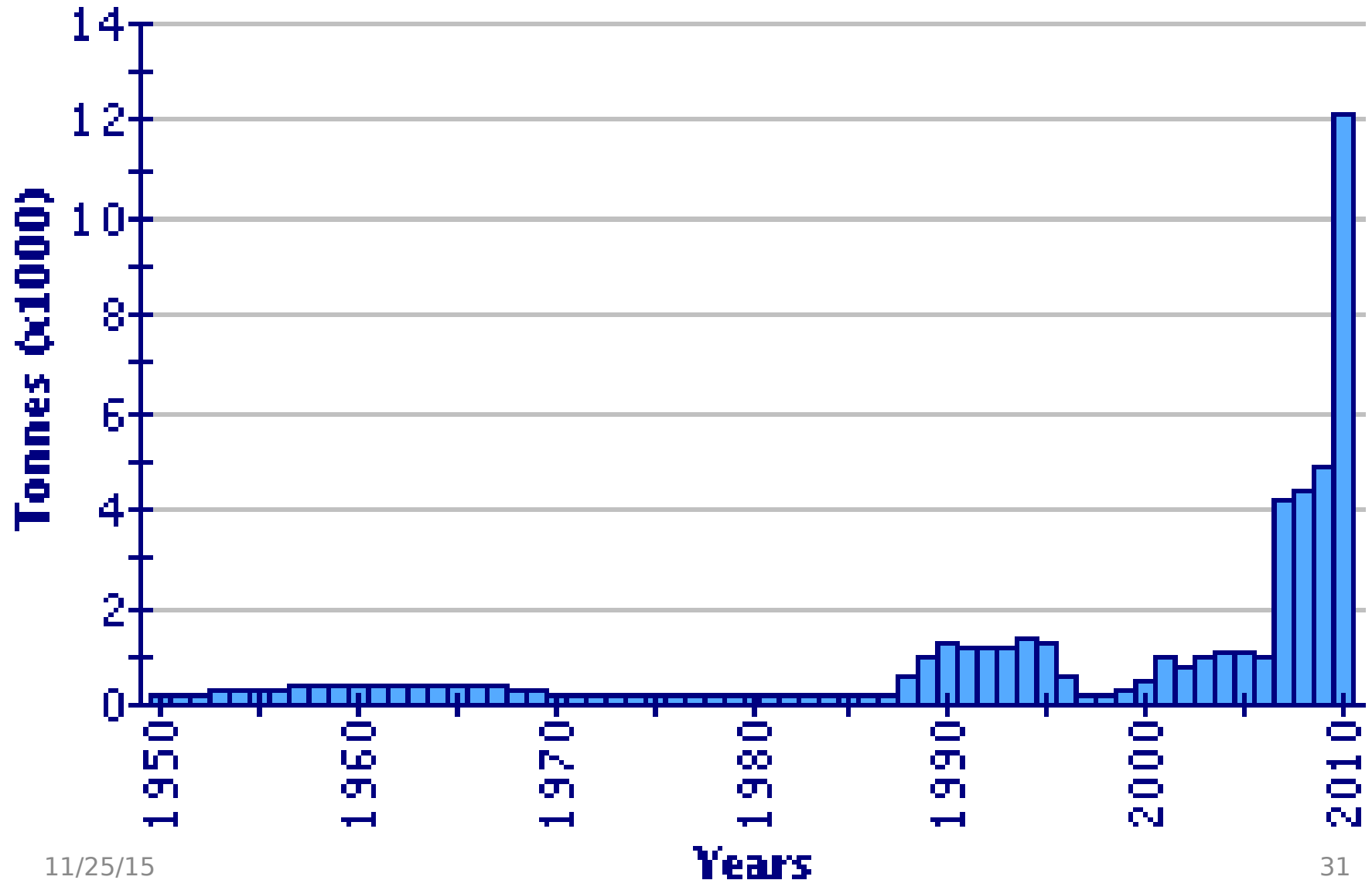
- Aquaculture production in Kenya has been characterized by low production levels:

1970 - 1980 = 900 t,

1980 - 2003 = 1,012 t,

2006 - 2008 = 4,219 t

Aquaculture production from 1950 to 2010



Reasons for low production

- Lack of readily available quality **feed**
- Lack of readily available quality **seed**
- Lack of effective **aquaculture policies and strategies**
- Finance
- Weak **extension services**
- Weak Human resource base (appropriate skills, trained staff, experience with high vol production)
- Weak **private sector involvement/**
Overdependence on public sector institutions

Turning Point !

