REDUCING DEPENDENCE ON FISHMEAL IN AQUACULTURE

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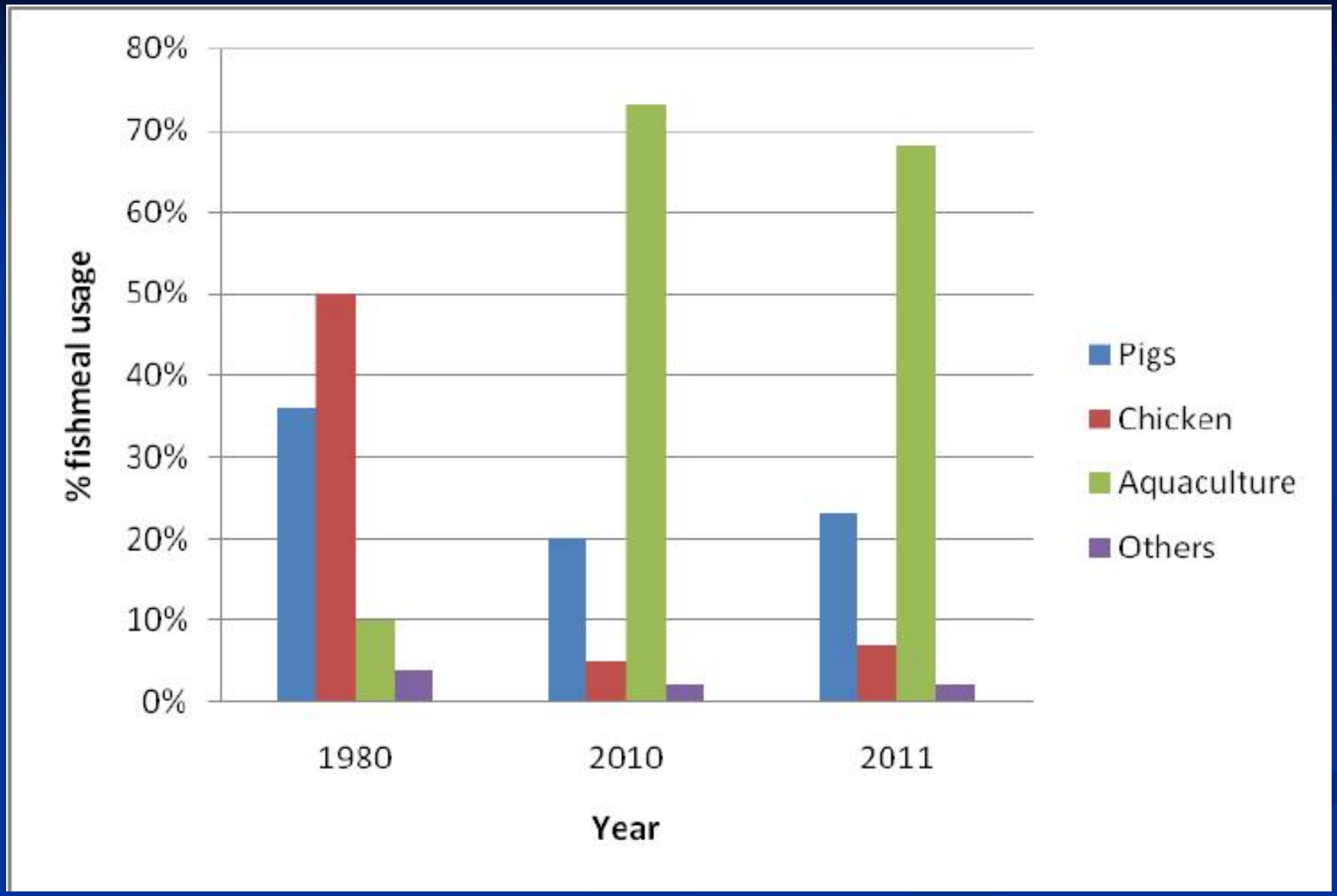
