Editorial

This issue contains good examples of the sorts of technical papers that *Aquabyte* really needs: a mathematical treatment of pond management options, by V.A. Omojola of Nigeria, and the application of standard toxicology methods to pesticide problems in rice-fish farming by Kyaw Myint Oo of the Union of Myanmar. Experience papers are always welcome, but papers like these which describe methods that will get NTAS members thinking (and hopefully trying them), are extremely valuable. The other two main articles show aquaculture in action in Vietnam (*Macrobrachium* in rice-based farming systems) and African catfish seed supply in Cameroon. Along with the regular features, there is a photo-essay by Graham Mair on a genetic route to all-male tilapia farming, and two requests for help from NTAS members - on feed consumption data and duckweeds. Please respond to these requests and also ask for help through these columns when you need it. That's what the NTAS is for. Please keep writing. ***R.S.V. Pullin***

Production Planning Aids for a Modular Pond System

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Introduction

A modular system was described by Agbayani et al. (1989) for improved pond management. This system can increase productivity through more efficient use of pond capacity: an alternative to adding more supplementary inputs, as recommended by Chong and Lizarondo (1982). Both these papers were concerned about closing the gap between the actual and potential yield of milkfish ponds.

For a modular pond system, it would seem necessary to tabulate or in some other way carry out some repetitive arithmetic to determine times for stocking, stock transfer and harvesting. This may be convenient where short periods and few stages of stock transfer are involved but becomes rather clumsy with multiple stages and long periods. Moreover, such a method may be less adaptable to production planning by computer.

This paper develops a series of short mathematical expressions that may be used to determine the necessary variables in production planning in a modular pond system.

System Description and Variables

This modular pond system involves the use of a number of adjacent ponds in which the pond area increases progressively from the first to the last. The first pond is stocked with fingerlings on the basis of the capacity of the largest pond. As the fish grow and require more space, they are transferred to the next pond in the series, and the vacated ponds are subsequently prepared for a number of days and then stocked with new fingerlings. A module here refers to the number of ponds through which the stock will be transferred to complete a production cycle.

The variables of interest are:

- the number of ponds in a module (m);
- the number of days during which the stock remains in each pond (retention time) (n);
- the number of days spent in preparing a pond for the next batch (p); and
- the total number of days available for production (T).

Derivation

1. Stocking

The first stocking will occur immediately after pond preparation, i.e., after p days; whereas the second stocking occurs after this stock has stayed in this pond for the required number of days, been transferred to the next pond and the pond prepared again. Therefore:

First stocking = Stocking (1) = $\bar{p}$

Second stocking = Stocking (2) = $\bar{p} + (\bar{n} + \bar{p})$ days

Third stocking = Stocking(3) = $\bar{p} + (\bar{n} + \bar{p}) + (\bar{n} + \bar{p})$ days $= \bar{p} + 2(\bar{n} + \bar{p})$ days

Generally, therefore,

$$\text{Stocking}(k) = [\bar{p} + (k-1)(\bar{n}+\bar{p})] + \left[\left(\sum_{i=1}^{k-1} p_i - (k-1)\bar{p}\right) + \left(\sum_{i=1}^{k-1} n_i - (k-1)\bar{n}\right)\right] \quad ...1.1)$$

where: $\bar{n}$ and $\bar{p}$ = budgetted values for n and p; n_i = i^{th} retention time; p_i = i^{th} pond preparation time; and k = k^{th} stock.

From 1.1, the number of stockings (k_1) within a culture period T is given by

$$k_1 = \frac{T - \bar{p}}{\bar{n} + \bar{p}} + 1 \quad ...1.2)$$

2. Stock Transfers (ST)

Let $ST_{i,k}$ represent the k^{th} stock transfer from pond i to pond i+1.

$ST_{1,1}$, i.e., first stock transfer from pond 1 to pond 2 will occur after pond preparation, stocking and maturity of tenure of the stock, i.e.,

$$ST_{1,1} = (\bar{n} + \bar{p})$$

The second one, $ST_{1,2}$ occurs after a repeat of the same process:

$$ST_{1,2} = 2(\overline{n} + \overline{p})$$

Similarly, it can be shown that

$$ST_{1,k} = k(\overline{n} + \overline{p}) \qquad ...2.1)$$

$ST_{2,1}$ occurs after an additional retention time, n, in the second pond

$$ST_{2,1} = \overline{n} + (\overline{n} + \overline{p}) \text{ and}$$

$$ST_{2,2} = \overline{n} + 2(\overline{n} + \overline{p})$$

Similarly,

$$ST_{2,k} = \overline{n} + k(\overline{n} + \overline{p}) \qquad ...2.2)$$

If there is a fourth pond it can be shown in the same way that

$$ST_{3,k} = 2\overline{n} + k(\overline{n} + \overline{p}) \qquad ...2.3)$$

In summary, from the results:

