

TABLE 26
Feed application methods by type of feed and category of respondents

Type of feed/application method	Intensive		Semi-intensive		Traditional		All categories	
	No.	%	No.	%	No.	%	No.	%
A. Manufactured pelleted feed								
1. Broadcasting	1	5	6	30	5	25	12	20
2. Feeding tray	0	0	0	0	0	0	0	0
3. Feeding bag	1	5	0	0	0	0	1	2
4. Feeding frame	0	0	1	5	0	0	1	2
5. Automatic feeding	15	75	0	0	0	0	15	25
Total	17	85	7	35	5	25	29	49
B. Pelleted cottage fish feed								
1. Broadcasting	0	0	2	10	2	10	4	7
2. Feeding tray	0	0	0	0	0	0	0	0
3. Feeding bag	0	0	0	0	0	0	0	0
4. Feeding frame	0	0	0	0	0	0	0	0
5. Automatic feeding	1	5	2	10	0	0	3	5
Total	1	5	4	20	2	10	7	12
C. Farm-made aquafeed								
1. Broadcasting	1	5	4	20	2	10	7	12
2. Feeding tray	0	0	0	0	0	0	0	0
3. Feeding bag	0	0	0	0	0	0	0	0
4. Feeding frame	0	0	0	0	0	0	0	0
5. Automatic feeding	0	0	0	0	0	0	0	0
Total	1	5	4	20	2	10	7	12
D. Supplementary feed								
1. Broadcasting	1	5	1	5	1	5	3	5
2. Feeding tray		0	0	0	0	0	0	0
3. Feeding bag	0	0	0	0	0	0	0	0
4. Feeding frame	1	5	3	15	2	10	6	10
5. Automatic feeding	0	0	0	0	0	0	0	0
Total	2	10	4	20	3	15	9	15
E. Pelleted animal feed								
1. Broadcasting	1	5	5	25	3	15	9	15
2. Feeding tray	0	0	0	0	0	0	0	0
3. Feeding bag	0	0	0	0	0	0	0	0
4. Feeding frame	0	0	0	0	0	0	0	0
5. Automatic feeding	0	0	0	0	0	0	0	0
Total	1	5	5	25	3	15	9	15

TABLE 27
Average purchase and depreciation values of fixed investment by type and category of respondents (US\$/ha)

Item	Intensive		Semi-intensive		Traditional		All categories	
	Purchase value (US\$)	Depreciation (US\$)						
A. Buildings	695	39	353	23	357	20.0	469	27
B. Truck/pick-up	198	14	26	2.5	10	1.0	78	6
C. Aerator*	296	27	186	15	32	4.0	171	15
D. Feeding machine	242	24	0	0	0	0.0	81	8
E. Pumps	215	18	126	10	29	2.0	123	10
F. Others	54	5	10	1	2	0.1	22	2
Total	1 700	126	701	52	430	27	944	68

*Few traditional farmers use aerators in grass carp pond because of the high stocking density used, and feed only with grasses.

TABLE 28
Average quantity of human labour by type of operation and category of respondents (man day/ha/year)

Type of operation	Intensive			Semi-intensive			Traditional			All categories		
	Hired	Family	Total	Hired	Family	Total	Hired	Family	Total	Hired	Family	Total
A. Pre-stocking	99.0	32.3	131.3	123.0	31.5	154.5	50.3	34.5	84.8	90.8	32.8	123.5
B. Stocking/ release of fingerling	93.8	33.0	126.8	28.5	31.5	60.0	33.0	32.3	65.3	51.8	32.3	84.0
C. Post-stocking	111.0	92.3	203.3	57.0	85.5	142.5	69.8	91.5	161.3	79.3	89.8	169.0
All operations	303.8	157.5	461.3	208.5	148.5	357.0	153.0	158.3	311.3	221.8	154.8	376.5

TABLE 29
Average cost of human labour by type of operation and category of respondents (US\$/ha/year)

Type of operation	Intensive			Semi-intensive			Traditional			All categories		
	Hired	Family	Total	Hired	Family	Total	Hired	Family	Total	Hired	Family	Total
A. Pre-stocking	413	132	545	532	139	671	232	169	401	392	147	539
B. Stocking/release of fingerling	390	128	518	133	153	286	163	159	322	229	147	376
C. Post-stocking	551	448	1 000	270	417	687	300	393	693	374	420	794
All operations	1 355	709	2 064	935	709	1 644	696	721	1 417	995	713	1 708

TABLE 30
Average cost (US\$/ha/year) of inorganic and organic fertilizers by type of fertilizers and category of respondents

Type of fertilizer	Intensive	Semi-intensive	Traditional	All categories
A. Inorganic				
1. Urea (nitrogen)	3.48	4.69	0.15	2.77
2. TSP (phosphate)	4.15	1.69	0.86	2.23
3. MP (potash)	-	-	-	-
4. DAP (potash)	-	-	-	-
5. Others	3.52	-	-	1.17
All inorganic	11.14	6.38	1.01	6.18
B. Organic				
1. Dung	-	-	-	-
2. Compost	7.03	2.08	0.70	3.27
All organic	7.03	2.08	0.70	3.27
All fertilizers	18.17	8.46	1.71	9.45

Compost was the most common organic fertilizer. The costs of organic fertilizer in intensive, semi-intensive and traditional fish farms were estimated at US\$7.03/ha/year, US\$2.08/ha/year, and US\$0.70/ha/year, respectively (Table 30).

Cost of seeds

Fingerling stocking density and cost differs for each farming system. The average stocking amount was very high because the farms applied multi-harvest and multi-stocking strategies in both intensive and semi-intensive fish farms. Different stocking models also had different costs due to the difference in prices for the different species.

Intensive fish farms had the highest stocking quantity (49 295 pieces/ha/year) and costs (US\$4 243/ha/year). This was followed by semi-intensive and traditional fish farms applying 34 661 pieces/ha (US\$2 946/ha/year), and 27 424 pieces/ha (US\$1 802/ha/year) (Table 31).