2008 Govt
launched
**Economic
Stimulus
Program (ESP).**
Aquaculture
identified as key
contributor to
GDP, hence a
viable economic
activity



- Fish farming became part of the ESP in the form of **Fish Farming Enterprise Productivity Program (FFEPP)** **Govt** **strategic positioning aquaculture as a viable economic activity**
- 2008 Directorate of aquaculture was formed
- National Aquaculture Development Strategy and Plan was developed
- Objective: Increase aquaculture production from **4000 t - over 20,000t medium term - projected over 100,000 t**

Fish Farming Enterprise Productivity Program (FFEPP)

- Constructed over 48,000 ponds of 300m² in over 160 constituencies in the country. Emphasis put on pond farming of Nile tilapia and African catfish. free fish seed and fish feed supplied to farmers
- **FFEPP** Assisted farmers to **form clusters** (Aquaculture Association of Kenya)
- **FFEPP Improved extension** (trainings, motor bikes)
- Selective breeding program initiated at Sagana ARDC
- Established 4 mini processing and cold storage facilities
- Developed fish feed and seed standards and accreditation of hatcheries.

FFEPP

- Govt injected **5.6 B KES** into the FFEPP
- Number of farmers rose from **7000** in 2008 to over **38,000** in 2013
- Pond surface area under fish farming has increased from **722 ha** in 1980 to **over 20,000 ha** by 2013 !
- The number of ponds rose to over 100,000
- Production of fish has increased from about **4000t** in 2008 to **over 12,000t** in 2011 to **over 48,000t in 2014!**
- Whole country has embraced eating fish (traditionally a preserve of people around the lakes and the coast)

FFEPP Achievements

- Number of accredited hatcheries rose to 150 from less than 20 in 2008
- Number of large commercial fish feed producers increased
- Fish Feed demand went up – over **50,000 t annually**,
- Seed/fingerling demand went up - over **100million** (African catfish and Nile tilapia)

Fish production Target

- Targeted total production is **450,000 MT by 2030** from both aquaculture and capture fisheries
- Aquaculture expected to play key role in meeting the target by producing over 50% of the total production figure.
Currently the fastest growing 2% in 2009 - 27 % in 2013 (Growth mainly in inland sector ,attributed to FFEPP)
- Aquaculture in marine sector has been dormant so far

Aquaculture in food and nutrition security and poverty reduction

- Fish plays a key role for food security. It is a primary source of proteins and essential nutrients.
- Aquaculture (+ fisheries and related activities) provide income and livelihoods for numerous communities across the world
- Aquaculture is predominantly carried out in the rural areas (Poverty and malnutrition remain largely a rural phenomenon in Kenya)

