

# **Agro-Ecological Technology – The Importance of Enhancing Farmers’ Ecological Literacy and Designing Innovative Communication Messages**

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## **Abstract**

Farmers’ ecological illiteracy has deepened their dependency on insecticides. Ecological processes are unobservable and effects often delayed. Thus despite multi-million dollar farmer field training programs to increase knowledge and skills, pesticide dependency had continued to persist. Training content generally lacked ecological principles leaving farmers lack of confidence to sustain ecological practices. Important interventions to help wean rice farmers from insecticide use in rice production will need to include training courses that focus on ecological principles such as plant compensation, secondary pest developments, pest population dynamics, naturally occurring biological control mechanisms, the important roles of non-rice habitats and the impact of insecticides on pests and natural enemies. This paper discusses with examples how ecological principles might be transformed into “simple rules” and using psychology principles to create games, analogies and farmer experiments to enhance learning using experiential learning methods and to build farmer confidence. Using cost effective media strategies such as multimedia campaigns and entertainment education programs on radio and TV ecological principles had been up-scaled to reach millions and facilitated change in mindsets and practices among rice farmers.

**Keywords:** Ecological literacy, cognitive dissonance, analogy technique, media, soap opera, communication

Ecological illiteracy continues to force farmers to be “locked into” pesticide dependency (Wyckhuys *et al*, 2019). Ecological processes are difficult for farmers to observe and often their effects are time delayed. Rural development and extension programs generally use farmer training to improve farmers’ knowledge and skills. However, increasing farmer knowledge may not necessarily translate into improving farmers’ decisions and practices. In many cases despite weeks of field school training changes in farmers’ practices did not sustain and they quickly reverted back to using pesticides as before. For instance in Indonesia millions of rice farmers underwent 16 weeks of Integrated Pest Management (IPM) training but today their insecticide use is among the highest in Asia. Training course contents usually lack key ecological principles leaving farmers lack of confidence in sustaining changes in their practices. Ecological principles such as predation, parasitism, plant compensation, secondary pest development mechanisms, naturally occurring biological control mechanisms and the impact of insecticides on these processes are seldom taught. Also ecological processes are unobservable and have delayed effects and thus difficult to teach. In addition pesticide marketing in most Asian countries is poorly regulated allowing pesticides to be sold as “fast moving consumer goods (FMCGs) with aggressive advertising, fake information to create fear, sales incentives and marketing campaigns to entice farmers to spray unnecessarily.

Agro-ecological technology applies ecological and social concepts and principles to enhance interactions between plants, animals, people and the environment so as to maximize local ecosystem services. It focuses on the ecological and social aspects in food production systems in order to develop sustainable and fair food systems. Among the elements of agro-ecology are diversity, synergies, efficiency, resilience, social values and responsible governance. The main principles are improving efficiency in resource use, conserving and protecting natural ecosystems, protecting rural livelihoods, equity and social well-being and enhancing resilience of people communities and ecosystems.

In this paper I would like to illustrate with some examples how we had transformed ecological principles into “simple rules” and used principles of psychology to create games, analogies and farmer experiments to enhance learning using experiential learning methods. These rules and games were then utilized in media strategies, such multi-media campaigns, entertainment education programs on radio and TV to upscale and reached millions.

## **Experiential learning techniques to communicate ecological principles and modify mindsets.**

**Cognitive dissonance technique.** Spraying in the early crop stages is not necessary and waste of money.

Many rice farmers in Asia would spray their crops early in the season thinking that these sprays would protect their fields from insects, especially the leaf feeders. However these sprays are often unnecessary, wasteful and even more damaging to production. At the early crop stages, a huge diversity of predators would migrate into the crop from neighboring habitats and spraying would be counter-productive as they destroy millions of naturally occurring biological control agents. In addition because of rice's plant compensation abilities, leaf damages at the early crop stages would have no yield consequences. These ecological concepts were "distilled" into a "simple rule" and farmers were invited to experiment by leaving half their fields that would not receive sprays in the first 40 days of the crop and the other half their normal practices. At the end of the season farmers would measure the yields from the 2 plots. Since early season spraying had always been the norm, farmers when presented with this rule were in cognitive dissonance and the yield results of the experiment would help them resolve their dissonance.

