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IT PAYS FOR GOVERNMENT TO INVEST IN BIOLOGICAL CONTROL R&D FOR AGRICULTURE:
CASE OF TRICHODERMA KONINGII FOR HIGHLAND FARMING

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HIGHLIGHTS

- Organic and good agricultural practices (GAP) farmers use *T. koningii* as biofungicide, soil amendment, and compost enhancer;
- *T. koningii* is effective against Fusarium wilt in sweetpotato and chrysanthemum (farmer testimonies);
- The sales of *T. koningii* pure culture at the BSU Plant Health Clinic is fluctuating but increasing at 29.7% annually; adoption rate in Benguet is roughly estimated at 0.03% in 2018.
- Major constraints to adoption are high price of pure culture, misconception that *T. koningii* is for organic farmers only, slow effect of the technology, limited information, limited market outlets and marketing strategy.
- Use of *T. koningii* increases yield by 4% to 92% based on field and pot experiments, and 10% to 50% based on farmer interviews (various crops and uses in the Benguet highland areas).
- The estimated aggregate benefits of investing in *T. koningii* R&D, measured using net present value (NPV), is Php4.3 M, and the internal rate of return (IRR) is 49.1% assuming 10-year period and 10% real social discount rate of pure culture sales, the NPV is Php26 M.
- Sensitivity analysis showed that as long as the incremental net benefit of using *T. koningii* R&D in a farmer's field is more that Php2000 per 500 sqm, then the estimated benefits to society of investing in *T. koningii* is positive.

INTRODUCTION

Biological control (BC) agents for agriculture aim to reduce dependence on hazardous synthetic pesticides, to ensure sustainability of farm resources and biodiversity, and to increase production, productivity, and farmers' income.

While researchers in the Philippines have already developed many BC products and biofertilizers, not many studies have evaluated and measured the actual and potential economic impact of BC research outputs in the Philippines. Moreover, despite the many BC research being conducted by research institutes and academic institutions, farmers who adopt good agricultural practices (GAP) and organic agriculture still lack ready-to-use biological pesticide and fertilizer inputs that they can use in their farms. It appears then that there is a gap between the research community and the farmers in terms of technology uptake or adoption, hence affecting the impact of BC R&D outputs.

This study takes the case of *Trichoderma koningii* strain KA, a fungus isolated by Dr. Asuncion Nagpala of Benguet State University (BSU) in 1997 from the soils of the Cordillera region with Utility Model Registration No. 22012000111 in 2012. It aimed to determine the adoption rate, constraints to adoption, and costs and benefits of using *T. koningii* in highland farming.

Trichoderma koningii strain KA

T. koningii is a microorganism found to be effective biological control for various diseases of highland horticulture crops, and a catalyst for composting (Bandao, 2017; Bulcio and Nagpala, 2014; Calpi, 2016; Galian and Nagpala, 2006; Mangili et al., 2008, 2014; Nagpala, 1999). Its application in the soil minimizes chemical-use because it not only controls pests, but also enhances plant growth and development that ultimately results in increased pest resistance and tolerance (Mangili et al., 2008).

T. koningii in pure culture form is currently available at the BSU Plant Health Clinic (BSU-PHC), and Bureau of Plant Industry-National Crop Research and Development and Production Support Center (BPI-NCRDPSC). The BSU-PHC produces and sells *T. koningii* strain KA pure culture at Php70 per plate. BPI-NCRDPSC, under its Trichoderma commercialization program provides it for free to farmers who attend trainings on the use and mass production of Trichoderma.

Figure 1. Trichoderma koningii pure culture being produced at BSU-PHC

METHODOLOGY

The study cost-benefit analysis (CBA) considering only incremental yield and reduced production cost based on experiments from Cordillera-based literature in the estimation of incremental net benefits.

Adoption rate, on the other hand, was estimated using actual sales data *T. koningii* pure culture from the BSU-PHC adjusted by -20% to account for potential non-use advantage.

For the cost measures, all costs from isolation, pot and greenhouse and field experiments, IP protection, pilot testing, promotion and production were included. The authors used NPV, IRR and BCR as evaluation criteria; 10% as social discount rate based on NEDA-ICC (2016); CPI base year 2012 based on PSA (2018) to account for inflation; 90% of market wage rate as shadow wage rate; and market for output prices.

