EFFECTS OF PRODUCTION FACTORS ON SHRIMP CULTURE IN BOUSHEHR, IRAN

REZA FAIZBAKHSH

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirement for the Degree of Doctor of Philosophy

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DEDICATION

To the every aquaculture and agriculture scientists in the world

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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By

REZA FAIZBAKHSH

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Chairman: Associate Professor Che Roos Saad, PhD

Faculty : Agriculture

Shrimp culture in Iran is a rather new industry. It began with feasibility studies in 1989 and the shrimp farms started production in 1992. Shrimp culture is important to the four southern provinces of Iran since it is a major source of employment and a factor in the local economies. A study has been done on the economics of the shrimp culture sector in Iran and data collected from 1999 to 2001.

Results show that feed variable is one of the factors important for growth and productivity in shrimp pond. According to the average of results, range for feeding shrimp in farm equal 3.35 to 4.5 ton ha^{-1} $crop^{-1}$. According to the standard condition, generally for semi intensive systems and *Penaues indicus* species feeding should be 2.5 to 3 tons ha^{-1} $crop^{-1}$ in every crop cycle. Thus there is an excessive used of feed for the average pond shrimp culture in this case study.

Results also show that the number of feeding per day is low which is 2 times day $^{-1}$. Feeding frequency should be increased to 4 times per day. The best time for feeding is also a factor by best time is around 6:00, 10:00, 18:00 and 20:00 h. Quality of feed is also important in shrimp culture. The average of stocking in the shrimp pond about 223,700 to 305,000 ha^{-1} or 1.6 to 2.2 m^{-2} individual larvae which is every low as standard results of larvae per square meter for semi intensive is around 15.

The number of aerator used of the farm was 1.5 to 2.05 unit ha^{-1}, which is lower than the standard number used which is around 3-4 aerators ha^{-1} which will allow more oxygen to be absorbed into the water. According to the results average number of tray number on the pond was 2-3 tray ha^{-1}, which is lower than the standard which is equaled 4-6 ha^{-1}. Tray number is an indicator whether prawn are eating and have enough feed and also whether they are healthy or not which indirectly will affect the pond production.

The number of labours on the farm was 7 to 8 or 0.50 to 0.57 person ha $^{-1}$. An optimum number should be 6 person or 0.36 to 0.43 ha $^{-1}$ working in the farm is enough. This is for efficiency used of labor existed on farm. Temperature is one of the biological variables on the shrimp pond that is relevant to total productions. According to the results the average temperature in shrimp farms was 29.83 to 31.4 ^{0}C. This range of temperature is well for shrimp culture because generally, the range of standard temperature for shrimp culture *Penaues indicus* species is 28 to 32 ^{0}C.

According to the results of study, average amount of Oxygen is 2.26 to 2.70 mg L^{-1}. This amount is much lower than 5 mg L^{-1}, which is the optimal level of oxygen in water. Thus, used of more aerators would help to ensure enough oxygen in the culture system.

The result also showed pH in the pond ranged from 8.11 to 8.67. Generally, optimal range for pH in the pond is 7.4 to 7.8, but tolerance level is from 7.0 to 9.0. Pond liming may help to buffer the pH in pond. Salinity is a biological variable in the shrimp pond. According to the result, the average salinity is 38.65 to 42.29 ppt, but the normal range for salinity is 33 to 35 ppt. Reduction of salinity to normal range could be achieved by adding fresh water to the pond.

The average pond depth range from 127.98 - 136.52 cm but normal range for shrimp pond is around 140 to 200 cm. Thus, shrimp farmer must deepen their pond depth, in order to give shelter from sun and more space for shrimp to grow, thus increase production.

Cobb Douglas productions function was used to determine the most economically efficient way of production in the shrimp culture, and function for biology and economic were analyzed where by: $Y = a_0 \prod_i X_i^{a_i}$, i=1, 2….n, with two inputs is: $Y = Ax_1^{ß1} x_2^{ß2}$, for data from 48 farms in the Heleh site, Boushehr province during 1999 to 2004. The final model, obtained from Cobb Douglas is :TP= -1.86 + 0.85 fc - 0.056 nw + 0.13 ss + 0.12 ti + 0.1 na , to give the coefficient Elasticity feed consumption (e_{fc} = 0.85), Elasticity labor