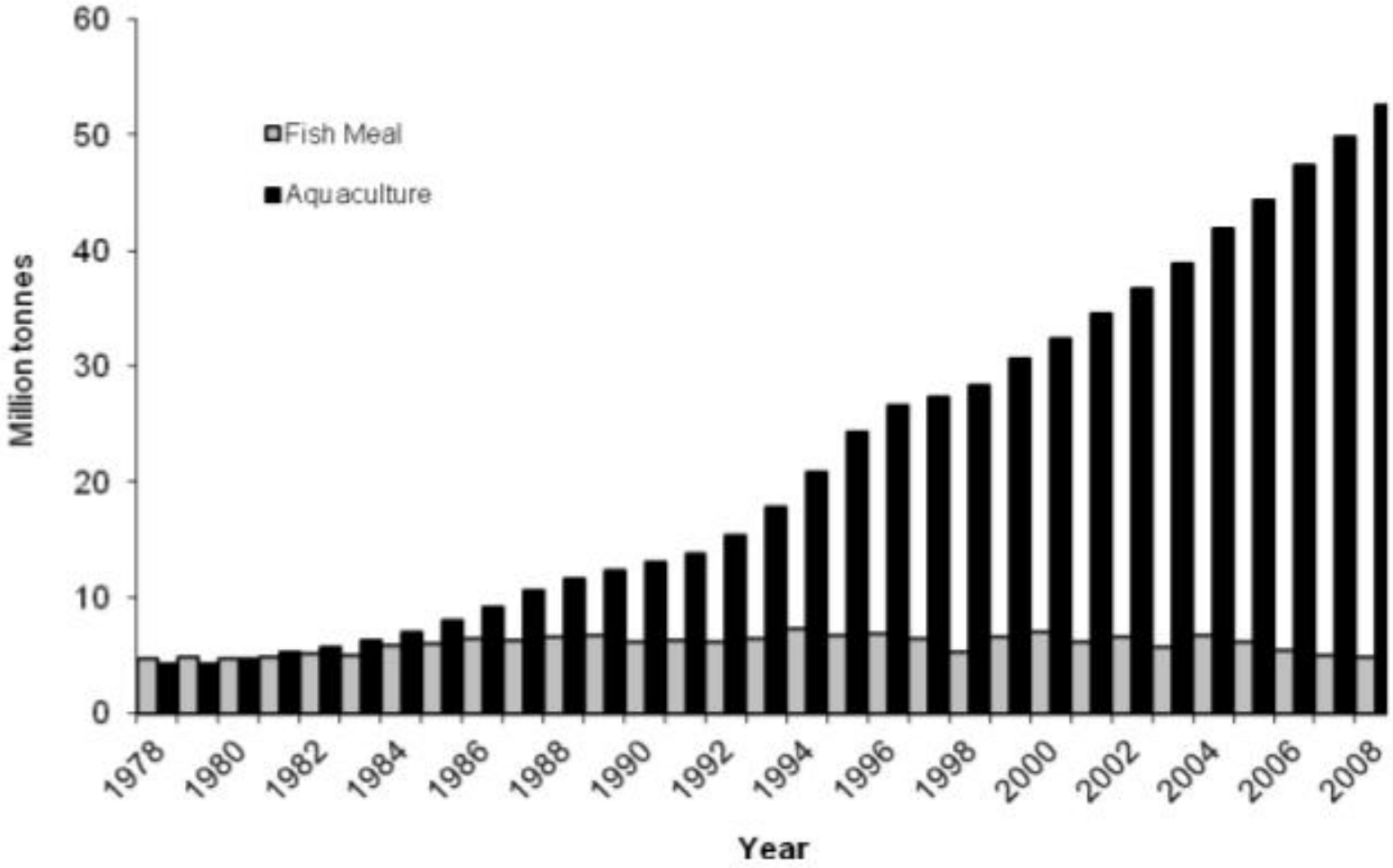
Thank you, World Ocean Forum for the invitation to participate