Aquaculture in food and nutrition security

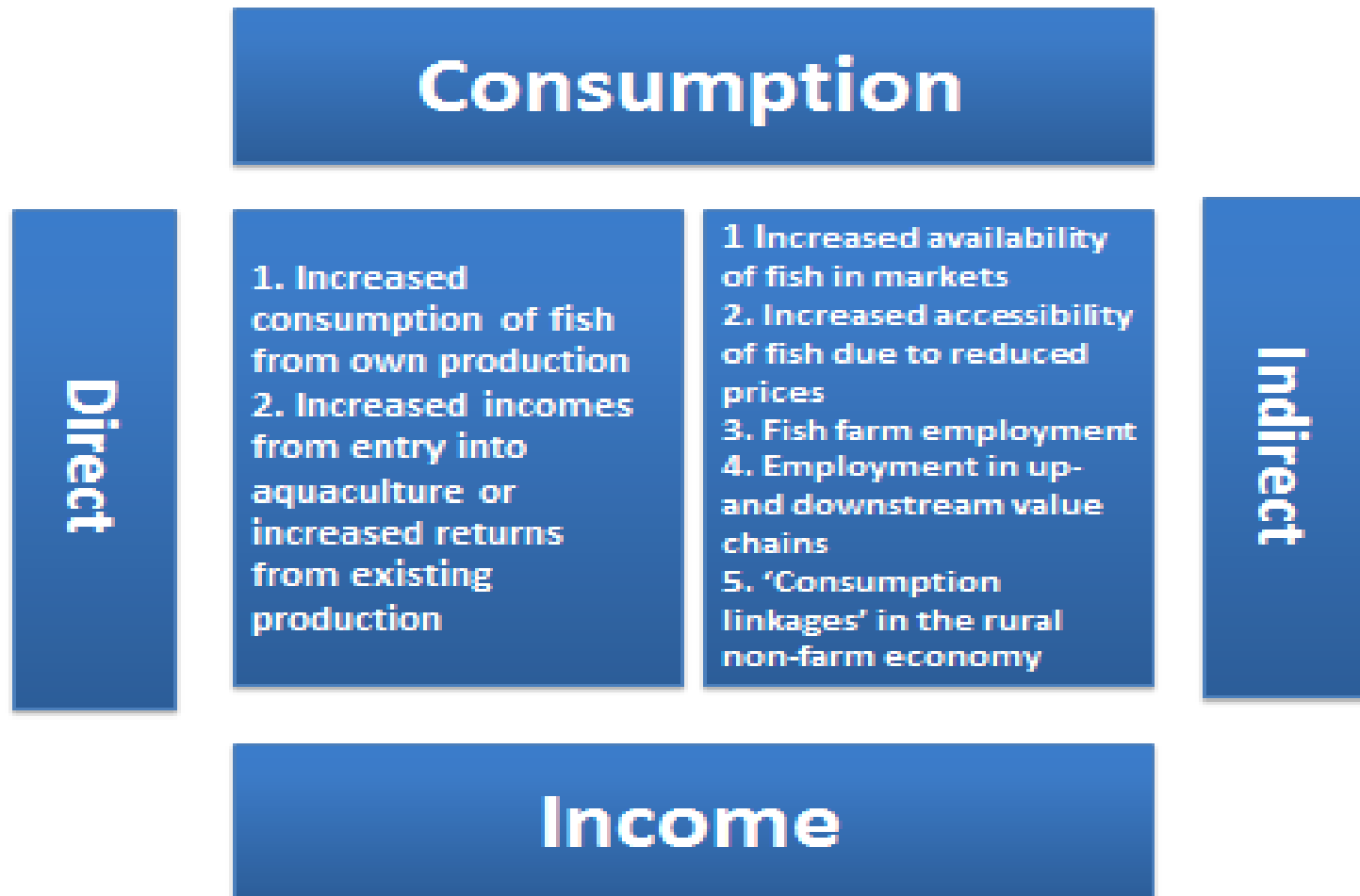
- In 2012 more fish for human consumption originated from aquaculture than from wild capture
- Aquaculture therefore a significant contributor to food and nutrition security
- Aquaculture seen as (i) important domestic provider of much needed quality protein, generally at prices affordable to poorer segments of the society (ii) provider of cash income and foreign exchange

Food and nutrition security

- Export oriented/industrial/commercial aquaculture = brings in foreign exchange revenue and employment
- **Extensive farms benefits lives of poor through improved food supply, employment, reduced vulnerability to natural calamities**
- Fisheries enhancements gives opportunities for resource poor people to benefit from these resources / culture-based fisheries increases fish supplies to communities

- Aquaculture provides contribution to food and nutrition security through 3 distinct pathways
 - (i) **Consuming the fish produced** (dietary intake, improved nutritional status-HUFAs, iron, zinc, calcium, Vit A)
 - (ii) **Sale of fish produced and from wages** – increased purchasing power, sufficient staples, non staples (vegetables), increase quality and quantity
 - (ii) **Women participation in aquaculture-** degree of control over family revenue, household food security improved

