Rearing cost analysis of natural enemy insects for fall armyworm control in Thailand

In Thailand, efforts to control the fall armyworm (*Spodoptera frugiperda*) have raised concerns about insecticide resistance, prompting the establishment of an integrated pest, disease, and weed management (IPM) system. As part of this initiative, the Department of Agriculture has promoted biological control through mass-rearing and distribution of multiple natural enemy species. However, the use of natural enemies remains limited, and their higher costs compared to chemical pesticides are major obstacles. Systematic knowledge of rearing costs is still insufficient, and variation in rearing scales reported in previous studies has hindered generalization. This study develops a cost estimation model that explicitly links release area to rearing scale, enabling evaluation of economic feasibility.

Rearing techniques at the Plant Protection Research and Development Office (PPRDO) of the Department of Agriculture were reviewed. Based on information for each operational step, required material quantities and costs were estimated from the maize area targeted for pest control. The natural enemies examined were the egg parasitoid wasp *Trichogramma pretiosum* and three predatory insects: *Eocanthecona furcellata* (stinkbug), *Sycanus versicolor* (assassin bug), and *Proreus simulans* (brown earwig). Assuming small-scale rearing at the maximum production capacity of a single worker, costs were estimated for each species. Results showed that average rearing cost per hectare declines with increasing release area due to the dilution of fixed costs (Fig. 1). For *T. pretiosum*, *E. furcellata*, and *S. versicolor*, water, utilities, and labor account for a large share of total costs, resulting in pronounced scale-related reductions (Fig. 1, Table 1). At maximum production scale, the rearing cost of *T. pretiosum* does not substantially exceed that of emamectin benzoate 5% water-dispersible granules, which are widely used in Thailand (≈9 USD ha^{-1}), suggesting it could partially substitute for chemical control (Fig. 1B, Table 1).

The cost estimation approach is applicable to other species and regions, providing a basis for the economic assessment of biological control. The model is simplified for laboratory-level estimation, based on standardized production periods, single-worker capacity, and assumed release densities, and may require adjustment for specific objectives. The labor and costs associated with release operations, as well as the use and production of natural enemies during pest-free periods, also warrant examination. As this analysis relies solely on PPRDO data, further data collection and validation are needed. Beyond rearing costs, further research on control efficacy, optimal release densities, and integration with other control methods is needed to support practical implementation.

Authors: Kusano, E., Kobori, Y. [JIRCAS]

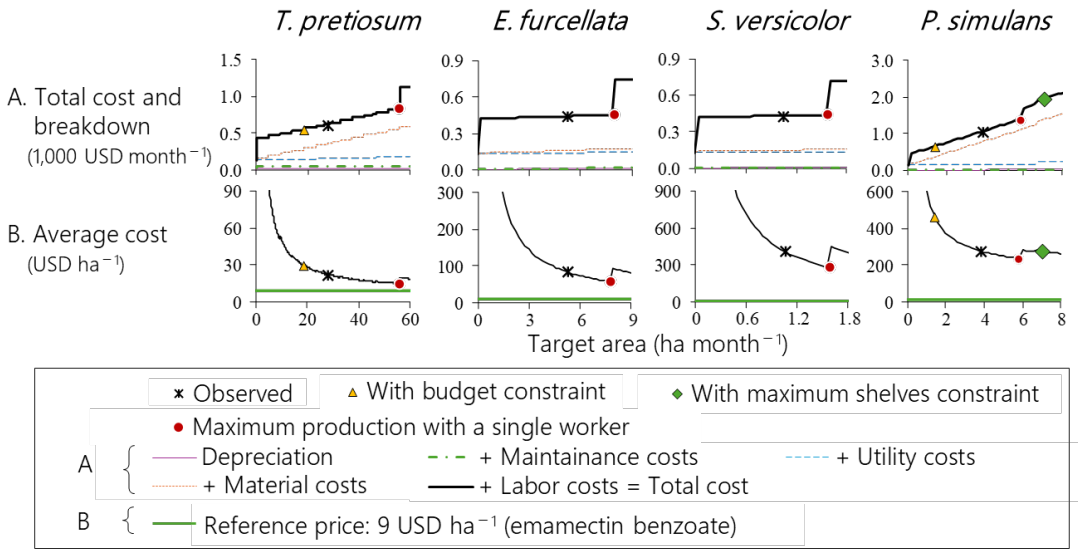

Fig. 1. Total and average costs of rearing natural enemy insects

Panel A shows stacked line charts of model-estimated costs, with observed values overlaid. Panel B shows line charts of model-estimated costs, with the reference price (9 USD ha^{-1}) indicated for comparison. "Observed" represents results from PPRDO interviews. "With budget constraint" indicates the level of subsidies for rearing natural enemy insects, and "With maximum shelves constraint" refers to the largest rearing scale that can fit in the room given shelf availability. Symbols were omitted when estimated values under budget or shelf constraints were excessively large. The target area was determined by the number of natural enemies used and the release density. Estimated costs include materials for release but exclude labor costs.

Table 1. Rearing cost breakdown at maximum single-worker scale

Item	*T. pretiosum*	*E. furcellata*	*S. versicolor*	*P. simulans*
Basic assumptions and results				
Target area (ha month^{-1})	55.93	7.93	1.59	5.82
Release density	62.5	3,125	3,125	10,000
Cost breakdown				
Total cost (USD month^{-1})	820	455	437	1,377
Average cost per NE (USD unit^{-1})	0.235	0.018	0.088	0.024
Average cost per area (USD ha^{-1})				
Total	14.67	57.40	275.73	236.77
Material cost	6.71	3.70	10.13	161.42
Depreciation	0.34	1.46	4.35	3.42
Maintenance cost	0.57	0.18	0.89	0.49
Labor cost	4.81	35.73	178.68	48.72
Utility cost	2.22	16.33	81.67	22.72

Values represent rearing costs at the maximum production scale of a single worker. NE = natural enemy. Release density indicates the number of NEs released per crop field. Units: *Trichogramma pretiosum* = strips of 3,571 *Corcyra cephalonica* eggs parasitized; predatory NEs = number of insects. Exchange rate: USD 1.00 = 35.29 Thai Baht (average for 2024).

Reference: Kusano et al. (2026) *CABI Agric Biosci* 7: 0006.

The figure and table are reprinted/modified from Kusano et al. (2026).