A simple rule-of-thumb, or heuristic, in pest management which was in conflict with farmers' prevailing perceptions was communicated to farmers to examine whether their cognitive dissonance would challenge them to evaluate it and change their misperceptions (Heong and Escalada 1997). Cognitive dissonance refers to a state when conflicting attitudes, beliefs or behaviors are presented. This produces a feeling of mental discomfort leading to an alteration in one of the attitudes, beliefs or behaviors to reduce the discomfort and restore balance. The simple rule used was: "In the first 40 days of the crop, leaf feeding insect control is not necessary." The farmer experiments were carried out by 101 rice farmers in Leyte Philippines and the numbers of sprays were reduced from 3.2 to 2 per season or about 40 %. Farmers' attitudes toward leaf-feeding insects also changed from 62.4% to 9.9 % believing that they needed to be sprayed.

**Leaf cut experiment** to illustrate the power of plant compensation.

Plant compensation is not easily observable to farmers. We invited farmers to cut leaves of the rice crop in a plot and compare the yields of the uncut plot. This field

experiment could be easily performed by using a shear to cut about a third of the leaf canopy in a plot and fenced it up. After 2 weeks farmers visited the area and observed that the cut plot and control plots had no significant differences because of plant compensation. At the end of the season yields of the uncut and cut plots were compared. Farmers then assigned local names, like Makabawi (in Tagalog) and Phuc Hoi (Vietnamese) to the plant compensation process.

### **Analogy technique** to illustrate egg parasitism

The “Analogy technique” is often used in management training and is based on using typical features of a known situation, finding similarities with these features and using them as mental stimuli. Egg parasitism is an important mortality factor to rice planthoppers. The ecological concept of parasitism is unknown to most farmers as it is not observable and difficult to see tiny hymenopteran parasitoids. Thus farmers do not have any local names for parasitoids. We used the analogy technique with bees as the known entity to parallel parasitoids as beneficial insects and thus needed to be protected from insecticide sprays. Farmers then called the parasitoids “small bees”. This techniques was used in the TV program series to help farmers understand and to act to restore biodiversity in the rice ecosystem in Vietnam (Heong *et al* 2014).

### **Cognitive game** to challenge overestimation of yield loss caused by stem borer pests

Cognitive techniques are often used in psychology to challenge and modify maladaptive thoughts, beliefs and images. Rice farmers generally overestimate losses from pest attacks and thus make unnecessary insecticide sprays—a loss aversion behavior. A cognitive exercise to facilitate the computation of yield loss from white head symptoms of rice stem borers was found to effectively help rice farmers make adjustments to their biases (Escalada and Heong 2004). After participating in the exercise, farmers reduced their insecticide sprays for stem borer control by 22% and their intended insecticide expenditures by 45%. The control farmers on the other hand did not reduce their sprays and reduced their intended expenditures by only 14%. Farmers who had done the exercise reduced their estimated loss from white head by 27%, while there was no reduction in control farmers. Similarly, farmers also reduced their control expenditures and perceptions of loss by 43% and 54%, respectively, while control farmers’ reductions were lower, 22% and 31%, respectively. Compared to the control farmers, higher reductions in beliefs were also found in farmers exposed to this

exercise. This participatory exercise has the potential of being implemented in extension, training and mass communication programs to educate farmers on plant compensation.

## **Cost effective media strategies for reaching millions**

### **Multi media campaigns**

A multi media campaign was used to motivate rice farmers in the Mekong Delta to modify their beliefs and pest management practices together with seed and fertilizer inputs (Huan *et al* 2008). Locally named ‘Ba Giam Ba Tang’ or ‘Three Reductions, Three Gains’, campaigns using leaflets, posters, billboards and radio spots, were launched in two provinces, Can Tho and Tien Giang. In both provinces, farmers’ practices changed significantly. Their insecticide sprays reduced by 13– 33 % while their seed rates dropped 10% and nitrogen rates, 7% and proportion of farmers using insecticides declined by 11%. These practices were supported by modifications in belief attitudes that favored high inputs. Farmers who reported significant reductions in the three inputs also changed their perception of yield loss. The campaigns in Can Tho and Tien Giang had significant multiplier effects. They stimulated several provincial governments as well as the Ministry of Agriculture and Rural Development to provide additional resources to reproduce the materials and campaign process for local use which eventually reached more than 3 million farmers in south and central Vietnam.