Contribution of Aquaculture to Food and Nutrition Security and Poverty Reduction





Aquaculture Research at Moi University

- Our research team has undertaken various researches in 4 particular areas

(i) Integrated aquaculture

(ii) Fish seed production

(iv) Fish feed

(iii) New aquaculture species

Integrated Agriculture- Aquaculture

Integrated Rice-fish farming

- (Kenya has over **11000 ha** of irrigated and over **12,000 ha** of rainfed rice fields)
- The rice fields are potential fish ponds in its aquatic phase. Water in the fields (diurnal fluctuations in temp, pH, DO) fast growth, tolerance/hardy desirable – Rice 3-4 months
- **Our research –field modification, rice variety, fish spp, economics**

INTEGRATED RICE-FISH FARMING



INTEGRATED RICE-FISH FARMING



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INTEGRATED RICE FISH FARMING



Integrated aquaculture-agriculture provides means to diversify and maximize outputs. Integrated systems benefit from synergies among the different components



Mangrove friendly Aquaculture- Silvofisheries

- Research : types of mariculture that can be carried out in mangrove areas without adverse effects on mangrove ecosystem (**pen, tray, cages silvofisheries**)
- **Silvofisheries** mangrove tree culture incorporated with mariculture (crab fattening in enclosed areas, ponds)
- Results - CBO (Tsunza)

Mangrove- friendly Aquaculture- Silvofisheries



SILVOFISHERIES (Prawns and Crabs)



CRAB FARMING



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CRAB FARMING



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CRAB FARMING





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Integrated solar salt-Prawn- Artemia culture

- Solar salt making process involves seawater being evaporated in controlled areas(reservoir ponds) to produce brine for crystallizing salt
- Seawater is pumped into reservoir ponds arranged in sequence for evaporation
- First reservoir ponds can be used to grow prawn. As evaporation continues more, Artemia can be cultured in reservoirs with more salt concentration
- **Our Research has demonstrated the Prawn-Salt-Artemia production**

Brine shrimp Artemia culture



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Research on Fish seed

- **Objective:** Improving the hatching rates of eggs and survival of fry and larvae of African catfish ***Clarias gariepinus***

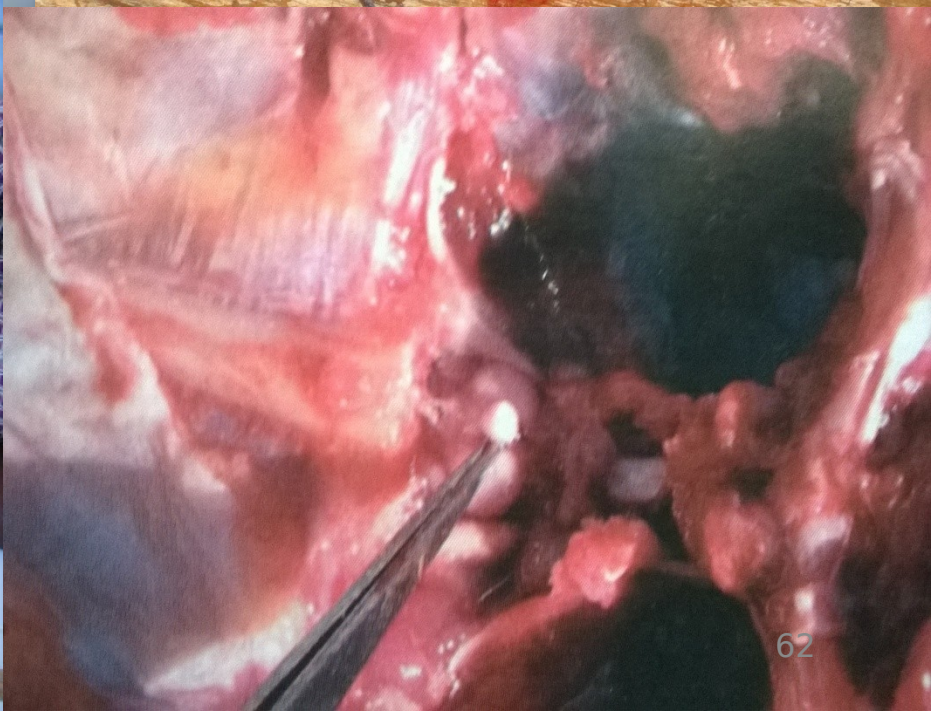
Artificial fertilization: **Eggs** - Parasitization of eggs by aquatic fungi. Saprolegnia spp - mycelia suffocation (7-70%) .**Massive larval** mortalities - yolc-sac fry (1-3 days), swim-up fry(4-7), larvae (+8 days)