TABLE 31
Number and cost of fish seed by type and category of respondents (No. of fish/ha; US\$/ha)

Species	Intensive		Semi-intensive		Traditional		All categories	
	Number	Cost	Number	Cost	Number	Cost	Number	Cost
1. Silver carp	15 653	442	5 652	615	7 285	415	9 530	491
2. Bighead carp	2 393	364	2 160	237	1 365	141	1 973	247
3. Grass carp	10 678	1 705	5 323	968	4 553	574	6 851	1 082
4. Black carp	752	351	541	224	441	109	578	228
5. Crucian carp	14 604	861	16 966	648	11 039	353	14 203	621
6. Wuchang bream	3 145	264	2 604	175	2 689	134	2 813	191
7. Other fishes	2 068	257	1 414	79	53	77	1 178	138
Total	49 295	4 243	34 661	2 946	27 424	1 802	37 126	2 997

Cost of feeds

Feed costs varied between fish farm systems. The feeding strategies adopted by intensive fish farms was generally characterized by using pellet feeds, while semi-intensive fish farms and traditional fish farms were partial users of pellet feeds, combined with some low value supplementary feeds. The cost of pelleted feeds in intensive, semi-intensive and traditional fish farms were US\$2 872.8/ha, US\$800.6/ha and US\$11.3/ha per year, respectively. Supplementary feed costs for intensive, semi-intensive and traditional fish farms were US\$678.6/ha/year, US\$560.8/ha/year and US\$400.6/ha/year respectively. Traditional fish farms incurred lowest supplementary feed costs than intensive and semi-intensive fish farms.

The total feed cost picture revealed that it was highest among intensive fish farms at US\$3 551/ha, followed by semi-intensive fish farms and traditional fish farms with US\$1 361/ha/year and US\$412/ha/year respectively (Table 33).

While intensive farms consumed more commercial pellets in their fish farming operations, semi-intensive fish farms applied partial commercial pellets and some farms used farm-made feeds to reduce costs. Supplementary feeds mainly include rice bran, wheat, oil cakes, soybean meal and grasses. These type of feeds are locally available at lower prices.

The study noted that snails were fed to black carps while silkworm meal was also used as supplementary feeds in some farms (Table 33).

Other variable costs

Staff salaries, electricity, office supplies, rent and drugs were reported as other variable costs. The average total other variable cost of intensive fish farms were estimated at US\$963/ha. Semi-intensive and traditional fish farms incurred costs of US\$483/ha and US\$179/ha, respectively (Table 34).

Staff salaries were the highest in intensive fish farms at US\$166/ha, relative to semi-intensive fish farms and traditional fish farms which were valued at US\$33/ha and US\$6/ha, respectively. The cost of drugs in semi-intensive fish farms were reported as the highest US\$81/ha compared with intensive fish farms and traditional fish farms of US\$47/ha and US\$26/ha, respectively.

3.5.3 Total costs

The total costs of traditional, semi-intensive and intensive fish farms were US\$3 839/ha/year, US\$6 494/ha/year, and US\$10 967/ha/year respectively. Variable costs accounted for 99 percent of the total costs in each category. Fixed costs accounted for a very small percentage (1.1 percent, 0.8 percent, 0.7 percent in intensive, semi-intensive and traditional fish farms respectively). Intensive fish farms had the highest total costs in fish production (Table 35).

TABLE 32
Average cost (US\$/ha) of fingerlings by type of species and category of respondents

Stocking/species	Intensive	Semi-intensive	Traditional	All categories
A. First stocking				
1. Silver carp	423	610	411	482
2. Bighead carp	320	237	141	233
3. Grass carp	1 616	957	574	1 049
4. Black carp	351	224	109	228
5. Crucian carp	837	646	352	612
6. Wuchang bream	225	175	134	178
7. Other fishes	257	79	77	138
All species	4 029	2 927	1 797	2 918
B. Second stocking				
1. Silver carp	18	6	4	9
2. Bighead carp	44	-	-	15
3. Grass carp	89	11	-	33
4. Black carp	-	-	-	-
5. Crucian carp	23	3	2	9
6. Wuchang bream	39	-	-	13
7. Other fishes	-	-	-	-
All species	213	20	6	79
C. All stocking				
1. Silver carp	442	615	415	491
2. Bighead carp	364	237	141	247
3. Grass carp	1 705	968	574	1 082
4. Black carp	351	224	109	228
5. Crucian carp	861	648	353	621
6. Wuchang bream	264	175	134	191
7. Other fishes	257	79	77	138
All species	4 243	2 946	1 802	2 997

TABLE 33
Average cost of feeds by type of feed and category of respondents (US\$/ha/year)

Type of feeds	Intensive	Semi-intensive	Traditional	All categories
A. Commercially manufactured pellets	2 872.8	714.9	-	1 195.9
B. Farm-made pellets	-	85.7	11.3	32.3
Subtotal	2 872.8	800.6	11.3	1 228.2
C. Supplementary feeds				
1. Rice bran	58.5	87.2	11.3	52.3
2. Wheat bran/flour	238.2	91.9	86.2	138.8
3. Pulse bran	-	-	-	-
4. Oil cakes	178.4	189.7	105.4	157.8
5. Fishmeal	-	-	-	-
6. Bone meal	-	-	-	-
7. Soybean meal	64.7	13.1		25.9
8. Aquatic plants/green grass	101.3	47.1	139.8	96.0
9. Slaughter waste		38.7	24.4	21.0
10. Snail meat	37.5	74.4	19.5	43.8
11. Worm meal	0.0	18.8	14.1	10.9
12. Others (specify)	-	-	-	-
Subtotal	678.6	560.8	400.6	546.7
All feed types	3 551.4	1 361.4	411.8	1 774.9

TABLE 34
Other variable costs by type and by category of respondents (US\$/ha/year)

Item	Intensive	Semi-intensive	Traditional	All categories
1. Staff salary	166	33	6	69
2. Electricity	252	99	25	125
3. Office supplies	62	7	-	23
4. Rent	435	261	123	273
5. Drugs	47	81	26	51
Total	963	483	179	542

Fry/fingerling/seed costs were the highest cost item among all farm groups (Figure 8). The percentage of seed cost to total cost were 39 percent, 45 percent and 47 percent for intensive, semi-intensive and traditional fish farms respectively.