e_{nw} = - 0.056, Elasticity number of tray (e_{ti} = 0.12), Elasticity post larvae stocking (e_{ss} = 0.13) , Elasticity number of aerator (e_{na} = 0.1), Totally, the final of model is following, TP = -9.829750– 0.934460 pH - 1.078061 sa + 0.906737 ox + 2.770623 te + 1.814048 dw. Also, coefficient for other variable were calculated such as : Elasticity Acidity – Alkalinity (e_{pH} = -0.93), Elasticity Salinity (e_{sa} = - 1.07), Elasticity Oxygen Demand (e_{ox} = +0.90), Elasticity Temperature (e_{te} =+ 2.77), Elasticity Deep water (e_{dw} = + 0.1.81) TP = -9.829750– 0.934460 pH - 1.078061 sa + 0.906737 ox + 2.770623 te + 1.814048 dw. Finally, results shows that about 4 economics variables and 3 biological variables have positive effects while 1 economic variables and 2 biological variables have negative effects to the culture production on the farms. Consequently, shrimp manager need to use all 10 variables to increase production.

For strategy 1, in the strategy shrimp farmer should be just focused to biological variables such as temperature, oxygen, salinity, pH and depth of pond. For strategy 2, shrimp farmer must focused to economical variables such as feed, post larvae stocking, number of tray, number of aerators and number of labour on the farms. For strategy 3, shrimp farmer should also focused to biological and economical factors to gather which must have interactions between them.

As a conclusion strategy 1 or strategy 2 is easier than strategy 3. For strategy number 3 some interactions between biological and economical variables are involved and very complex.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

KESAN FAKTOR-FAKTOR PENGELUARAN KE ATAS PENTERNAKAN UDANG DI BOUSHEHR, IRAN

Oleh

REZA FAIZBAKHSH

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Pengerusi: Profesor Madya Che Roos Saad, PhD

Fakulti : Fakulti Pertanian

Penternakan udang merupakan sebuah industri yang baru di Iran. Ia bermula dengan kajian kesesuain pada tahun 1989 dan ladang penternakan udang mula mengeluarkan hasil pada 1992. Penternakan udang merupakan sebuah industri yang penting kepada 4 wilayah di bahagian selatan Iran sebagai sumber pekerjaan dan merupakan faktor dalam ekonomi penduduk tempatan. Satu kajian telah dijalankan ke atas sumbangan ekonomi sektor penternakan udang di Iran dengan maklumat terkumpul dari tahun 1999 hingga 2001.

Hasil kajian telah menunjukkan bahawa pembolehubah bahan makanan udang merupakan salah satu daripada faktor penting yang mempengaruhi tumbesaran dan produktiviti di dalam kolam ternakan udang. Berdasarkan hasil kajian secara purata, julat pemberian makanan udang di dalam kolam

ternakan menyamai 3.35 hingga 4.5 ton ha $^{-1}$ pusingan $^{-1}$. Mengikut keadaan piawai, kebiasaannya bagi sistem separa intensif dan pemberian makanan *Penaues Indicus,* penternak hanya memerlukan 2.5 hingga 3 ha $^{-1}$ pusingan $^{-1}$ dalam setiap kitaran ternakan. Oleh yang demikian, terdapat penggunaan bahan makanan yang berlebihan bagi penternakan udang kolam secara purata dalam kajian kes ini.

Hasil kajian juga menunjukkan bahawa kekerapan pemberian makanan setiap hari sebanyak 2 kali sehari adalah rendah. Kekerapan pemberian makanan harus ditingkatkan keempat kali seharí. Masa pemberian makanan juga merupakan faktor penting dengan masa terbaik sekitar jam 6:00, 10:00, 18:00 dan 20:00. Kualiti bahan makanan juga amat penting bagi penternakan udang. Purata kemasukan udang dalam kolam ternakan adalah sebanyak 223,700 hingga 305,000 ekor ha $^{-1}$ atau 1.6 hingga 2.2 ekor m^{-2} bagi larva, iaitu amat rendah memandangkan jumlah larva bagi setiap $meter^2$ bagi sistem semi intensif adalah 15.

Jumlah alat pengudaraan yang digunakan di lading-ladang adalah 1.5 hingga 2.05 unit ha^{-1}, iaitu lebih rendah daripada jumlah piawai yang digunakan sebanyak 3-4 alat pengudaraan ha^{-1} dimana ia akan memberikan jumlah oksigen yang lebih banyak ke dalam air kolam. Berdasarkan hasil kajian, bilangan talam makanan dalam kolam secara purata adalah sebanyak 2-3 talam ha^{-1}, iaitu lebih rendah daripada jumlah piawai sebanyak 4-6 talam ha^{-1}. Bilangan talam makanan merupakan indikator keadaan sebenar dan menunjukkan samada udang mendapat makanan yang mencukupi dan dapat memantauan kesihatan udang yang mana secara tidak langsung memberi kesan terhadap pengeluaran udang dari kolam.