Tested several fungicides & chemotherapeutics for external protozoan parasites

Our Protocols on fungal and bacterial control routinely used in hatcheries in Kenya and Eastern Africa



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Tilapia eggs – Mouth Brooding

Spawning frequency 4-6 weeks
More frequent if eggs are removed from the mouth

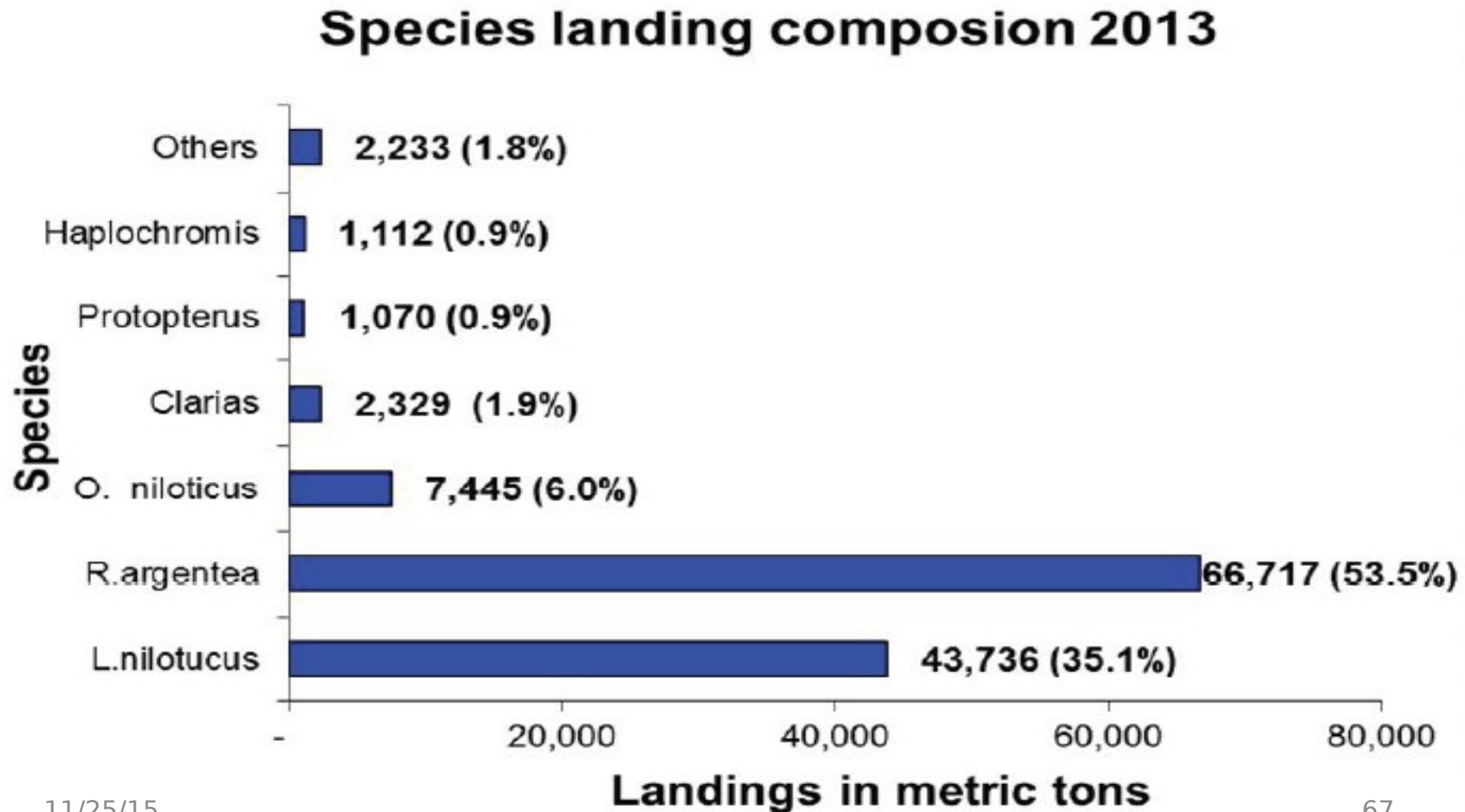


Yolk-sac tilapia fry

Research on Fish feed

- Fishmeal is a major protein source in aquafeeds ; contains amino acids, fatty acids, micronutrients, attractants and growth factors. In Kenya main source of fishmeal is “omena” (***Rastrineobola argentea***) – commercially important fish species (top in L.Victoria fishery)