Feed costs account for 32 percent, 21 percent and 11 percent of total costs in intensive, semi-intensive and traditional fish farms respectively. In three categories, intensive fish farms have the highest percentage of feed costs.

Labour costs were highest in traditional systems (37 percent), followed by semi-intensive (25 percent) and intensive (19 percent) (Table 35).

TABLE 35
Total costs by item and by category of respondents

Item	Intensive		Semi-intensive		Traditional		All categories	
	Amount/ ha/year (US\$)	%	Amount/ ha/ year (US\$)	%	Amount/ ha/ year (US\$)	%	Amount/ ha/ year (US\$)	%
A Variable costs								
1. Labour cost	2 064	18.8	1 644	25.3	1 417	36.9	1 708	24.1
2. Fertilizers	18	0.2	8	0.1	2	0.0	9	0.1
3. Fry/fingerlings	4 243	38.7	2 946	45.4	1 802	47.0	2 997	42.2
4. Feeds	3 551	32.4	1 361	21.0	412	10.7	1 775	25.0
5. Other variable costs	963	8.8	483	7.4	179	4.7	542	7.6
Subtotal	10 840	98.8	6 443	99.2	3 812	99.3	7 032	99.0
B Material input*	8 776	80.0	4 799	73.9	2 395	62.4	5 323	75.0
C Depreciated fixed costs	126	1.1	51	0.8	27	0.7	68	1.0
Total	10 967	100	6 494	100	3 839	100	7 100	100

*Material input costs =total variable costs - labour cost

3.6 Comparative analysis of farm income

3.6.1 Gross revenue

Intensive, semi-intensive and traditional fish farms recorded gross revenues of US\$14 800/ha/year, US\$8 429/ha/year and US\$5 261/ha/year, respectively. The average gross revenue of all categories was US\$9 498/ha/year (Table 36). As expected, intensive fish farms registered the highest gross revenue while traditional fish farms, the lowest (Figure 9).

Gross margin

Intensive fish farms had the highest gross margin of US\$3 960/ha/year, semi-intensive fish farms and traditional fish farms had lower gross margins of US\$1 986/ha/year and US\$1 449/ha/year respectively. All fish farms were able to realize profits, regardless of category. The average gross margin of fish farms was US\$2 466/ha/year (Table 37). This figure was almost double the average gross margin obtained from agricultural crop production (about US\$1 000/ha/year) in Jiangsu province (Anon., 2006a).

3.6.2 Net margin/return

The average net margin was recorded at US\$2 398/ha/year. The net margins for intensive, semi-intensive and traditional fish farms were estimated at US\$3 834/ha/year

US\$1 935/ha/year and US\$1 422/ha/year respectively (Table 37). Intensive fish farms had the highest net margins in fish farming.

TABLE 36
Annual gross revenues per hectare (US\$) by harvest and species and by category of respondents

Type of operation	Intensive	Semi-intensive	Traditional	All categories
A. First harvest				
1. Silver carp	2 333	904	1 271	1 502
2. Bighead carp	1 090	289	818	732
3. Grass carp	3 354	2 518	1 315	2 396
4. Black carp	870	1 025	216	704
5. Crucian carp	3 207	765	988	1 931
6. Wuchang bream	917	1 599	488	724
7. Others	1 230	431	165	609
All species	13 001	7 531	5 261	8 598
B. Second harvest				
1. Silver carp	101	68	0	57
2. Bighead carp	193	174	0	122
3. Grass carp	197	103	0	100
4. Black carp	619	113	0	244
5. Crucian carp	71	68	0	46
All species	1 182	527	0	569
C. Third harvest				0
1. Silver carp	39	0	0	13
2. Bighead carp	0	0	0	0
3. Grass carp	83	0	0	28
4. Black carp	82	0	0	27
5. Crucian carp	0	0	0	0
All species	204	0	0	68
D. Fourth harvest				
1. Silver carp	64	0	0	21
2. Bighead carp	160	0	0	53
3. Grass carp	0	0	0	0
4. Black carp	42	0	0	14
5. Crucian carp	0	0	0	0
All species	266	0	0	89
E. All harvest				
1. Silver carp	2 538	972	1 271	1 594
2. Bighead carp	1 443	464	818	908
3. Grass carp	3 633	2 621	1 315	2 523
4. Black carp	1 614	1 138	216	989
5. Crucian carp	3 278	833	988	1 978
6. Wuchang bream	917	1 599	488	724
7. Others	1 230	431	165	609
All species	14 653	8 058	5 261	9 324
F. Biomass carried for next year				
	146	371	0	174
All harvests	14 800	8 429	5 261	9 498

3.7 Comparative analysis of financial impacts of feeding systems

3.7.1 Benefit cost ratio/gross total factor productivity

The average benefit cost ratio (BCR) for intensive, semi-intensive and traditional fish farms were 1.35, 1.30 and 1.37 respectively (Table 37). Intensive fish farms had the lowest benefit cost ratio, while traditional fish farms, the highest.