and thanks to my excellent colleagues Remedios Bolivar and Mokarrom Hossain


80%
70%
60%
50%
40%
30%
20%
10%
0%
% fishmeal usage
1980
2010
2011
Year
Pigs
Chicken
Aquaculture
Others

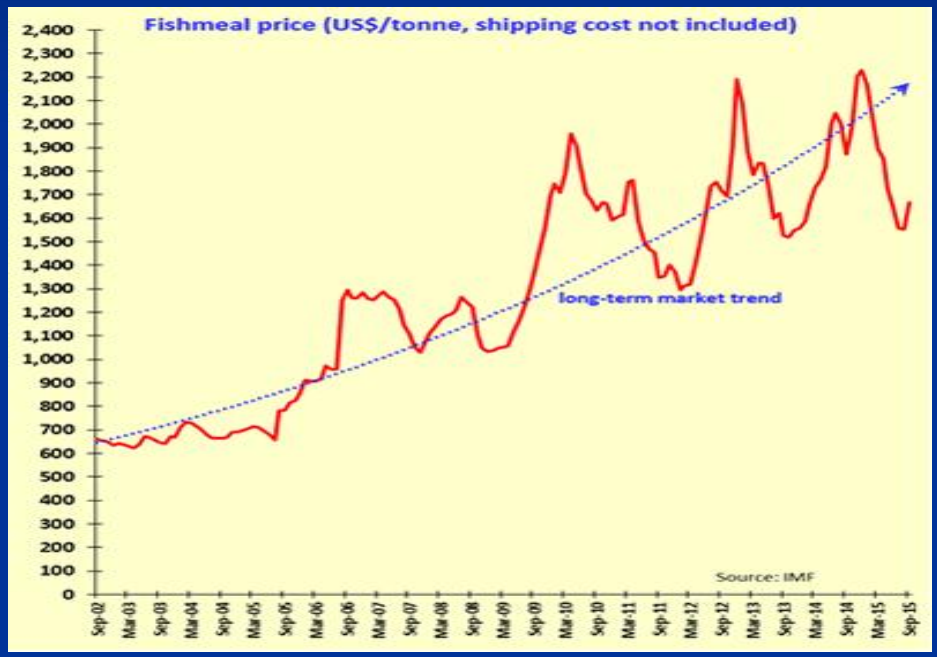


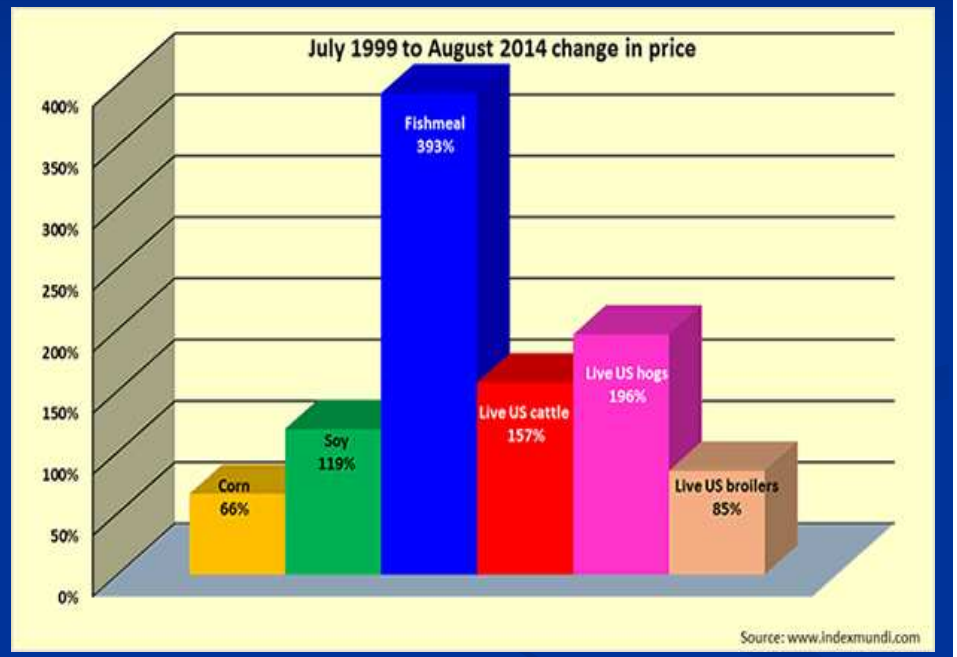
source: OECD, "Green Growth in Fisheries and Aquaculture Production and Trade"