### **Radio soap opera series**

A radio soap opera created using the entertainment–education (E–E) process contributed towards creating favorable attitudes and change practices in rice farmers’ pest management in Vietnam (Heong *et al* 2008). Between pre- and post-launch of the soap opera farmers’ insecticide sprays dropped 31% from 1.9 to 1.3 sprays per season. Corresponding changes in attitudes were also observed. In addition, farmers also reduced their nitrogen and seed use by 7 % and 9 %, respectively. In the post-test farmers who had listened had higher reductions in insecticide sprays (60 %), nitrogen (9 %) and seeds (33 %) compared to those who had not listened to the soap. There were also similar changes in their belief attitudes favoring judicious use of pesticides, fertilizers and seeds. We also found that the E–E process provided a platform for communication between technical specialists and creative artists, thus enabling technical information to be simplified and incorporated into drama scripts.

## TV program series to restore rice landscape biodiversity

A TV series using entertainment-education principles and broadcast over Vinh Long Television station in Vietnam helped changed rice farmers' beliefs and pest management practices (Heong *et al* 2014). The evaluation survey conducted two months after the end of the broadcast showed that farmers sprayed significantly less insecticides (19 % less), used less nitrogen fertilizer (6 % less), and used lower seed rates (12 % less). In addition, there were significantly more farmers believing in statements that favor ecological engineering among the viewers than the non-viewers. Viewers scored higher in the belief index compared to the non-viewers by about 14%, indicating that their attitudes towards ecological engineering practices had gained positively. Although there was about a 9% increase in favor of ecological engineering adoption, there were at least two barriers that remain unchanged.

The TV series had succeeded in initiating changes in farmers' beliefs and adoption of ecological engineering practices. This might be due to entertainment-education content and the engagement of key stakeholders and partners in the project process. Decision theories and sociological tools and a six phase engagement process were used to ensure quality partnerships with local stakeholders.

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# 農業生態科技：強化農民生態素養和設計創新交流訊息的重要性

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## 摘要

缺乏生態素養會加深農民對農藥（殺蟲劑）的依賴。生態學上的過程難以觀察，而其影響亦通常不會在第一時間顯現。因此，縱使花費數百萬元訓練農民以增進其相關知識與技能，對農藥的依賴依然故我。訓練的內容一般缺乏可資依循的生態準則，致使農民缺乏維持生態實踐的自信。欲幫助稻農戒除農藥的使用，相關的重要介入措施包括在訓練課程中強調生態準則，如植物補償、次級病蟲害發展、害蟲族群動態、天然生物性防治機制、非稻田棲地的重要角色、農藥對害蟲和天敵的影響等等。本文舉例討論生態準則如何轉化為「簡明規則」，並依心理學原理創造遊戲、類比、農民實驗，以體驗式學習法強化學習，進而建立農民自信。透過廣播與電視上的多媒體宣傳活動和娛樂教育節目等具有良好成本效益的媒體策略，生態準則的受眾得以擴及數百萬人次，並促使稻農的心態和實踐手法有所改變。

**關鍵詞：**生態素養、認知失調、類比技巧、媒體、肥皂劇、通訊

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為使多數讀者可清楚瞭解本研究內容，本場特委託專業翻譯團隊將原文譯為中文，為利閱讀流暢，部分語句可能與原文直譯略有差異。