Jumlah tenaga kerja di ladang ternakan adalah 7 hingga 8 orang atau 0.50 hingga 0.57 orang bagi setiap ha $^{-1}$. Jumlah pekerja yang optimum adalah 6 orang atau 0.36 hingga 0.43 orang ha $^{-1}$. Ini adalah untuk menggunakan tenaga kerja sedia ada di ladang ternakan secara cekap. Suhu juga merupakan salah satu faktor biologi bagi kolam ternakan udang yang mana amat berkaitan dengan hasil pengeluaran keseluruhan. Berdasarkan hasil kajian, suhu purata kolam ternakan udang adalah 29.83 hingga 31.4 ^{0}C. Julat suhu ini adalah sesuai untuk penternakan udang kerana secara amnya, julat suhu piawai untuk penternakan udang spesis *Penaues indicus* adalah dari 28 hingga 32 ^{0}C.

Berdasarkan hasil kajian, jumlah oksigen dalam air secara purata adalah sebanyak 2.26 hingga 2.70 mg L^{-1}. Jumlah ini adalah lebih rendah daripada 5 mg L $^{-1}$, yang merupakan paras oksigen dalam air yang optimum. Oleh yang demikian, penggunaan lebih banyak alat pengudaraan akan membantu untuk memastikan jumlah oksigen yang mencukupi dalam sistem penternakan udang tersebut.

Hasil kajian juga menunjukkan bahawa nilai pH dalam kolam adalah dalam julat 8.11 hingga 8.67. Secara umumnya, julat pH dalam kolam yang optimum adalah dalam 7.4 hingga 7.8, namun paras toleransi pH adalah daripada 7.0 hingga 9.0. Proses pengkapuran (liming) kolam mungkin dapat mengimbangkan nilai pH di dalam kolam. Tahap kemasinan juga merupakan satu daripada faktor biologi bagi kolam ternakan udang. Berdasarkan hasil kajian, tahap kemasinan purata adalah sebanyak 38.65 hingga 42.29 ppt, namun julat tahap kemasinan optimum adalah daripada 33 hingga 35 ppt. Penurunan tahap kemasinan air kolam ke dalam julat yang normal dapat dicapai dengan menambahkan air tawar ke dalam kolam ternakan udang tersebut.

Kedalaman kolam ternakan secara purata adalah dalam julat 127.98 - 136.52 cm namun julat normal kolam ternakan udang adalah sekitar 140 hingga 200 cm. Oleh yang demikian, penternak udang perlu menambah kedalaman kolam mereka, untuk memberikan teduhan daripada sinar matahari dan juga memberikan lebih ruang untuk udang membesar, seterusnya meningkatkan lagi hasil pengeluaran udang.

Fungsi pengeluaran Cobb Douglas telah digunakan untuk menentukan cara pengeluaran kultur udang yang paling efisien dari segi ekonomi, dan fungsi biologi dan ekonomi telah dianalisis seperti berikut : $Y = a_0 \prod_i X_i^{a_i}$, i=1, 2….n, dengan dua input iaitu : $Y = Ax_1^{ß1}x_2^{ß2}$, bagi data daripada 48 ladang ternakan udang di kawasan Heleh, Wilayah Boushehr antara tahun 1999 hingga 2004. Model akhir yang diperolehi daripada Fungsi Cobb Douglas ialah : TP= -1.86 + 0.85 fc - 0.056 nw + 0.13 ss + 0.12 ti + 0.1 na , untuk memberikan persamaan tersebut Keanjalan penggunaan bahan makanan (e_{fc} = 0.85), Keanjalan tenaga kerja (e_{nw} = - 0.056), Keanjalan bilangan talam makanan (e_{ti} = 0.12), Keanjalan kemasukan pasca larva (e_{ss} = 0.13) , Keanjalan bilangan alat pengudaraan (e_{na} = 0.1). Secara keseluruhannya, persamaan model akhir adalah seperti berikut, TP = -9.829750– 0.934460 pH - 1.078061 sa + 0.906737 ox + 2.770623 te + 1.814048 dw. Selain itu, persamaan bagi pembolehubah yang lain juga ditentukan iaitu: Keanjalan keasidan – kealkalian (e_{pH} = -0.93), Keanjalan kemasinan (e_{sa} = - 1.07), Keanjalan permintaan oksigen (e_{ox} = +0.90), Keanjalan suhu (e_{te} =+ 2.77), Keanjalan kedalaman air kolam (e_{dw} = + 0.1.81) dengan TP = -9.829750– 0.934460 pH - 1.078061 sa + 0.906737 ox + 2.770623 te + 1.814048 dw. Pada akhirnya, hasil kajian menunjukkan bahawa empat pembolehubah ekonomi telah memberi kesan positif dan satu pembolehubah ekonomi memberi kesan negative, tiga pembolehubah biologi memberikan kesan positif dan dua pembolehubah biologi telah memberi kesan negative terhadap peningkatan hasil pengeluaran udang di ladang ternakan. Oleh itu, pengurus ladang ternakan perlu menggunakan kesemua 10 pembolehubah untuk meningkatkan hasil pengeluaran udang.