seen on www.knowtheflow.com

fishmeal-based feeds

environmentally and
economically unsustainable





Indexmundi data

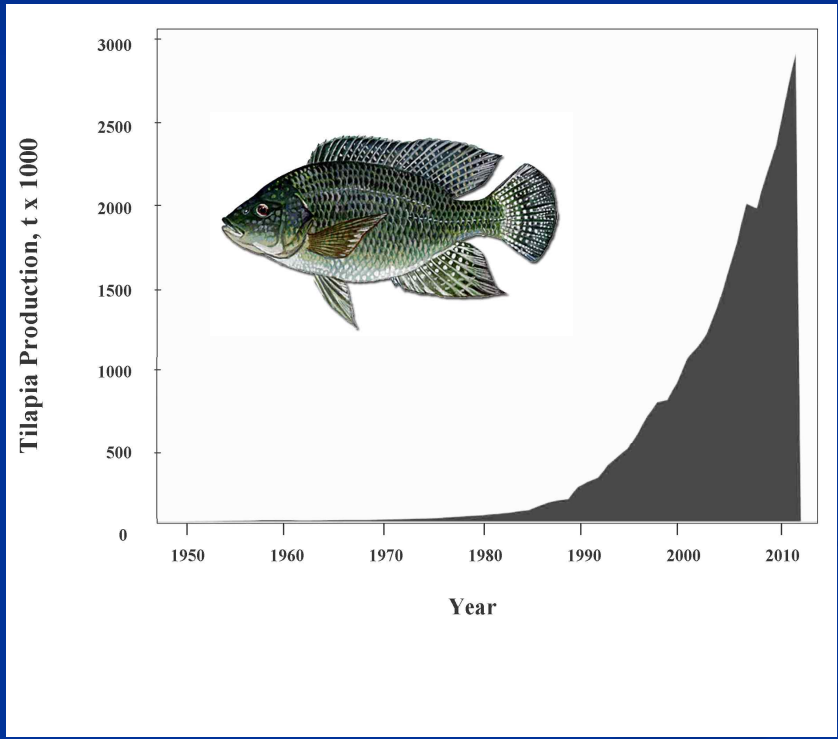
Major species [edit]

Top 15 cultured fish species by weight in millions of tonnes, according to FAO statistics for 2013 [1]			
Species	**Environment**	**Tonnage (millions)**	**Value (US$, billion)**
Grass carp	freshwater	5.23	6.69
Silver carp	freshwater	4.59	6.13
Common carp	freshwater	3.76	5.19
Nile tilapia	freshwater	3.26	5.39
Bighead carp	freshwater	2.90	3.72
Catla (Indian carp)	freshwater	2.76	5.49
Crucian carp	freshwater	2.45	2.67
Atlantic salmon	marine	2.07	10.10
Roho labeo	freshwater	1.57	2.54
Milkfish	freshwater	0.94	1.71
Rainbow trout	freshwater, brackish, marine	0.88	3.80
Wuchang bream	freshwater	0.71	1.16
Black carp	freshwater	0.50	1.15
Northern snakehead	freshwater	0.48	0.59
Amur catfish	freshwater	0.41	0.55

See also: List of commercially important fish species

world Nile tilapia production

Omnivorous but frequently mass-cultured
with fishmeal-based feeds



FAO data; from Brown et al. (2014)

Farm Budget –Tilapia Pond Culture in the Philippines (P/ha/yr)*

Gross Income (P)		643,854
Less: Cash Cost		
Fingerlings	37,801	
Feeds	262,400	
Fertilizers	5,417	
Diesel	42,652	
Hired Labor	19,718	
Non-cash Cost	49,088	
Total Cost		417,076
Net Income		226,778
Price/kg (P)	40	
Cost/kg (P)	26	
Profit Margin	35%	

63%

* P = Philippine pesoes

Semi-intensive tilapia culture in the Philippines

- Increased production
- dependence on commercial, often fishmeal-based feeds
  - 60-70% of production cost is due to feed cost