- *R. argentea* is Food for humans (**nutrient dense**), also used in poultry feeds and livestock feed industry
- Our research: **GET alternative !** – Atyid shrimp (***Caridina nilotica***) “Ochonga”
- Our Research Briefs have influenced policy makers and animal feed manufacturers to use “ochonga”

Lake Victoria species catch composition 2013



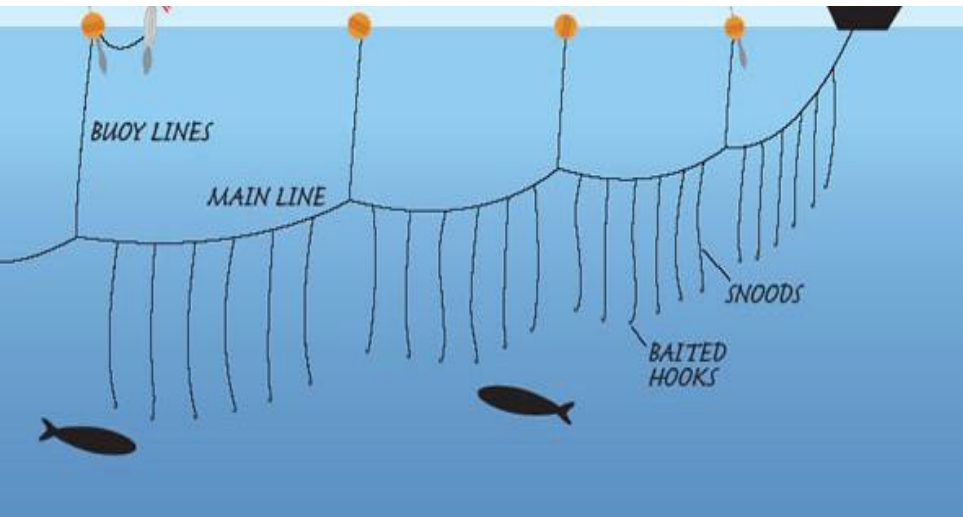
New Aquaculture species (Endemic)

“Ningu” *Labeo victorinus* highly relished as a delicacy in East Africa. Potamodromous, leaves lake swims upstream at start of rains to spawn