$$ST_{1,k} = k(\overline{n} + \overline{p})$$
$$ST_{2,k} = \overline{n} + k(\overline{n} + \overline{p})$$
$$ST_{3,k} = 2\overline{n} + k(\overline{n} + \overline{p})$$

one can deduce the general form

$$ST_{i,k} = (i-1)\overline{n} + k(\overline{n} + \overline{p}) \qquad ...2.4)$$

This gives us the day on which the k^{th} stock transfer from pond i to pond i + 1 will occur.

3. Total Number of Stock Transfers (TST)

The second question of relevance here is calculating the total number of stock transfer (TST) that will occur within a given total production period, T. This will be equivalent to the sum of the transfers from pond 1 to 2, 2 to 3, 3 to 4, etc.

The number of stock transfers from pond 1 to 2 in T days is given by making equation 2.1 equal to T, i.e.,

$T = k(\overline{n} + \overline{p})$ so that

$$k_2 = \frac{T}{(\overline{n}+\overline{p})} \qquad ...3.1)$$

The same quantity for pond 2 to 3 is given by substituting for k in the relation (equation 2.2)

$T = \overline{n} + k(\overline{n} + \overline{p})$, so that

$$k_3 = \frac{(T-\overline{n})}{(\overline{n}+\overline{p})} \qquad ...3.2)$$

and from pond 3 to 4

$$k_4 = \frac{(T-2\overline{n})}{(\overline{n}+\overline{p})} \qquad ...3.3)$$

So, if there were four ponds, for instance,

$$TST = \frac{T}{(\overline{n}+\overline{p})} + \frac{(T-\overline{n})}{(\overline{n}+\overline{p})} + \frac{(T-2\overline{n})}{(\overline{n}+\overline{p})}$$

If the answer is not a whole number, ignore the fractional part of the solution. An attempt is made below to develop a general form for this relation, but the significance of the fractional part of the solution must first be examined (see 5 below).

4. Harvesting: Timing and Number of Harvests

Harvests are stock transfers from the last pond away from the system.

Since the number of ponds per module is m, and from the general relation,

$$ST_{i,k} = (i-1)\overline{n} + k(\overline{n} + \overline{p}) \qquad ...4.1)$$

the k^{th} harvest from the last pond (m) will be given by

$$ST_{m,k} = (m-1)\overline{n} + k(\overline{n} + \overline{p})$$

The number of harvests in a given production period T is derived as follows:

$$T = \left[(m-1)\overline{n} + k(\overline{n}+\overline{p})\right] + \left[\left(\sum_{i=1}^{k-1} p_i - (k-1)\overline{p}\right) + \left(\sum_{i=1}^{k-1} n_i - (k-1)\overline{n}\right)\right]$$

$$\Rightarrow k_5 = \frac{T-(m-1)\overline{n}}{\overline{n}+\overline{p}} \qquad ...4.2)$$

If there has been at least one harvest, however, the number of harvests in T subsequent days will be given by

$$k_6 = \frac{T}{(\overline{n}+\overline{p})} \qquad ...4.3)$$

5. Interpreting Fractional Solutions

Fractional solutions crop up when k is made the subject of the above relations, as in equations 1.2, 3.1 to 3.3 and equation 4.2. These equations answer the question: "how many ...?", and the issue here is understanding the implication of a solution such as "3.33 harvests".

In all the cases, the fractional part refers to time - how soon the event in question will be repeated; or when it was last done. Formally expressed, let the fractional part = F, then the number of days (r) to repeat the event is given by

$$r = (1-F)(\overline{n} + \overline{p}) \qquad ...5.1)$$

Alternatively, r_2, the day the event occurred last, is given by

$$r_2 = F(\overline{n} + \overline{p}) \qquad ...5.2)$$

A FEW WORKED EXAMPLES

The data for these examples are from Agbayani et al. (1989). For the system described in their paper,

m = 3 n = 30 p = 15 T = 150

Suppose, however, that

$p_1 = 12$ $p_2 = 16$ $n_1 = 30$ $n_2 = 15$

a. When will the third stocking occur?