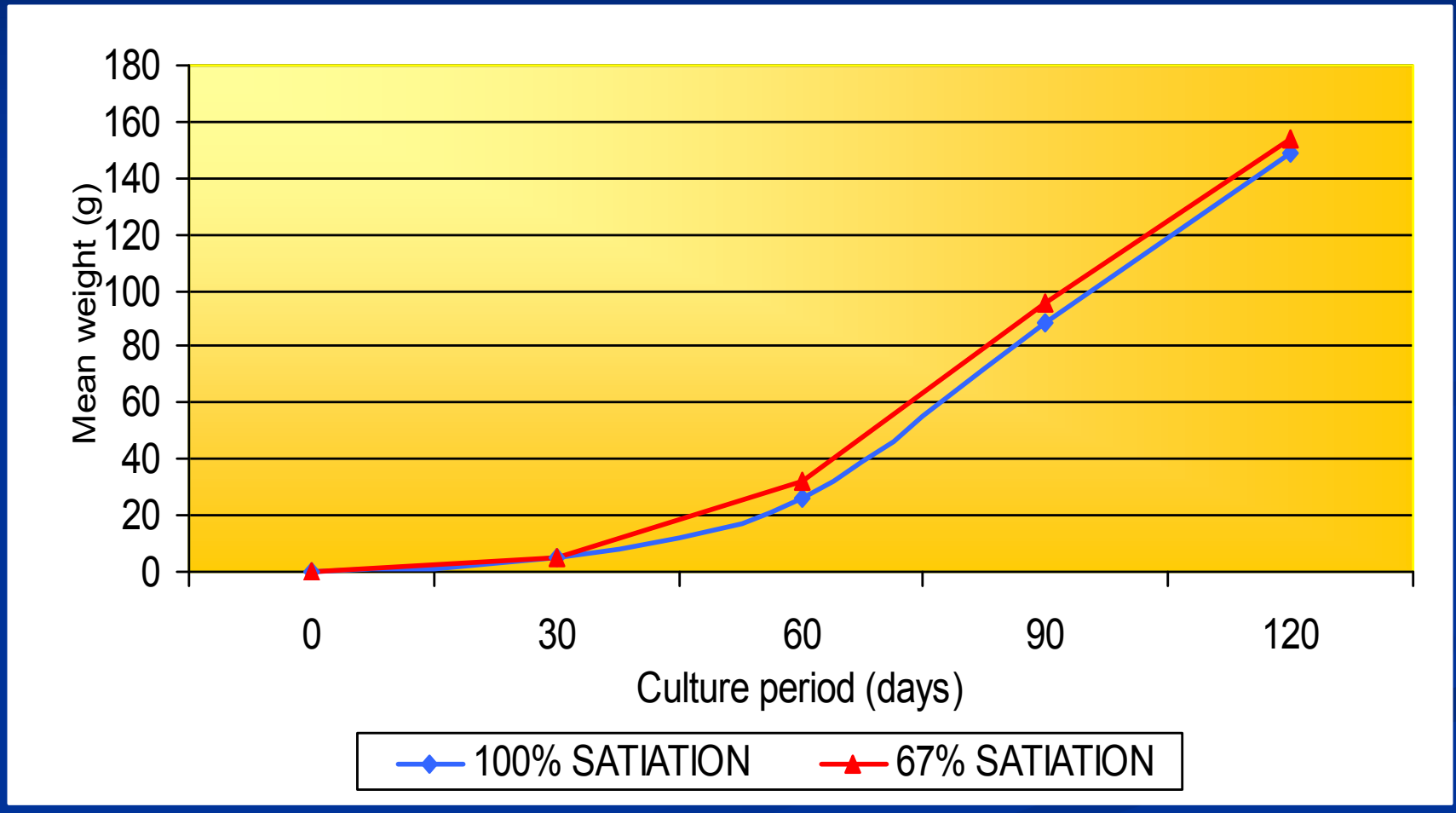
Production methods emphasizing reduced feeding

I. Delayed feeding onset
II. Sub-satiation feeding
III. Combined delayed feeding onset + sub-satiation feeding
IV. Alternate day feeding strategy

II. Sub-satiation Feeding Strategy

- Tilapia were fed at 100% satiation and 67% satiation levels with initial feeding at 45 days

Mean weight of Nile tilapia in ponds at two satiation levels



On-farm mean growth performance of Nile tilapia at two satiation levels

Performance	100%	67%
Final Mean Weight (g)	149.0 ± 45	154.0 ± 26
Mean Daily Weight Gain (g day^{-1})	1.24 ± 0.38	1.28 ± 0.22
Extrapolated Gross Yield (kg ha^{-1})	3,136 ± 1,149	3,575 ± 1,257
FCR	3.41 ± 1.60	2.39 ± 1.10
Survival (%)	57 ± 22	65 ± 20
Quantity of feeds (kg ha^{-1})	9,396 ± 2086	7,554 ± 1741