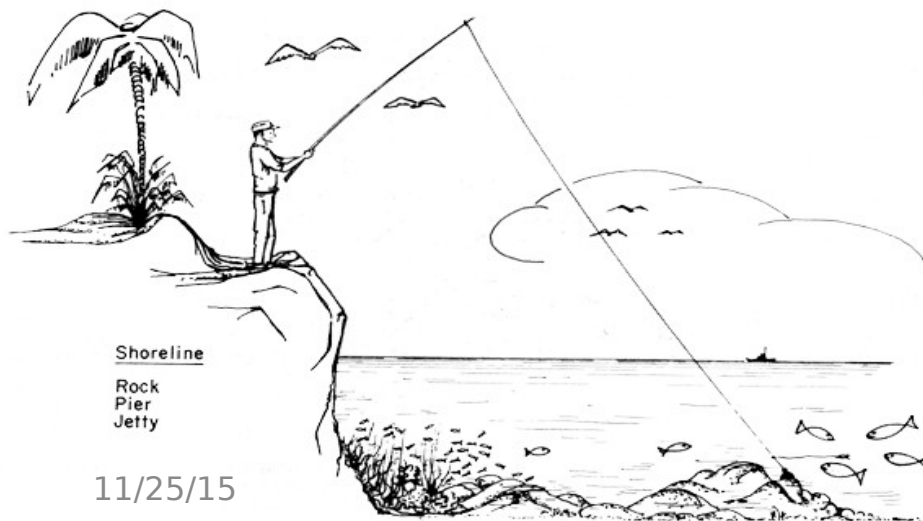




Investment Opportunities



- Fish **seed** production (Tilapia-stocking ponds, Catfish – stocking ponds & bait for long line fishery)
- Fish **feed** production
- Cage farming



Cage farming



Cage farming L.Victoria (SON Farm, Jinja)



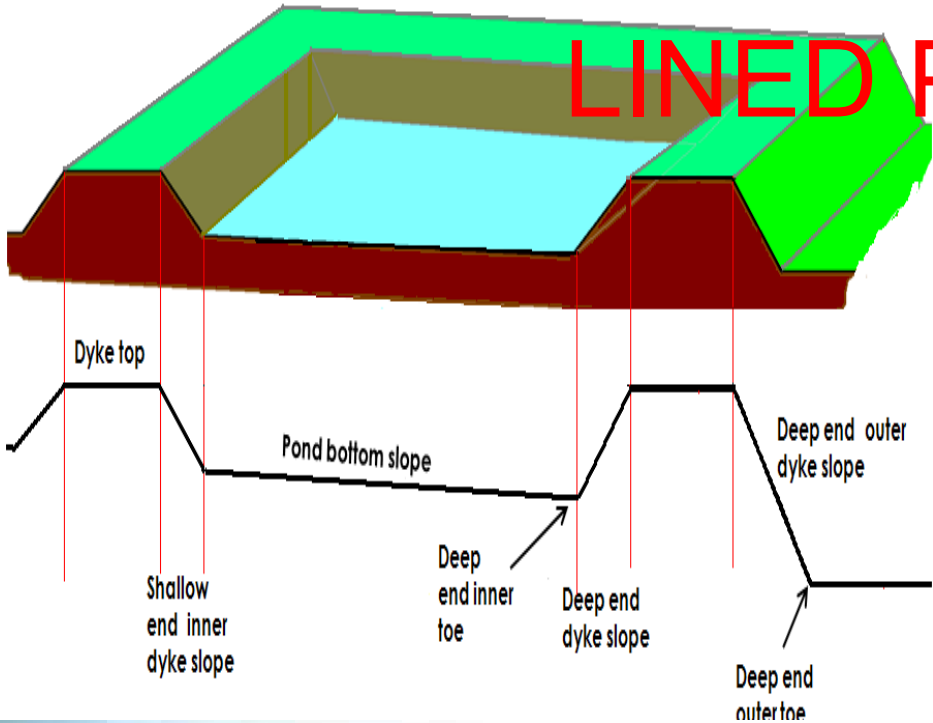
Opportunities

- Ready market for fish in Kenya, Africa and the world
- **Decreased** fish supply from L.Victoria
- **Availability of processing facilities** (belonging to Nile Perch Export Processing Factories working at 30-50%capacity) - fish can be processed into a wide array of products – live, fresh, chilled, frozen, heat-treated, fermented, dried, smoked, salted, pickled, boiled, fried, freeze-dried, minced, powdered, canned

Increase production zone

- Potential exists for farming several fish species in Kenya: **Warm water f/w spp**(Tilapia, Catfish, Carp),
Cold water fw spp (Trout), **Marine water** (molluscs, oysters, prawns).
- Small scale subsistence (women groups, middle class) = Extensive (oyster farming in Gazi, seaweed farming south coast), semi-intensive, intensive. Semi-intensive forms bulk (+ 70% of total annual production)
- Extend production range - **use lined ponds!**

LINED PONDS



Thesis: Aquaculture development represents a critical opportunity for food security, employment, food and nutrition security

