6. **Economics (J. Perran Ross)**

For the purposes of this introduction farming (closed cycle captive breeding) and ranching eggs collected from the wild are combined as the process of raising crocodilians from eggs or hatchlings to market size is essentially the same. More detailed treatment of farming and ranching are given in sections 4.4 and 6.1-6.5.

The basic calculation for any commercial production is:

\[
\text{PROFIT} = \text{SALE VALUE OF THE PRODUCT} - \text{COST OF PRODUCTION}
\]

For agricultural/animal husbandry activities of all kinds, including raising crocodilians, this relationship must be considered in two calculations over a period of time from 'birth'/incubation to when an animal reaches market size.

Initially, an egg or hatchling has a relatively low value and this increases slowly as the animal grows, but remains quite low, and then increases sharply as the animal approaches a size where it can be sold. The value then continues to increase slowly as the animal gets larger. The cost of production starts at a value well above zero because the costs of establishing a facility (purchasing land, building enclosures and infrastructure, bank loans to capitalize this development, labour, technical advice, etc.) must be prorated among all the animals that the farm will produce. Every hatchling must pay a small portion of the up-front starting cost. From there, the cumulative costs of housing, feeding and maintaining the animal to market size increase in a roughly straight-line manner.

These two lines - Value and Cumulative Cost - determine at what point (if any) the value of each animal is greater than the cost of producing it and some profit can be made. However, as the animal continues to grow, the cumulative costs of producing increase while its value increases less quickly until the cost exceeds the value. Holding an animal in the farm beyond this point just costs money that will never be recovered and this situation is true for all animal husbandry - pigs, chickens, beef cows and crocodilians. This relationship is shown in Figure 1. And the area where value is greater than cost is obvious.

![Figure 1. Relationship of value of a farmed crocodilian and cost of production showing the small window of profitability.](image)

We can consider in more detail, four areas of this graph that strongly influence the economic viability of a farming operation. Recognition, understanding and management of these factors is an important consideration for profitable operation:
a. Start-up costs and investment in infrastructure

If the start-up costs of a facility per animal produced exceed the highest value at sale, then the farm can never make a profit. Overcapitalization and investment in extremely complex and expensive facilities is self-defeating. However, undercapitalization resulting in insufficient or inefficient operations can affect animal survival and growth rate, with profound effects on profit. An optimal start-up investment allowing adequate operation but not overwhelming value is location, crocodilian species and situation dependent. Careful research, development of business plans and recognition of uncertainty and instability in costs and sale prices are crucial to success. The other solution to this problem is to increase the number of animals produced so that the start-up cost is divided among more animals and therefore lower- but again overcrowding can negatively affect survival and growth. The effect of undercapitalization is equally dire. There are numerous examples of attempts to start village/artisanal level farms with very low levels of investment, facility and infrastructure and technical and husbandry knowledge. These invariably fail because the low survival and growth ensure the Value curve never intersects the Costs curve.

![Figure 2. Four areas of critical concern in the cost-value relationship.](image)

![Figure 3. Effect of excessive start-up cost or inadequate facilities investment.](image)

b. The critical importance of high survival and high growth rates to economic success.

Many facilities can raise crocodiles but if mortality is high or growth rate low (and these often occur together as they have similar causes based in poor nutrition, crowding and generally inadequate
husbandry) the economic impact is disastrous. Both the Costs and Value in our economic viability graph are per animal values - that is, they represent the dollar figures for sales value or expense divided among all the animals that can be brought to sale. If survival is low (or mortality high-same thing) the cost of raising all those dead animals up to the point when they died must be reflected in cost curve, but they contribute nothing to the value curve. Dead crocodilians represent lost revenue in the farm. The impact of slow growth is less direct but may be more detrimental. If growth rate is slow then Value curve shifts to the right and reduces the area of intersection with the cost curve and may even miss it altogether.

![Figure 4. Impact of reduced growth rate on profitability](image)

Note also that, at reduced growth rates, the time to reach market size is longer and so the 'window of profitability' is shorter. A farmer with higher growth rates has a wider window of opportunity to seek favourable market prices. With slower growth the farmer has a shorter period in which his stock is profitable and may have less flexibility in negotiating sales prices. The optimal situation is to sell stock when the difference between costs and value is greatest, but practical considerations (eg cash flow, buyer pressure, different market demand) may make sales at the edges of the profit window (ie smaller or larger stock) economically sensible. What must be avoided is pushing the slow growth rate out beyond the point where Value and Cost can intersect and many farmers have fallen into this trap.