Partial budget analysis

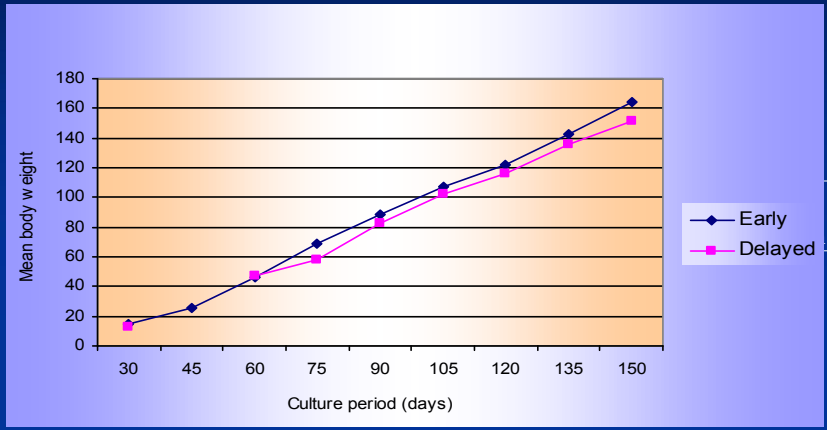
INCOME (SELLING FISH)	100% satiation, 45 day onset P 158,256.50	67% satiation, 45 day onset P 177,969.50
COSTS		
Fingerlings	16,800.00	16,800.00
Feeds	112,752.00	90,651.00
Diesel & oil	2,200.00	2,200.00
Fertilizers	6,314.00	6,282.00
Electricity	1,000.00	1,000.00
Labor	9,750.00	9,750.00
PROFIT	**P 9,440.50**	**P 51,286.50**

IV. Alternate Day Feeding Strategy

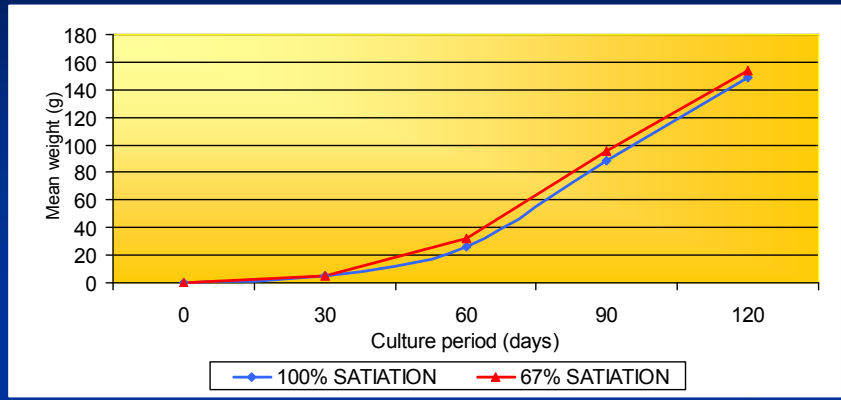
- Alternate day feeding strategy was compared with daily feeding to determine the effects on growth rate, survival, yield, and net profit.

Sun	*Mon*	*Tue*	*Wed*	*Thu*	*Fri*	*Sat*
	~~1~~	2	~~3~~	4	~~5~~	6
~~7~~	8	~~9~~	10	~~11~~	12	~~13~~
14	~~15~~	16	~~17~~	18	~~19~~	20
~~21~~	22	~~23~~	24	~~25~~	26	~~27~~
28	~~29~~	30	~~31~~			

