Chapter 20
ECONOMICS OF BIOLOGICAL CONTROL

I. Need for Cost-Benefit Analysis in Biological Control Programs.

A. Cost-benefit analysis is the process of measuring and comparing costs and benefits associated with some action. A common use for cost-benefit analysis is to evaluate a new technology (such as use of BC agents) to see if adoption will result in higher or lower profits to associated groups such as growers, consumers, the public, etc.

B. A cost-benefit analysis can provide a systematic evaluation of a new control technique (such as IPM) compared to the old technique (such as unilateral chemical control) and indicates whether the new technique has any economic advantage and estimates the magnitude of that advantage.

C. The use of cost-benefit analysis can be helpful to those interested in the use of biological control because it helps them to:

1. Understand the value of BC better;
2. Provides a basis for deciding whether to adopt biological control (or IPM); and
3. Justify a research investment (such as grower groups funding foreign exploration for natural enemies).

D. Unfortunately, very few biological control projects have been adequately analyzed using cost-benefit analysis.

II. Data Needed in Cost-Benefit Analysis.

A. Data needed to do an ideal cost-benefit analysis on a biological control project consist of two parts:

1. Data are needed which indicate:

a. The crop damage in terms of quantity and quality resulting from varying levels of pest infestation (yield responses to insect damage);

b. The efficacy of biological control agents at different levels of infestation;

c. When applicable, the resource requirements of the biological control method (augmentation or conservation) such as labor and equipment for application (egg cards, distribution boxes, etc.), the quantity of biological control agents, and the labor required to determine the need for conservation or augmentation (field monitoring);

d. The effects in subsequent time periods on infestation, yield and other pest controls needed; and

e. The interactive relationships among biological control agents and factors such as soil fertility, crop varieties and weather.

2. Data are needed on the prices of product and inputs used in the production of the crop. In addition, where the crop may be in competition with other enterprises on the farm, costs and returns associated with the competitive crops are also needed.

B. The data that an economist needs is usually more complicated and requires extensive experimental design than the entomologist might develop on his own. The economist needs data that usually covers a greater range of conditions than the entomologist.

III. An Example of Cost-Benefit Analysis - BC of the Mexican Bean Beetle on Soybean (not an ideal case)

A. Analysis was conducted by K. H. Reichelderfer (1979) on the economic feasibility of using the parasitic wasp *Pediobius foveolatus* to manage the Mexican bean beetle.

B. Costs and returns were estimated for:

1. Conventional insect control using either carbaryl or disulfoton;

2. Biological control using the wasp; and
3. Biological control using the wasp in conjunction with commercial scouting.

C. Reichelderfer assumed that the yield was the same in each case and then computed the change in cost of production for insecticides vs. biological control.

D. Results showed that the cost of biological control was lower than the cost of insecticides giving a higher net return per hectare (assuming equal yields).

E. It was found that the net economic advantage for BC without scouting vs. conventional insecticide control ranged from $7.43 to $0.12 per hectare, respectively, in some states.

F. The economic difference suggests that the yield produce under biological control could be reduced as much as 29.3 kilos per hectare below that for insecticidal control, before BC would lose its economic advantage.

IV. Risk Dimensions for Growers Using BC.

A. All growers are decision makers who always face uncertain outcomes (Nothing is guaranteed in farming except it's a risky way to make a living). If the growers have some knowledge of the chances of possible outcomes (from paths they take) and the factors that affect the outcomes, then they will be in a better position to make decisions that include their attitudes toward risk.

B. Remember the more a grower is willing to gamble the better prospect he is to accept the idea of biological control. Those growers who cannot afford to lose much (monetarily) usually do not want to risk using BC. They rather pay the price of "prevention" insecticide treatments than take a chance on BC not coming through for them. The prevention treatments are basically an insurance policy. You must remember that because biological control is a living entity it is not always dependable because it is affected by other factors in the environment such as weather, insecticide use, etc.