TABLE 37
Summary of annual financial and economic indicators by category of respondents, per hectare

Item	Intensive	Semi-intensive	Traditional	All categories
A. Gross revenue (US\$)	14 800	8 429	5 261	9 498
B. Total costs (US\$)	10 967	6 494	3 839	7 100
C. Total variable costs (US\$)	10 840	6 443	3 812	7 032
D. Total fixed costs (US\$)	126	51	27	68
E. Gross margin (US\$)	3 960	1 986	1 449	2 466
F. Net margin/return (US\$)	3 833	1 935	1 422	2 398
G. Net return to land (US\$)	3 399	1 674	1 299	2 125
H. Net return to labour (US\$)	1 770	291	5	690
I. Break-even price (US\$)	0.73	0.79	0.61	0.71
J. Prevailing market price (US\$)	1.11	0.98	1.02	1.04
K. Break-even production (kg/ha)	11 085	6 891	4 132	7 369
L. Actual production (kg/ha)	38 251	16 111	9 343	21 235
M. Gross total factor productivity	1.35	1.30	1.37	1.34
N. Net total factor productivity	0.35	0.30	0.37	0.34

Total costs = variable costs + fixed cost; total variable cost = value of total aquaculture inputs (fertilizer, feeds, fingerlings, hired and family labour, electricity, and other variable costs); total fixed cost = sum of tax (fees, lease, interest and rental), repair costs of equipment, operating costs of equipment plus depreciation; gross revenue = value of total aquaculture outputs (value of home consumed fish + value of marketed fish; gross margin = gross revenue less total variable costs; net margin/return = gross revenue less total cost; net return to land = net return less land rent payment; net returns to labour = net return less cost of labour; net return to capital = net return less 10 percent of fixed investments; gross total factor productivity (benefit cost ratio, BCR) = gross revenue divided by total costs; net total factor productivity = net return divided by total costs; break-even price = total cost divided by total production; break-even production = total cost divided by average price.

3.7.2 Net returns to land

The average net returns to land for intensive, semi-intensive and traditional fish farms were estimated at US\$3 399/ha/year, US\$1 674/ha/year and US\$1 299/ha/year, respectively. Intensive fish farms had the highest return to land compared to semi-intensive and traditional fish farms, although the investment in intensive fish farms was the highest among all categories (Table 37).

3.7.3 Net returns to labour

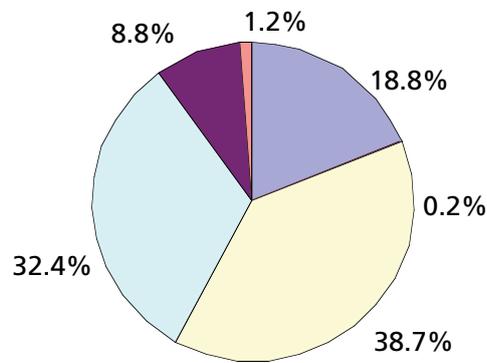
The average returns to labour for intensive, semi-intensive and traditional fish farms were estimated at US\$1 770/ha/year, US\$ 291/ha/year and US\$ 5/ha/year, respectively. Intensive fish farms had better returns to labour. The efficiency of labour use in intensive fish farms was higher than that of semi-intensive and traditional fish farms. The contributory characteristics for success were high input/proportionally higher output, the focus on fish farming compared to other activities (Table 37).

3.7.4 Break-even analysis of costs, prices and production

The average break-even price for intensive, semi-intensive and traditional fish farms were estimated at US\$0.73/kg, US\$0.79/kg and US\$0.61/kg. The average harvest

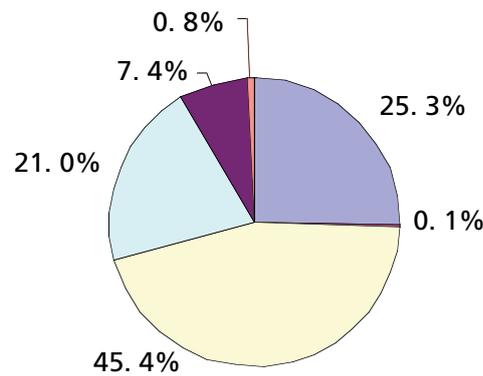
FIGURE 8
Comparison of total cost composition by category

■ Labour cost ■ Fertilizer □ Fry/fingerlings □ Feeds ■ Other variable costs ■ Fixed costs



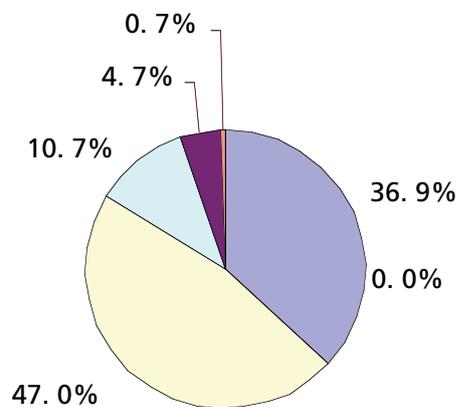
Intensive fish farm

■ Labour cost ■ Fertilizer □ Fry/fingerlings □ Feeds ■ Other variable costs ■ Fixed costs

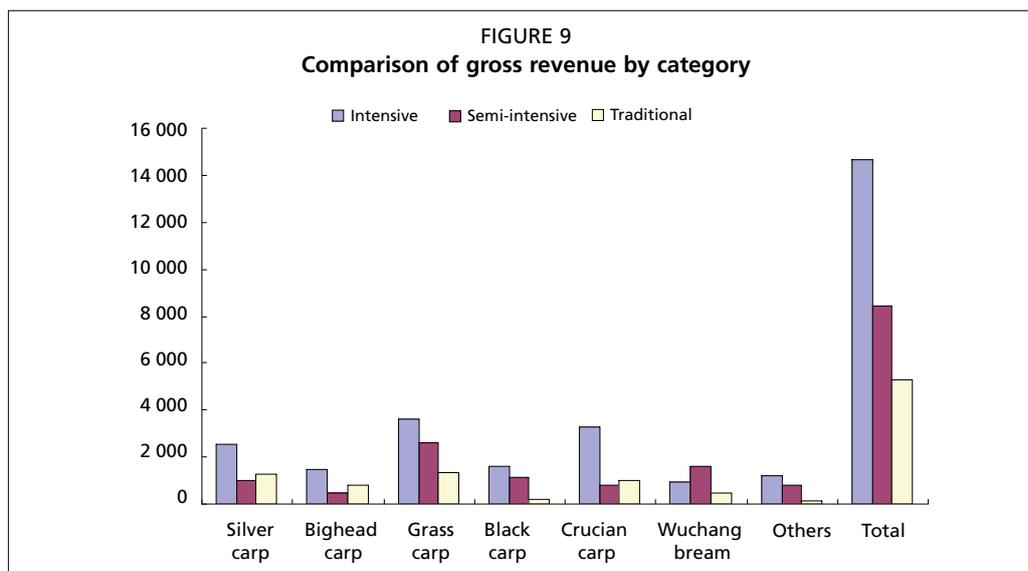


Semi-intensive fish farm

■ Labour cost ■ Fertilizer □ Fry/fingerlings □ Feeds ■ Other variable costs ■ Fixed costs