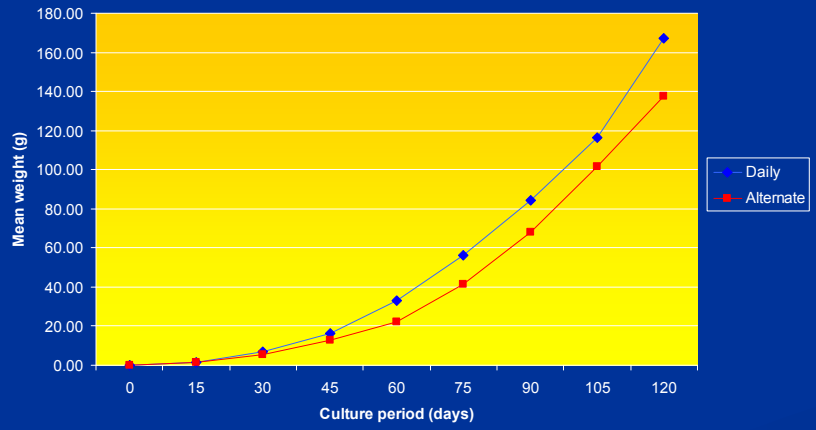
Comparative growout



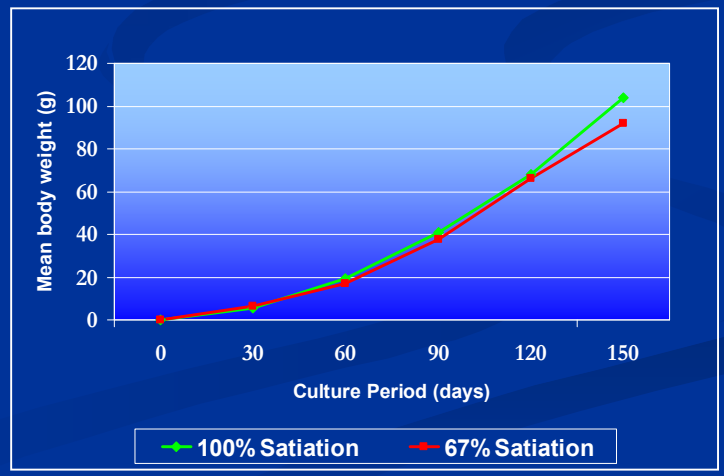
Delayed onset – 5 mo



Sub-Satiation – 4 mo



Alternate days – 4 mo



Delayed onset + SS – 5 mo

On-farm mean growth performance of Nile tilapia fed daily and on alternate day

Performance	Daily	Alternate day
Final Mean Weight (g)	167.35 ± 53	137.79 ± 72
Mean Daily Weight Gain (g day^{-1})	1.39 ± 0.44	1.15 ± 0.60
Extrapolated Gross Yield (kg ha^{-1})	2,994 ± 808	2,807 ± 857
FCR*	2.2 ± 0.73	1.0 ± 0.34
Survival (%)	55.34 ± 20	63.42 ± 26
Quantity of feeds (kg ha^{-1})*	6,331 ± 1,088	2,689 ± 601

Partial budget analysis

INCOME (SELLING FISH)	Daily P 136,534.00	Alternate Days P 120,920.00
COSTS		
Fingerlings	19,600.00	19,600.00
Feeds	110,722.00	48,197.00
Diesel & oil	2,500.00	2,500.00
Fertilizers	8,454.00	8,454.00
Electricity	1,200.00	1,200.00
Labor	18,000.00	9,000.00
PROFIT	**-(P 23,942.00)**	**P 31,969.00**

Conclusions

- Alternate day feeding reduces production costs by approximately 50%.
- The cost savings was not accompanied by any significant reduction in production.
- feed utilization is clean and efficient when tilapia feed on the plankton pool.
- Alternate day, delayed onset and sub-satiation feeding provide yields equal to controls but at a cost savings.

REPLACEMENT OF FISHMEAL WITH SUNFLOWER CAKE

Figure 1. Giant freshwater prawn (Macrobrachium rosenbergii)

experimental isonitrogenous (26% crude protein) and isocaloric diets for Nile Tilapia (*Oreochromis niloticus*)

Types of Diets	Diets for Tilapia (26% CP)*			
Ingredients	Diet-1 (Control)	Diet-2 (30% SFC)	Diet-3 (40% SFC)	Diet-4 (50% SFC)
Fish meal (chewa)	16.00	11.00	9.50	8.00
Mustard Oil Cake	15.00	9.00	7.00	5.00
Soybean Meal	15.00	8.00	7.00	5.00
Sunflower cake	0.00	30.00	40.00	50.00
Rice bran	41.00	20.30	14.80	10.30
Maize (yellow)	6.30	15.00	15.00	15.00
Vegetable oil	1.00	1.00	1.00	1.00
Wheat flour	5.00	5.00	5.00	5.00
Salt	0.50	0.50	0.50	0.50
Vitamin & mineral premix	0.20	0.20	0.20	0.20
Total	100.00	100.00	100.00	100.00

Growth performance on diets with sunflower cake (p>0.05)

	Diet-1 (Control)	Diet-2 (30% Sunflower cake)	Diet-3 (40% Sunflower cake)	Diet-4 (50% Sunflower cake)
No. of tilapia fry stocked	613	613	613	613
Survival rate (%)	71.27 ± 14.21	78.58 ± 4.52	76.89 ± 7.92	78.53 ± 6.98
Total Initial weight (g)	7,070.05 ± 3.12	7,070.05 ± 3.12	7,070.05 ± 3.12	7,070.05 ± 3.12
Total Final weight (g)	70,393.69 ± 9,674	76,166.38 ± 3,548	77,657.16 ± 1,087	71,963.50 ± 7,384
Total Weight gain (g)	63,323.64 ± 9,674	69,096.33 ± 3,550	70,587.11 ± 1,085	64,893.45 ± 7,384
% Weight gain	895.66 ± 137	977.32 ± 51	998.39 ± 15	917.86 ± 104
FCR	1.68 ± 0.44	1.47 ± 0.04	1.37 ± 0.05	1.49 ± 0.13
PER	2.00 ± 0.47	2.21 ± 0.06	2.25 ± 0.08	2.16 ± 0.19
SGR (% per day)	1.00 ± 0.06	1.03 ± 0.02	1.04 ± 0.01	1.01 ± 0.04