From equation 1.1,

Stocking (3)= [15+2(45)]+[(28-30)+(55-60)]
= 105 + [-2+ -5]
= 105-7
= 98

The third stocking will occur on the 98^{th} day.

b. How many stockings will occur during the production time?

From equation 1.2,

$$k_1 = \frac{T-\overline{p}}{\overline{n}+\overline{p}} + 1 = \frac{150-15}{30+15} + 1 = 4$$

c. How many stock transfers will occur from pond 1 to 2, if T were 106 days?

From equation 3.1,

$$k_2 = \frac{T}{\overline{n}+\overline{p}} = \frac{160}{45} = 2.36$$

This implies that by the 106^{th} day, there would have been two stock transfers from pond 1 to 2, while the fractional part, 0.36, gives an indication of the time.

Using $r = (1-F)(\overline{n} + \overline{p})$,
$r = (1-0.36)(45)$
$= 28.8$ or 29 days to the nearest day

The next stock transfer will therefore occur in 106 + 29 = 135th day.

Here a fractional refers to time, not an activity (of stock transfers in 3 above) so we round-off rather than ignore it.

d. How many harvests would we have had in 120 days?

Using equation 4.2

$T = 120-7 = 113$

$$k_5 = \frac{113-(3-1)30}{30+15} = \frac{60}{45} = 1.18$$

We would have had one harvest, with (1-0.18) (15 + 30) (using equation 5.1) = 36.9 or approximately 37 days to the next harvest, which therefore will be due on

113 + 37 = 150th day

6. Further Development of the Approach

It has been shown in 3 above that for m = 2, total number of stock transfers = $T/(\bar{n}+\bar{p})$, and for m = 3, total number of stock transfers = $(2T-\bar{n})/(\bar{n}+\bar{p})$. The denominator is the same for all values of m, but the numerator changes and an attempt is made here to make the numerator a function of m. Consider the following:

m	Numerator of 'k'
2	T
3	2T - $\bar{n}$
4	3T - 3$\bar{n}$
5	4T - 6$\bar{n}$
6	5T - 10$\bar{n}$
7	6T - 15$\bar{n}$

It is obvious that T, with respect to m, carries a coefficient of (m - 1). Considered as a series, the coefficient n increases as the sum of an arithmetic progression whose common difference (d) is 1, the first term (a), 1, and the final term (n), (m - 2).

Taking the general equation for the sum of an arithmetic series:

$$S_n = \frac{n}{2}[2a+(n-1)d] \quad ...6.1)$$

and substituting our own terms we have

$$S_{m-2} = \frac{m-2}{2}[2+(m-2-1)]$$
$$= \frac{m-2}{2}(2+m-3)$$
$$= \frac{m-2}{2}(m-1)$$
$$= \frac{(m-2)(m-1)}{2} \quad ...6.2)$$

i.e., the coefficient of $n = \frac{(m-2)(m-1)}{2}$

A general relationship for the number of stock transfers can therefore be written as

$$TST = \frac{(m-1)T - \frac{1}{2}\bar{n}(m-2)(m-1)}{\bar{n}+\bar{p}}$$
$$= \frac{(m-1)T - 0.5\bar{n}(m^2-3m-2)}{\bar{n}+\bar{p}} \quad ...6.3)$$

Neat as this equation is, however, it is incapable of discriminating against the fractional residuals, which it compounds for each compartment to give a value of TST which is larger than the actual value.

Concluding Remarks

The author hopes that this paper will stimulate readers to think further about the development and use of such production planning aids. Comments from other NTAS members would be most welcome.

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Rice-Freshwater Prawn (*Macrobrachium rosenbergii*) Farms in the Mekong Delta, Vietnam

NGUYEN QUANG TUYEN

Introduction

The Mekong Delta of Vietnam covers 4 million ha, of which 2.3 million ha are under rice cultivation. The delta floods annually. Water depth in the ricefields is around 0.3-3.0 m during the wet season and brackishwaters cover about 1.6 million ha in the dry season. Aquaculture in ricelands has been practised here for a long time and integrated rice-freshwater prawn farming has become more and more popular.

The giant freshwater prawn (*Macrobrachium rosenbergii*) occurs in the two main river systems of the Mekong Delta: "song Tien" and "song Hau" in parts of Hau Giang, Cuu Long, Tien Giang, An Giang and Dong Thap provinces.

The total annual freshwater prawn production in Vietnam during 1985-90 was reported to vary from 5,000 to 6,000 t, most of it from natural fisheries (Kwei Lin and Lee 1992).

Farming Systems

These integrated farming systems were developed by farmers of the Mekong Delta to produce more food and more cash crops.