Traditional fish farm



price at pond, i.e. US\$1.11/kg (152 percent), US\$0.98/kg (124 percent) and US\$1.02/kg (167 percent) for intensive, semi-intensive and traditional fish farms respectively (Figure 10). This means that since the actual prices were higher than the estimated break-even prices, fish farmers were financially secure in their fish farming endeavors. (Table 37)

The break-even production of intensive, semi-intensive and traditional fish farms was 11 085 kg/ha/year, 6 891 kg/ha/year and 4 132 kg/ha/year. This also was lower than that of average harvest production. The actual average production were estimated at 38 251 kg/ha/year (345 percent), 16 111/kg/ha/year (233 percent) and 9 343/kg/ha/year (226 percent) for intensive, semi-intensive and traditional fish farms respectively (Figure 11). The actual production levels were higher than the break-even production levels for all farm categories. This implies that all fish farms are operating well as far as yield performances are concerned (Table 33).

3.8 Production problems

Of all fish farmer respondents, 65 percent of the fish farmers did not wish to expand their fish farming activities. Thirty five percent planned to expand fish farming in the future (Table 38). Respective percentages of 50, 45 and 10 of intensive, semi-intensive and traditional fish farmers indicated their desires to expand. The market for carp is still considered strong within China indicating a fairly prosperous future for farmers.

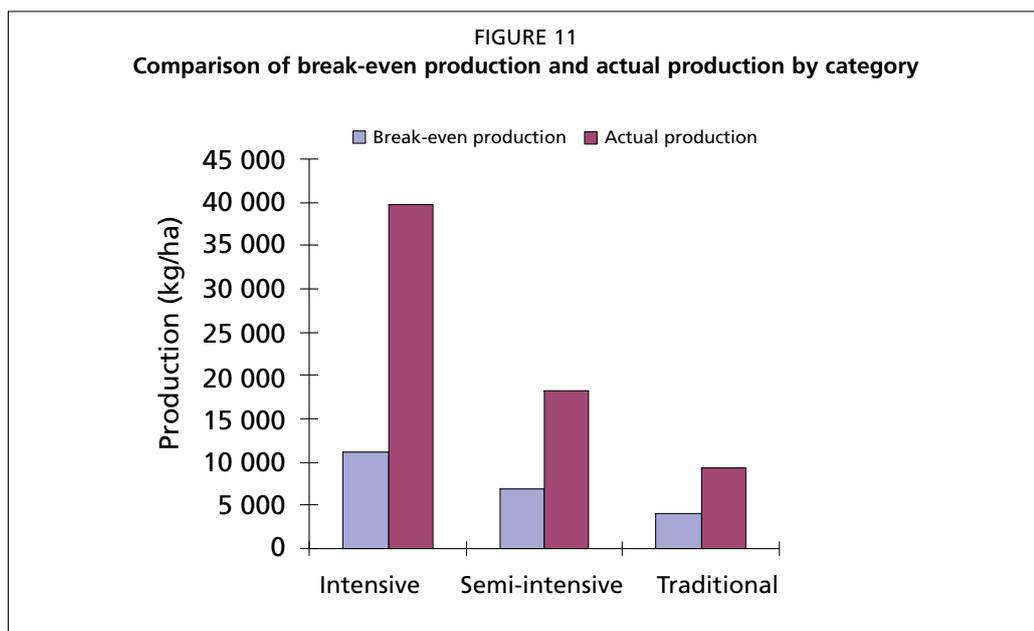
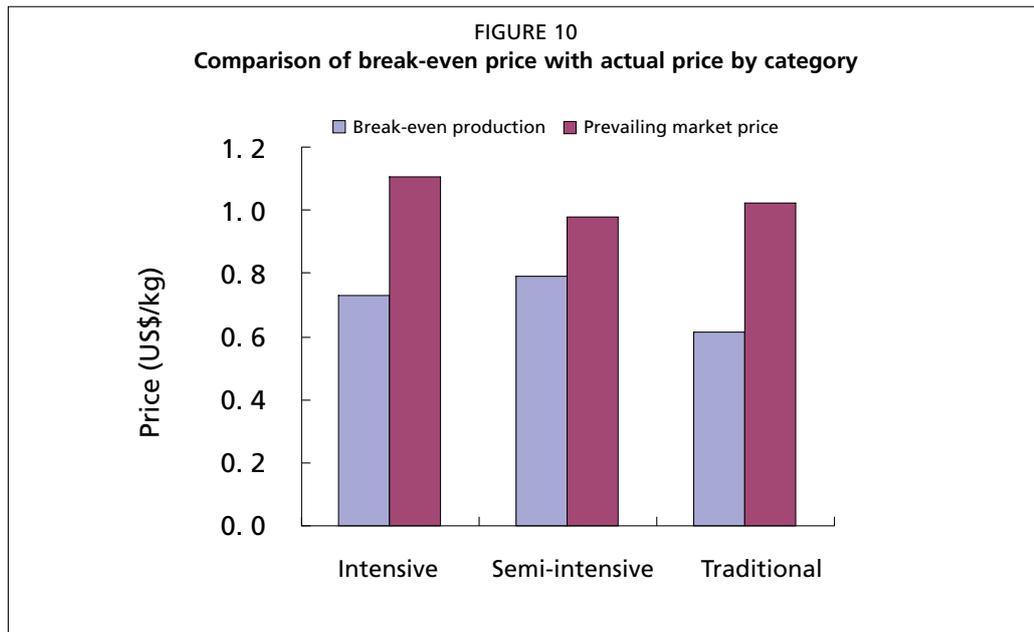
TABLE 38

Fish farmer's future production expectations by category of respondents

Seeking to expand	Intensive		Semi-intensive		Traditional		All categories	
	No.	%	No.	%	No.	%	No.	%
Yes	10	50	9	45	2	10	21	35
No	10	50	11	55	18	90	39	65
Total	20	100	20	100	20	100	60	100

3.8.1 Enabling factors to expand production

The principal enabling factors for expansion in production were improved fish disease control (25 percent), better management (23.33 percent), high quality seed supply (23.33 percent), more feed input (21.67 percent), improved stocking density (25 percent), and improved pond water quality (20 percent) (Table 39). Disease control was perceived to be a very significant issue among intensive and traditional farmers.