Growth performance on diets with sunflower cake **(p>0.05)**

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PER	2.00 ± 0.47	2.21 ± 0.06	2.25 ± 0.08	2.16 ± 0.19
SGR (% per day)	1.00 ± 0.06	1.03 ± 0.02	1.04 ± 0.01	1.01 ± 0.04

Economic efficiency of sunflower cake diets for tilapia, * Feed cost reduction per kg tilapia gain vs control Diet-1

	Diet-1 (Control)	Diet-2 (30% Sunflower cake)	Diet-3 (40% Sunflower cake)	Diet-4 (50% Sunflower cake)
Cost of Feed (BDT/kg)	38.59	33.24	32.00	30.50
FCR	1.68	1.47	1.37	1.49
Cost of feed per kg of tilapia gain	64.83	48.86	43.84	45.45
Cost reduction per kg of tilapia gain (BDT)	0.0	15.97	20.99	19.38
% cost reduction per kg gain	0.0	24.63	32.38	29.89

experimental Diets for freshwater prawn *(Macrobrachium rosenbergii)*

Types of Feed (% CP)	Feeds for freshwater Prawn (30% CP)			
Ingredients	Diet-1 (Control)	Diet-2 (30% SFC)	Diet-3 (40% SFC)	Diet-4 (50% SFC)
Fish meal (chewa)	25.00	17.50	15.00	13.00
Mustard Oil Cake	16.00	12.00	11.00	10.00
Soybean meal	16.00	12.00	10.00	8.00
Sunflower oil cake	0.00	30.00	40.00	50.00
Rice bran (auto)	31.30	15.80	11.30	6.30
Maize (yellow)	4.00	5.00	5.00	5.00
Soybean oil	1.00	1.00	1.00	1.00
Wheat flour	5.00	5.00	5.00	5.00
Salt	0.50	0.50	0.50	0.50
Lime stone	1.00	1.00	1.00	1.00
Vitamin & min. premix	0.20	0.20	0.20	0.20
Total	100.00	100.00	100.00	100.00

Growth performance of juvenile prawns fed with different level of sunflower cake (p>0.05)

Parameter	Diet-1 (Control)	Diet-2 (30% Sunflower cake)	Diet-3 (40% Sunflower cake)	Diet-4 (50% Sunflower cake)
No. of Juvenile stocked	297	297	297	297
Survival rate (%)	92.42 ± 2.58	94.48 ± 3.79	92.80 ± 4.00	94.18 ± 3.28
Total initial weight (g)	754.70 ± 0.55	755.27 ± 0.77	755.72 ± 0.01	754.83 ± 0.78
Total final weight (g)	10005.78 ± 885.48	11168.14 ± 1037.75	10726.68 ± 776.11	11343.26 ± 1247.23
% Weight gain	1225.85 ± 118.17	1378.73 ± 137.87	1319.41 ± 102.71	1402.77 ± 165.44
SGR (% per day)	1.12 ± 0.04	1.17 ± 0.04	1.15 ± 0.03	1.18 ± 0.05
FCR	2.79 ± 0.14	2.68 ± 0.20	2.75 ± 0.07	2.56 ± 0.24
PER	1.03 ± 0.05	1.11 ± 0.08	1.06±0.03	1.14±0.10

economic efficiency of sunflower cake diets vs. control for prawn grow-out; BDT (Bangladeshi currency) 78 = $1 US

Parameters	Diet-1 (Control)	Diet-2 (30% Sunflower cake)	Diet-3 (40% Sunflower cake)	Diet-4 (50% Sunflower cake)
Cost of feed (BDT*/kg)	43.68	38.27	36.34	34.68
FCR	2.79	2.68	2.75	2.56
Cost of feed per kg prawn gain	121.87	102.56	99.94	88.78
Cost reduction per kg prawn gain (BDT)	0.0	19.31	21.93	33.09
% cost reduction per kg gain	0.0	15.84	17.99	27.15

Funding for this research was provided by the

Aquaculture CRSP
now called AquaFish CRSP
(Collaborative Research Support Program)

The Aquaculture CRSP is funded in part by United States Agency for International Development (USAID) Grant No. LAG-G-00-96-90015-00 and by participating institutions.