Maintaining high survival and growth is a complex highly technical and quite well understood process involving advanced knowledge and manipulation of diet, density of animals in pens, behaviour (aggression), genetics (managing fast and slow growing hatchlings), disease management. One key question of debate is whether maintaining stock at a high temperature by artificial heating ensures a sufficiently high growth rate to offset this expense. For some species and situations (e.g. Alligator in Louisiana) this is clearly the case, but it may not work economically in all situations. There is huge wealth of research on these topics and abundant information available for specific countries and different species and types of facility. Successful farmers know and use this information to optimize growth and maintain high survival, with consequent economic benefits. Sections of this Capacity Manual address many of these issues and provide resources for information.

c. Maintenance expenses during grow out

Growing crocodilians must be housed, provided with food, clean water, warmth and nutritional and medical supplements. This all costs money. Maintenance expenses can be considered to be fixed- i.e. independent of the number of animals held or variable - that is, changing as they are needed for a larger or smaller number of animals. Start-up costs are a fixed cost. Other fixed costs might be the cost of licenses, water supply, energy for lighting and heating and (within a range of number of crocodiles held) labour. Food is a variable cost - more animals need more food, and larger animals need more food. Other variable costs include tag and marking (eg PIT tags), waste water effluent treatment where this is required and veterinary/medical and nutritional supplement expense. One way to ensure the
Cost and Value lines intersect to produce a profit is to minimize maintenance costs. Crocodile farmers are often preoccupied with costs of providing food. Certainly a reliable cost of high quality protein food is a necessary component of any farm. Many successful farms are associated with other animal production systems (eg chickens, pigs) so that the waste products of one operation (dead chickens, still births, abattoir waste etc.) can be the food source for the other (crocodiles) sometimes with an advantageous economy of waste disposal expenses. Like many other elements of crocodilian husbandry, finding the optimum balance among these costs and gains is a multidimensional and complex problem. Seeking information from researchers and other technical resources, sharing knowledge with effective farmers and carefully experimenting within a facility all contribute to successful solutions to this issue.

d. Impact of fixed costs and economies of scale

The variable costs change with the number of animals in stock. With fewer crocodilians, lower costs and lower revenues should balance out, all other things being equal, and some farms successfully operate on low numbers and low margins by optimizing the other critical factors (start-up costs, maintenance, growth and survival). However, if the fixed costs can be distributed over a larger number of animals with no reduction in growth or survival, then the cumulative cost curve can be significantly lowered, reducing the time to reach the profit window and increasing the area beneath it. This can be accomplished with very careful attention to husbandry, and sometimes requires higher expenditures overall- but offset by lower per-animal costs. Operations in several countries, and most notably the extremely large operations captive breeding caiman (*Caiman crocodilus*) in Colombia, demonstrate the effectiveness of this strategy and the details of how this was achieved are instructive. Key elements appear to be the availability of very abundant capital to build huge facilities, a large investment in technical knowledge (specifically of incubation and early nurturing methods) and an organism that was naturally adapted to high density.

![Figure 5. Effect of different levels of maintenance expenses on profitability of crocodilian raising operations.](image)

Figure 5. Effect of different levels of maintenance expenses on profitability of crocodilian raising operations.

The take-home message here is straightforward and universal for all animal husbandry operations. There are no simple formulas for success, each situation requires unique analysis and multi-dimensional or 'trade-off' solutions- but economically viable operations must plan and manage their start-up costs and investment, and optimize growth rate and survival to bring animals to market at the earliest opportunity when they have the greatest difference between cumulative costs and market value. This may not be the size at which the price per animal is highest- a consideration often overlooked by farmers.

But what happens if animals are maintained beyond the first profitable size? With no other action, the cost of keeping them continues to grow as an unrecoverable loss. However, there are a number of ways to create a second intersection with the value curve. The daily cost of keeping large animals, prorated against
all accumulated costs of all their siblings who were sold as skins at the optimum age/size is actually lower--that is, the cost curve, like the value curve, is actually Sigmoid ('S' shaped) when viewed over a long period. Additional 'values' can be created so that these larger animals become profit centres again. Two obvious added values for larger crocodilians are display value and as breeding stock for captive breeding. Facilities that have the capacity to display larger crocodilians and an audience willing to pay, can retrieve much of their accumulated costs. Similarly, an effective breeding adult can produce significant numbers of eggs for which the cost has already been paid over the life of the animal, and these, fed back into the production system, effectively reduce the start-up cost for a cohort of captive hatchlings, with the subsequent positive effect on the profit window. Advances in behavioural management, genetic testing and breeding, artificial insemination, and technical elements of incubation can all contribute to squeezing effective returns from larger animals.

It is also instructive to examine the impact of regulatory activities on the economics of raising crocodilians. Because of their global status and international (CITES) and national protections, crocodilians require special regulatory regimes and these unavoidably impose expense on operators that they must calculate into business plans as part of cumulative costs. Costs of regulation include license and access fees, record keeping and inventory management expense, opportunity costs of inspection (lost time, disturbance to stock) and the special requirements for export permits and tags. Examination of our Cost-Value relationship also provides rational incentives for common, although usually illegal behaviour. The obvious negative impact of high mortality can be offset by introducing new stock from the wild - either legally or illegally, and the strong incentive to do so is evident. Ironically, and counter-intuitively, it can be argued that this driver also serves as a positive incentive for sustainable use and conservation of robust wild populations. If wild populations near a farm are accessible and numerous, the cost of “replacements” is low but if the source of replacements is distant or depleted the cost may cause a detrimental up-step in the cumulative cost curve to the detriment of the profit window.

Recognition and management of the interacting economic drivers, careful and accurate accounting of real costs and knowledge-based manipulation of these factors can all contribute to economically viable crocodilian farming and ranching. The following sections of this manual provide additional detail on these factors.