Semi-intensive farmers were looking to increase their usage of commercial feeds, thus changing to intensive.

TABLE 39
Enabling factors to produce more fish by category of respondents

Enabling factor	Intensive		Semi-intensive		Traditional		All categories	
	No.	%	No.	%	No.	%	No.	%
More feed	6	30	6	30	1	5	13	21.7
High stocking of fry	6	30	8	40	1	5	15	25.0
Quality of fry	7	35	6	30	1	5	14	23.3
Better management	7	35	7	35	0	0	14	23.3
Disease control	8	40	5	25	2	10	15	25.0
Improved water quality	6	30	6	30	0	0	12	20.0

3.8.2 Disabling factors to expand production

The study reveals that the factors that prevent expansion in production, included lack of money (45 percent), poor access to market facilities³ (11.67 percent), limited seed availability (6.67 percent), and a lack of knowledge (5.0 percent).

TABLE 40
Disabling factors to produce more fish by category of respondents

Disabling factor	Intensive		Semi-intensive		Traditional		All categories	
	No.	%	No.	%	No.	%	No.	%
Lack of money	7	35	7	35	13	65	27	45
Limited seed availability	1	5	3	15	0	0	4	7
Poor market facility	2	10	3	15	2	10	7	12
Limited knowledge	1	5	2	10	0	0	3	5

High prices of commercial feed were reported as a significant problem for intensive farmers. Commercial feed procurement and availability were not considered as a problem (Table 41)

TABLE 41
Problems concerning industrially manufactured pellet feeds by category of respondents

Problems	Intensive		Semi-intensive		Traditional		All categories	
	No.	%	No.	%	No.	%	No.	%
Procurement	0	0	1	5	2	10	3	5
Availability	0	0	2	10	0	0	2	3
High price	20	100	4	20	0	0	24	40
Total	20	100	7	35	2	10	29	48

Farm-made feed was not commonly applied in carp fish farms (Table 42) because of a reluctance to use costly feeding machines.

TABLE 42
Problems concerning farm-made feed by category of respondents

Problems	Intensive		Semi-intensive		Traditional		All categories	
	No.	%	No.	%	No.	%	No.	%
Procurement	0	0	0	0	0	0	0	0
Availability	0	0	0	0	0	0	0	0
High price	0	0	2	10	2	10	4	7
Total	0	0	2	10	2	10	4	7

Supplementary feed is popular in carp farming. There was no problem in procurement and the price was affordable for the farmers. A few semi-intensive fish farms (5 percent) reported that the availability of supplementary feed was problem (Table 43).

TABLE 43
Problems concerning supplementary feed ingredients by category of respondents

Problems	Intensive		Semi-intensive		Traditional		All categories	
	No.	%	No.	%	No.	%	No.	%
Procurement	0	0	0	0	0	0	0	0
Availability	0	0	1	5	0	0	1	2
Price	0	0	0	0	0	0	0	0
Total	0	0	1	5	0	0	1	2

³ While there is high demand in carp market, fish farmers are not able to sell their fish in the larger market because of a poor delivery chain (distance from some mountainous areas), as well as lack of real time market information.

There were also problems reported in the supply of fingerlings (Table 44). Semi-intensive fish farms (15 percent) and traditional fish farms (20 percent) reported that procurement of fingerlings in the market is below the stocking demand⁴. High fingerling prices were reported as a problem for about 5 percent of semi-intensive fish farms. Uncertainty of the health of fingerling was reported as problem for a few intensive fish farms (5 percent) and semi-intensive fish farms (10 percent).

TABLE 44
Fingerling related problems by category of respondents

Problems	Intensive		Semi-intensive		Traditional		All categories	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent
Procurement	0	0	3	15	4	20	7	12
Availability	0	0	0	0	0	0	0	0
Price	0	0	1	5	0	0	1	2
Health	1	5	2	10	0	0	3	5
Total	1	5	6	30	4	20	11	18

In China, there are a lot of fish varieties sold on the market. Consumers have a lot of choice on what species to buy. Since most carps are considered as low meat quality commodities, their low selling prices were reported as a major problem for 15 percent, 15 percent and 20 percent of intensive, semi-intensive and traditional fish farms, respectively. A farmer suggested that lack of training in fish marketing is also a problem (Table 45)

TABLE 45
Marketing related problems by category of respondents

Problems	Intensive		Semi-intensive		Traditional		All categories	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent
Transportation	0	0	0	0	0	0	0	0
Storing/icing/packaging	0	0	0	0	0	0	0	0
Price	3	15	3	15	4	20	10	16
Market intermediary								
Influence	0	0	0	0	0	0	0	0
Training	1	5	0	0	0	0	1	2
Total	4	20	3	15	4	20	11	18

4. PROFIT MODEL AND EFFICIENCY ANALYSIS

4.1 Production model

A regression model was used to analyse the relationships between production, profit and inputs, gross profit was used as the dependent variable while training days attended, fertilizer cost, seed cost, age, labour cost, education and feed costs were used as the independent variables in the regression model. The general model is expressed below:

$$\text{Total income} = f(\text{labour, seed, feed, education})$$

Results of the regression analysis using SPSS 11 are indicated below:

TABLE 46
Regression model summary

Model	R	R Square	Adjusted R Square	Standard error of the estimate
1	0.939	0.882	0.873	1 641.23

Predictors: (Constant), edu, feed, labour, seed

⁴ There were some problems in obtaining high quality and appropriate species.