Data for the CBA were collected using document and local literature review, key informant interviews, and expert opinion. Case studies supplemented the key informant interviews to understand the adoption constraints, and capture nuances and other impacts of the *T. koningii* biocontrol technology.

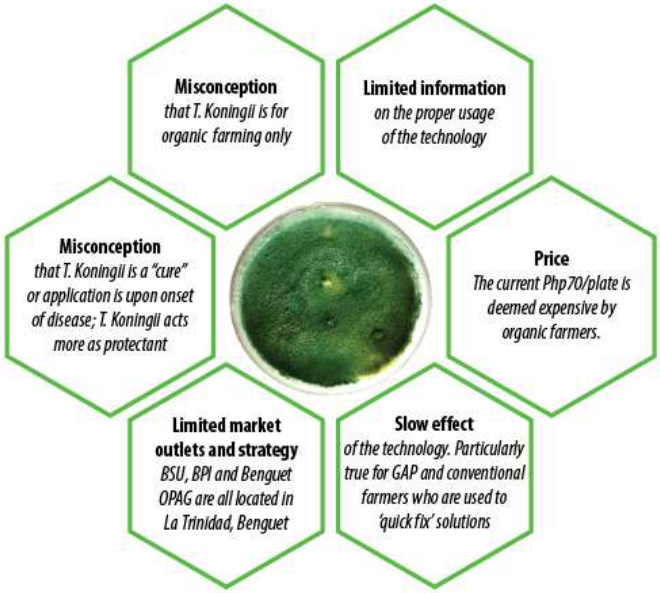
FINDINGS

Adoption Status

The total sales of the *T. Koningii* pure culture from 2011 to 2018 increased at a geometric annual growth rate of 29.7% based on the available data from BSU-PHC. The number of customers has increased until 2016 but decreased in 2017 owing to the BPI-NCRDPSC Trichoderma commercialization project. About 17% of the total number of buyers at the BSU-PHC have repeated purchasing the *T. Koningii* pure culture. The nature of *T. Koningii* being a fungus is it could stay and reproduce in the soil for extended period given suitable environmental conditions.

Over the years, the market of the technology expanded to as far as South Cotabato in 2016. In 2018, the estimated adoption rate of the BSU produced *Trichoderma koningii* in Benguet is at 0.03% and 10 % for the organic farmers under the BSU Internal Guarantee System.

Perceived Constraints to *T. koningii* Adoption



Effects or Changes Because of Using the Technology

Effect of T. koningii application based on field and pot experiments

The following table presents a summary of changes in mean yield of harvested crops per hectare because of using *T. koningii* based on various experiments conducted for various crops under highland conditions from literature.

Source of field experiment	Crop/Location (Town)	Disease/ Use	Farmers' Practice (FP)	Treatment	% Increase in mean total yield (t ha^{-1})
Nagpala, 1999	Garden pea/ La Trinidad	Root rot/wilt	Urea +lime	Urea+lime+*T. Koningii*	4%
Galian, J. 2005	Garden pea	Plant growth promoter	Untreated	30 g *Tricho. KA*	12%
Mangili et al., 2008	Cabbage/ Buguias	Clubroot	Pentrachlo-nitrobenzene	*T.Koningii* cultured in rice hull substrate (1 tbs/planting hole)	25%
	Chinese cabbage/ Buguias	Clubroot	Pentrachlo-nitrobenzene	*T.Koningii* (same as above)	28%
Bulcio and Nagpala, 2009	Cabbage	Clubroot	T14+urea +lime	20 g *Tricho. KA*	28%
Mangili et al. 2014	Strawberry/On-station	*Fusarium* and *Phytopthora*	Untreated (FP)	*T.Koningii* only grown in rice hull	17%
	Strawberry/ Betag,.La Trinidad	*Fusarium* and *Phytopthora*	Untreated (FP)	with spore count of $1x10^7$ @1tbsp/hill)	16%
	Strawberry/ Puguis, La Trinidad	*Fusarium* and *Phytopthora*	Untreated (FP)		29%
	Potato-on station	Bacterial wilt	Untreated	*T.Koningii only*	24%
	Potato/Benguet	Bacterial wilt	Untreated	*(same as above)*	47%
Galian, J.L. 2017	Sweet potato/	Fusarium wilt	Untreated	20 plates/1 hectare	92%
			Benomyl	20 g/16 li	18%

Perceived effects or changes based on farmer interviews

10 - 50% increase yield due to less occurrence of crop diseases

Saved PhP 16,000 to PhP 51,000 ha^{-1} from farm inputs

Stable, faster growth and higher survival rate, resistance to blight and lower soil borne disease incidence

Cost Benefit Analysis

The incremental net benefits of using *T. koningii* ranged from Php 28,528 to Php 249,200 per hectare per year or average of Php 138,134 per hectare per year based on the value of the summarized yield changes and associated input changes. This incremental net benefit estimate was multiplied with the estimated time series adoption area for the technology derived using the 35 packs per hectare farmer application rate to generate the benefit streams.