V. Examples of Savings Derived from Biological Control Projects.

Table 25.1. Cost/benefit figures (in U.S. dollars) for several biological control successes resulting from CIBC wor for which fairly accurate data are available (modified from Huffaker *et al.* (1976); adjusted to the year 2000).

Pest species controlled	Area	Date of control	Total cost	Benefit per annum	Percentage of Cost	Total value benefit to Year 2000
Aspidiotus destructor [1] Coconut scale	Principe, West Africa	1956	10,000	180,000	1800	7,920,000
Diatraea saccharalis [2] Sugarcane borer	Antiqua, West Indies	1931-1945	21,250	41,250	194	2,676,250
Sugarcane borer [3]	St. Kitts, West Indies	1934	500	125,000	25,000	8,250,000
Sugarcane borer [2]	St. Lucia, West Indies	1933	2500	30,000	1200	1,860,000
Sugarcane borer [4]	Barbados	1967	150,000	1,000,000	667	33,000,000
Cardia macrostachya [5] Black sage	Mauritius	1952	25,000	250,000	1,000	12,000,000
Operophtera brumata [6] Winter moth	Nova Scotia, Canada	1954-1962	150,000	175,000	117	6,650,000
Diprion hercyniae [6] European spruce sawfly	Canada	1932-1946	250,000	375,000	150	15,875,000
Opuntia megacantha [7] Cactus	South Africa	1950	42,500	237,500	560	11,887,500
Planococcus kenyae [8] Coffee mealybug	Kenya, East Africa	1939	75,000	1,250,000	1667	76,250,000

[1] Simmonds (1960); [2] Box (1960) (to 1968 when sugar production ceased); [3] Box (1960); [4] Alam *et al.* (1971); [5] Simmonds (1967); [6] CIBC (1971); [7] Petty (1950)(not from CIBC work); [8] Melville (1959)(not from CIBC work)

Table 25.2. Estimates of savings to the agricultural industry to 1979 in California through major successful biological control projects (1928 to 1979). Modified from modified from Huffaker *et al.* (1976).

Project	Degree of Success	Yearly savings $ over previous losses plus pest control costs	Total savings $ to 1979
Klamath weed	Complete	2,000,000-weight gain in cattle (1953-1959)1 2,500,000-weight gain in cattle (1959-1979)b	66,500,000
Grapeleaf skeletonizer	Partial to complete	75 (1945-1956)[a] 100 (1956-1979)[b]	3,300,000
Spotted alfalfa aphid	Substantial	5,580 (1958-1959)[b] 3,000 (1959-1979)[b]	74,160,000
Citrophilus mealybug	Complete	2,000 (1930-1959)[a] 2,500 (1959-1979)[b]	92,500,000
Olive parlatoria scale	Complete	465 (1962-1966)[b] 725 (1967-1979)[b]	11,750,000
Black scale on citrus	Partial to complete	1684 (1940-1959)[a] 2100 (1959-1979)[b]	69,360,000
Walnut aphid	Substantial	$250 (1970-1979)[b]	2,500,000
TOTAL			987,070,000

[a] Drawn from Huffaker *et al.* (1976) cited from DeBach (1964). 1964 dollars.
[b] Computed by Huffaker *et al.* (1976) in 1973 dollars. Recalculated to 1979 dollars.

VI. Trends and Future Possibilities in Biological Control

A. During the last 20 years, more emphasis has been placed on the conservation and augmentation of BC agents as opposed to increased spending for importation of natural enemies.

B. Development of IPM and sustainable agriculture (= LISA and SARE) programs as well as ‘invasive species’ has renewed interest in BC.
C. The Federal Government has created the National Biological Control Institute (NBCI) to promote biological control with limited success due to Federal bureaucracy.
D. Funding is being allocated at the national level for applied biological control research through competitive grants programs such as the National Research Initiative (NRI) and NBCI.
E. Insect pathology has increased as a field of study, with more of a molecular biology slant.
F. Research has increased in the area of BC of weeds.
G. The importance of the evaluation phase in BC projects has been emphasized greater and more methodologies will probably be developed in the future. This is needed to address our ability to predict the outcome of introductions and possible non-target impacts.