TABLE 47
ANOVA analysis of regression

Model	Sum of Squares	df	Mean Square	F	Level of significance
Regression	1 106 467 060.795	4	276 616 765.199	102.693	0.000
Residual	148 149 166.660	55	2 693 621.212		
Total	1 254 616 227.455	59			

Predictors: (constant), education, feed, labour, seed; b. dependent variable: gross income

TABLE 48
Coefficients of regression of total income and labour, seed, feed cost and education

Model	Unstandardized coefficients		Standardized coefficients		t	Level of significance
	B	Standard Error	Beta			
Constant	426.764	950.594			0.449	0.655
Labour	1.304	0.363	0.182		3.592	0.001
Seed	1.124	0.163	0.37		6.908	0.000
Feed	1.607	0.144	0.607		11.163	0.000
Education	83.966	85.713	0.047		0.980	0.332

Dependent variable: gross income

From the above analysis, the regression model has a good fit with the production function ($R^2 = 0.882$, $F = 102.6$ significant level at 0.01). The model can be used to explain the factors that affect fish production. Specifically, regression results suggest that 88.2 percent of the behavior of gross profit can be explained by the independent variables. The t-value for education ($t = 0.332$) is not significant at 5 percent level while the other variables are shown significant.

Of all independents, i.e. labour cost, seed cost, feed cost and education were positively related with the dependent (gross income). This means we may increase the gross income by increasing the inputs of labour, seed, and feed. Feed is identified as the most significant contributory factor to production increases. The more educated the fish farmer, the higher total income expectations. It can be argued that more educated farmers can provide better management in the farms which will consequently increase farm production and income.

4.2 Technical efficiency analysis

The general stochastic frontier production function was used to express the relationship between inputs and output. The general production model was as below:

$$\ln(Y_i) = \beta_0 + \beta_1 \ln(X_1) + \beta_2 \ln(X_2) + \dots + \beta_k \ln(X_k) + (V_i - U_i)$$

Where

Y_i is the production of the i -th farm ($i = 1, 2, 3, \dots, n$)

X_i is a vector of input quantities applied by the i -th farm

β_i is a vector of unknown parameters to be estimated

V_i is a random variable assumed to be independently and identically distributed with mean zero and variance σ_v^2 [$N(0, \sigma_v^2)$] and independent of U_i ; and

U_i is a non-negative random variable associated with technical inefficiency in production. It is assumed to be independently distributed as the truncation (at zero) of the normal distribution with mean μ_u and variance σ_u^2 [$N(\mu_u, \sigma_u^2)$];

The technical efficiency of the i -th sample farm, denoted by TE_i is derived as follows: $TE_i = \exp(-U_i)$

The maximum likelihood estimate (MLE) of the parameters of the model and the generation of farm-specific TE are estimated using the FRONTIER 4.1 package (Coelli, 1994).

The coefficients and technical inefficiency factors are shown in Table 49. All the production costs had a significant effect on the production function. Pond number, average water area, age, sex and experience had positive relationship to the technical

efficiency, while pond size, average pond water depth, marital status, family size, education, and training had negative relationship to technical efficiency.

Applying t test, the results show that the technical efficiency of intensive and traditional fish farms has no significant difference ($\alpha=0.05$), while semi-intensive fish farms has significant difference with intensive and traditional fish farms (Table 50).

The highest average technical efficiency was reported in intensive fish farms (0.816), followed by traditional (0.8) and semi-intensive (0.77). This can be explained by the low feed management efficiency of semi-intensive fish farms. This low feed management efficiency among semi-intensive farms may be due to their eagerness to increase production by simply increasing the feeds supplied without looking at the feed conversion ratios. Intensive fish farms had more efficiency in feed management under the high input of feed costs. Traditional fish farms with their lower investment on feeds, also had a high efficiency in feeding based on a lower input scenario.

TABLE 49
Maximum-likelihood estimates of the stochastic c-d production frontier function and technical inefficiency model