Untuk strategi 1, penternak udang hanya perlu memfokuskan kepada pembolehubah biologi seperti suhu, paras oksigen, paras kemasinan, pH dan kedalaman kolam. Untuk strategi 2, penternak udang harus memfokuskan kepada pembolehubah ekonomi seperti bahan makanan udang, kemasukan pasca larva, bilangan talam makanan, bilangan alat pengudaraan dan jumlah tenaga kerja di lading ternakan. Untuk strategi 3, penternak udang perlu juga memfokuskan kepada kedua-dua pembolehubah biologi dan ekonomi kerana semestinya terdapat perkaitan antara kesemua pembolehubah tersebut.

Sebagai kesimpulannya, strategi 1 atau strategi 2 adalah lebih mudah daripada strategi 3. Bagi strategi 3, terdapat interaksi antara pembolehubah biologi dan ekonomi dan interaksi ini sangat kompleks.

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I certify that an Examination Committee has met on 25th September 2006 to conduct the final examination of Reza Faizbakhsh on his Doctor of Philosophy thesis entitled "Effects of Production Factors on Shrimp Culture in Boushehr, Iran" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

Mihdzar Abdul Kadir, PhD
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Zainal Abidin Mohamed, PhD
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Internal Examiner)

Annie Christianus, PhD
Lecturer
Faculty of Agriculture
Universiti Putra Malaysia
(Internal Examiner)

James Fraser Mulr, PhD
Professor
Institute of Aquaculture
Universiti of Stirling, UK
(External Examiner)

HASANAH MOHD GHAZALI, PhD
Professor/ Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 22 NOVEMBER 2006

This thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee are as follows:

Che Roos Saad, PhD
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Mad Nasir Shamsudin, PhD
Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

Saeed Yazdani, PhD
Associate Professor
Faculty of Agriculture
Universiti of Tehran
(Member)

AINI IDERIS, PhD
Professor/ Dean
School of Graduate studies
Universiti Putra Malaysia

Date: 14 DECEMBER 2006

DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

REZA FAIZBAKHSH

Date: 20 NOVEMBER 2006

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ADB	Asian Development Bank
Aerator	Present Value of Total Aerators used per ha
AIT	Asian Institute of Technology (Thailand)
ASCC	Asian Shrimp Culture Council
CBA	Cost Benefit Analysis
CRS	Constant Returns to Scale
CD	Cobb-Douglas
DOF	Department of Fisheries (Thailand)
DRS	Decreasing Returns to Scale
EPM	Expected profile Model
Eviews	Econometrics Views (Soft ware)
FCR	Feed Conversion Ratio
Feed	Kilogram or ton of shrimp feed per hectare at each farm
FOI	Iranian Fisheries Organization
HR	Harvest Size (gram)
IMO	Iran Metrological organization
IFRO	Iranian Fisheries Research Organization
IPFC	Indo-Pacific Fisheries Council
IRR	Return Rate of Internal
IRS	Increasing Returns to Scale
MIDAS	Mekong international Development Associates
MPA	Marine Protected Areas
NACA	Net Work of Aquaculture Centre in Asia – Pacific
NOK	Norwegian Koron

NSO/DOF	National Statistical Office and Development of Fisheries
PDIFO	Planning and Development Iranian Fisheries Organization
SD	Stocking Density (PL/M2)
Seed	Stocking Density mesured at the Number of See Per ha
Shilat	Fisheries Department Government Islamic Republic of Iran
SR	Survival Rate (Percent %)
TDRI	Thailand Development Research Institute
TPH	Total Ponds Harvest (Post Larvae/ ha)
UNDP	United Nations Development Programme
UPM	Universiti Putra Malaysia
USDA	United State Agriculture Department