- Does aquaculture represent a positive net addition to the livelihood portfolio of rural families and communities ?
- Can aquaculture contribute to improving livelihoods for poor people?
- If so, **Which** technologies should be favoured, **How** should they be promoted, **Who** should be targeted (artisanal, small/medium/large scale)?
- Position the concept of sustainability within the concept of aquaculture dev/food security

Fish is important in household food and nutrition security

- Fish is important in the diets of the poor throughout much of Asia and Africa forming a high proportion of animal source food intake
- Fish is an excellent source of micronutrients, essential fatty acids and animal protein
- **Our recommendation is that fish in general and aquaculture in particular be incorporated into food and nutrition security policies, strategies and programs**
- Need to change intra household distribution of fish through education(children/pregnant women)

Aquaculture can be an important driver of economic growth, sufficient to reduce poverty

- Aquaculture creates wealth & reduces income disparities (Fisheries and aquaculture employ **over 550m** people -directly and indirectly, **Kenya 1.1m** employed (directly/indirectly))
- The contribution of aquaculture to national GDP excluding multiplier effect (up to 1%)
- **Profits from fish farming and related activities are often spent locally contributing to rural non-farm economic growth**

Aquaculture can be a development option for the poor and socially marginalized

- Poor people(those with least income and assets) are particularly vulnerable to external shocks. **They are able to benefit from aquaculture as employees or producers**
- **Poor consumers purchase more fish when available** and it meets their needs in terms of price and culturally determined preferences
- **THEREFORE** Strong case for aquaculture to be considered as part of national economic development strategies

Access and **value** chain efficiency

- **Economic access increases** when farmed fish is **cheaper**, the result of **increased production** and productivity and of more efficient value chains

Aquaculture **value chain actors** consume more of the fish they produce or trade and/or spend more aquaculture derived income buying fish

THANK YOU

- **More fish means lower prices and greater access** (not guaranteed if production is concentrated amongst a small number of large scale producers OR if the fish is destined for export).
- Small holders should be assisted to drive the growth in aquaculture production, small holders to work in clusters in order to share risks and increase their empowerment

- **Greater impact on food and nutrition security will depend on**
 - type of fish** (Nile tilapia and catfish- omnivores, easy to culture, ready market ?)
 - size of fish for sale** (bigger fish fetch higher prices but take longer to attain the size therefore more expensive. Small fish cheaper, market segment is larger. Rural and urban poor normally consume low quality, cheap fish and lots of dried and fermented fish(cf Study in Bangladesh and Nigeria -intra household consumption pattern)

Access to inputs and technical know-how and education

- Markets for aquaculture produce are strong and growing and its contribution to reducing poverty and hunger can be maximized if essential inputs are available and appropriate **policies, technologies** and **entrepreneurial skills** are in place
- Need for improved **access to information on fish, nutrition and health** through **integration of nutrition education with aquaculture programs (fairs, fish festivals, media-based campaigns)**

Aquaculture can empower women and improve household nutrition

- Important to explicitly include women in aquaculture initiatives and to identify mechanisms to effectively address social and cultural norms including workload sharing
- **Policy guidelines on gender in aquaculture within the Code of Conduct on Responsible Fisheries**

Aquaculture sustainability depends on good governance

- Governance encompasses institutions, **policies, legislations,** and **processes**- Government should assess policies, interventions and investments with direct and indirect links to aquaculture to ensure positive impacts
- Aquaculture developments must assure **ecological sustainability**

Sustained uptake of aquaculture depends on technical and business skills and strong market linkages

- Aquaculture is normally most prevalent in communities where there are both **indigenous technological knowledge and skills and resources** for aquaculture to help fulfill livelihood ambitions
- Households adopting aquaculture **assess costs and benefits versus other livelihood options (crop or livestock farming, off-farm employment)** especially when **subsidies are removed**.
- Groups, cooperatives, and clusters facilitating connections to markets help sustain uptake

Aquaculture must change if it is to appeal to the youth

- The average age of fish farmers is above 40 yrs as most youths seek better paid and less physically demanding employment
- Solution is to make aquaculture more profitable and less labor intensive through farming **genetically improved strains** of higher value species, use of **quality seed** and more environmentally friendly, high **quality and affordable feed**, and **better management**.