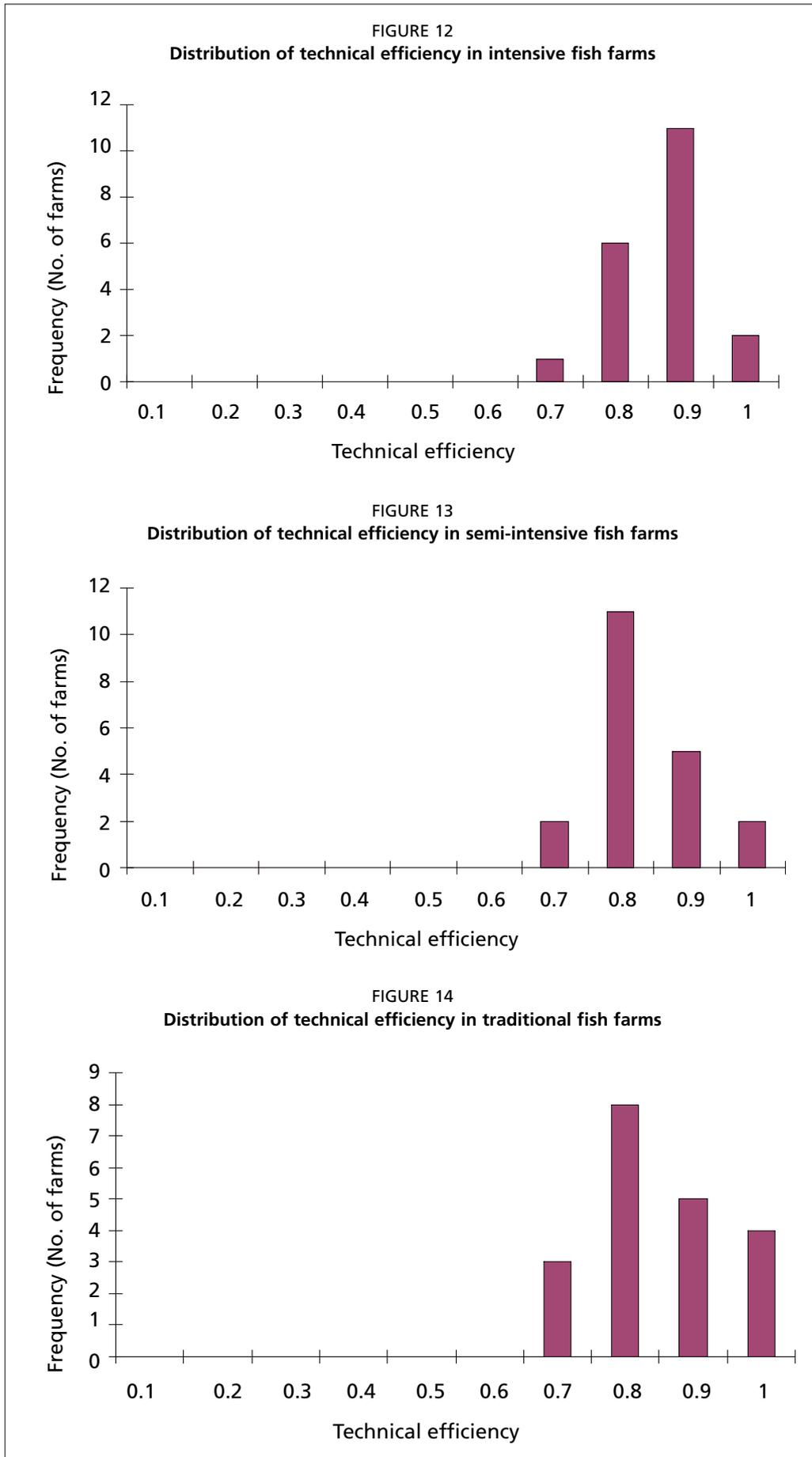
		Coefficient	Standard error	t-ratio
Stochastic frontier function				
beta0		3.494	0.513	6.813
beta1	Labour cost	0.201	0.066	3.045
beta2	Fertilizers	0.017	0.017	0.979
beta3	Fingerlings	0.460	0.056	8.198
beta4	Feeds	0.067	0.016	4.167
beta5	Variable costs	0.010	0.016	0.647
beta6	Fixed costs	0.021	0.021	1.030
Technical inefficiency factors				
delta1	Pond number	0.005	0.004	1.345
delta2	Pond size	-0.002	0.001	-1.509
delta3	Average water area	0.075	0.031	2.383
delta4	Average water depth	-0.024	0.051	-0.466
delta5	Age	0.004	0.003	1.700
delta6	Sex	0.050	0.097	0.512
delta7	Marital status	-0.018	0.083	-0.215
delta8	Family size	-0.009	0.017	-0.524
delta9	Education (year)	-0.038	0.028	-1.362
delta10	Experience (year)	0.000	0.004	-0.104
delta11	Training	-0.017	0.067	-0.258
	δ^2	0.029	0.029	0.006
	Γ	0.123	0.123	0.254
$\lambda = -2(L(H_0) - L(H_1)) = 174$				

TABLE 50
Feeding technical efficiency by category of respondents

	Intensive	Semi-intensive	Traditional
Average	0.816 ^a	0.769 ^b	0.803 ^a
Maximum	0.926	0.925	0.993
Minimum	0.611	0.605	0.679

Average values with different superscripts are significantly different ($p < 0.05$)

Analysing the distribution of feeding technical efficiency in intensive, semi-intensive and traditional fish farms, the highest frequencies of intensive fish farms occurred at TE of 0.8–0.9, while semi-intensive fish farms and traditional fish farms occurred at TE of 0.7–0.8 both (Figures 12, 13 and 14).



5. CONCLUSIONS AND RECOMMENDATIONS

Results of the study imply that intensive and semi-intensive fish farms have higher input level and higher production, the economic return is also higher. The major factor is the adoption of commercial feed and intensive feed management. Improved fish production and gross income will result from a combination of increases in adoption of commercial feed inputs and intensive feed management. Feeding fish with commercial pellets and supplementary feeds were the common approach used to improve the production of traditional fish farms.

The intensive fish farms have the highest technical efficiency among the three categories. The technical efficiency analysis indicates that semi-intensive farms have the lowest technical efficiency in feed management and hence this category of fish farms need to improve the technical efficiency through improved farm management. Traditional fish farms should adopt pellet feed feeding strategies to increase the production. Feeding fish with partial commercial feeds and supplementary feeds will be a good strategy in improving production.

The fixed costs in intensive fish farms were the highest in all categories. Buildings, pickup/trucks and feeding machine were used to improve the feed efficiency. Semi-intensive and traditional fish farms has comparatively lower fixed inputs, as feed stuffs are broadcasted into pond by hand.

Lack of money, inadequate access to market facilities, limited seed availability, and a lack of knowledge were reported as the major constraints to expanding production. Expansion in production could be facilitated by improved disease control, better farming practices, high quality/certified seed supply, increased feed input, better stocking, access to credit and improved pond water quality.

The high price of commercial feeds, the poor health fingerlings and lack of marketing training were reported as the problems for intensive fish farms. Lower market price of commercial feed and local resources for supplementary feed development for fish farming are suggested. Training and education can be provided by the commercial feed companies.

The results of the regression analyses as reflected in the values of R^2 and F and t statistic suggest that seed, feed application and labour are statistically significant predictors of the behavior of net profit in carp production. Increasing the use of these inputs shall increase profitability.

Recommendations:

- i) To promote the application of commercial feed and supplementary feed in aquaculture practice.
- ii) To carry out research on how to improve the feeding efficiency in semi-intensive fish farms.
- iii) To improve the market accessibility for aquaculture products in terms of access to real time information and improved delivery systems.
- iv) To improve the quality of seed supply system to farmers.
- v) To establish a training and education programme for rural fish farmers.

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