On the other hand, the government invested a total of Php 2.84 million for research, development and promotion of *T. koningii*. This amount includes the costs of isolation, pilot testing, pot and field experiments, and operating and maintenance cost of the *T. koningii* pure culture production. While the benefit measures were conservative including only the sales from the BSU-PHC, the cost estimates included those incurred by the BPI-NCRDPSC also a government agency.

Assuming a 10-year period, the total discounted benefits is Php 6.12M and a total discounted cost of Php 1.8M. The computed NPV is Php 4.3M, BCR is 3.4, and IRR is 49.1%.

Extending the analysis to 20 years and assuming an annual growth rate in sales of *T. koningii* pure culture at 29.7% would give an NPV of 26 M and IRR of 51.8%. Even assuming the lowest net incremental benefit of Php 28,528 per hectare per year, the NPV is still positive at Php 3.7M with IRR of 13% higher than the 10% hurdle rate if the project duration is 20 years. Also assuming the *T. koningii* annual sales growth assumption is only 5%, the NPV is still positive at Php 1.02 M.

The above economic impact measures do not include the valuation of other social impacts associated with reduced use of synthetic pesticides and fertilizers. For example, the use of *T. koningii* as substitute to synthetic fungicides would also mean lowering health risk not only to the user but also to community members. Using *T. koningii* also helps improve soil nutrient uptake and nitrogen metabolism (Galian, 2017) which could reduce use of chemical-based fertilizer thus possibly generating environmental benefits. Finally, with BC products promising safer food, there is also a potential demand-side benefit particularly the increased willingness to pay for safe vegetable products.

Sensitivity Analysis

Varying real SDR assumption (10yrs)

	NPV (PhP)	BCR	IRR
5%	6.0M	3.73	56.1
10%	4.3M	3.43	49.1
15%	3.1M	3.09	42.5

Varying sales growth rate assumption (20yrs)

	NPV (PhP)	BCR	IRR
5%	10.2M	5.70	50.7
10%	11.9M	6.51	50.9
15%	17.3M	8.98	51.4

Varying incremental net benefits (10yrs)

	NPV (PhP)	BCR	IRR
28670	-513023	0.71	
138564	4.3M	3.43	49.1
249480	9.1M	6.18	77.4

It Pays for Government to Invest in Biological Control R&D for Agriculture: Case of *Trichoderma koningii* for Highland Farming

CALL TO ACTION

- This study presents evidence of positive economic return on investment from *T. koningii* R&D. Funding agencies and donors can consider supporting similar effective biological control R&D and commercialization efforts.
- For BCA researchers, demonstrate as many empirical evidences of the efficacy of your BCA at the on-farm field level for various crops and pests or diseases. Documented evidences and participatory experiments are important in technology promotion, marketing and impact evaluation.
- Timely intellectual property registration of BCA is important to increase potential for commercialization.
- An increased market for the pure culture can reduce the production cost per unit given the present overhead cost. BSU-PHC can collaborate with the BSU-University Business Affairs unit to expand the *T. koningii* pure culture production and marketing.
- BSU-PHC can train strategically located farmer-entrepreneurs to mass-produce *T. koningii* in substrate. These trained producers can continue to avail of the pure culture at BSU.
- BCA researchers can consider conducting further on-farm and participatory field experiments to determine optimal rates, method and timing of use of *T. koningii* for combatting fusarium wilt, clubroot and other diseases.

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ABOUT THE MATERIAL

Informing Policy and Practice is published quarterly by the Institute of Social Research and Development and R & E Publications Office of Benguet State University. It synthesizes findings from research and development activities, or presents results of quick survey and opinion poll on social, economic, and policy issues and concerns affecting the Cordillera region. It also distills the key messages and provides recommendation for the information and consideration of relevant stakeholders and policymakers.

This issue presents evidence that it pays for government to invest in effective biological control/ R&D for agriculture.

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