缺乏生態素養令農民只能持續依賴著農藥（殺蟲劑）（Wyckhuys 等，2019）。農民難以察覺生態學上的過程，而其影響亦鮮於第一時間顯現。農村的發展和擴張計畫一般常透過訓練來改善農民的知識和技能。然而，增進農民的知識不代表他們的決策和實踐會一齊進步。許多案例中，儘管接受了數週的田野學校訓練，農民的實踐改變無法持久，很快又會回到使用農藥的老路。舉例來說，印尼有數百萬名稻農接受了 16 週的病蟲害整合管理 (Integrated Pest Management) 訓練，但是如今印尼的農藥使用量仍舊在亞洲國家中名列前茅。訓練課程的內容常缺少關鍵的生態準則，使得農民沒有自信能維持實踐方法的改變。生態準則包括捕食行為、寄生行為、植物補償、次級病蟲害發展機制、天然生物性防治機制、農藥對上述過程的影響等。農民接受的訓練內容鮮少觸及這些生態準則，再加上生態過程難以觀察，造成的影響也不會立即顯現，因而造成教導上的困難。此外，許多亞洲國家對農藥的行銷缺乏妥善規範，使農藥商得以利用積極廣告、假訊息製造恐慌、促銷優惠、行銷宣傳等手法誘使農民噴灑不必要的農藥，令農藥成為快速消費品。

農業生態科技運用生態與社會概念和準則，強化植物、動物、人與環境間的互動，以將當地的生態系服務最大化。這類科技著重在糧食生產系統的生態和社會層面，目的是為了發展永續公平的糧食系統。生態農業的元素包括多樣性、綜效、效率、韌性、社會價值、責任治理等。主要原則在於改善資源利用的效率；保育和維護自然生態系統；維護農村生計、公平性、社會福利；強化人類聚落和生態系統的復原力。

本文意圖透過案例述說我們如何將生態準則轉化成「簡明規則」並使用心理學原理創造遊戲、類比、農民實驗，進而利用體驗學習方法強化學習，再將這些規則和遊戲運用在媒體策略中，如多媒體宣傳以及廣播和電視上的娛樂教育節目等，以傳播至數百萬民眾。

### **透過體驗式學習技巧傳授生態準則並改變心態。**

**認知失調技巧：**種植作物初期灑農藥不但沒必要還浪費錢。

亞洲地區有許多稻農會在作物成長初期就噴灑農藥，希望藉此保護農田不受害蟲侵擾，特別是啃食稻葉的昆蟲。然而，這時期的農藥噴灑經常是不必要的，不只浪費，更可能有害收成。在作物生長初期，有多種多樣的掠食者會從鄰近的棲地遷移到作物區，噴灑農藥會摧毀數以百萬計自然出現的生物防治媒介，反而對作物不利。此外，由於稻米的植物補償能力，生長初期的葉片損傷對產量沒有實質影響。將這些生態觀念「去蕪存菁」後，轉化成簡明的規則，並邀請農民參與實驗，將一半的農田在播種後的最初 40 日不噴灑農藥，另一半則維持他們的一

貫作法。待當季收成結束後，由農民量測兩邊田地的產量。因為農民已認定在生長初期灑農藥的方式是常規作法，上述的實驗規則令其發生認知失調，而實驗的產量成果則幫助這些農民解決失調問題。

在害蟲防治的操作上，衝擊農民普遍認知的實踐方法，透過簡單的經驗法則或啟發式的教學方法，讓農民得以檢視自己的認知失調是否挑戰並改變了自己過去的誤解 (Heong & Escalada 1997)。認知失調是指在態度、信仰、行為等方面發生衝突的狀態。認知失調會讓心裡產生違和感，迫使個人在態度、信仰或行為方面作出改變以降低違和感並取回平衡。這裡採用的簡明規則是「作物生長的頭 40 天不需要防治食葉的昆蟲」。農民實驗經由 101 名菲律賓雷伊泰 (Leyte) 省的稻農實行，噴灑的次數由一季 3.2 次降至一季 2 次，約減量 40%。農民對食葉昆蟲的態度也有所變化，相信有必要噴灑農藥的農民比例由 62.4% 降至 9.9%。

**葉片修剪實驗：**展現植物補償的力量。

農民無法輕易觀察到植物的補償效應。我們請農民在一邊的耕地上剪掉稻作的葉子，與另一邊未剪葉的稻作產量相比較。此田野實驗的執行方法簡明，用一把剪刀剪掉葉冠約三分之一的部分，再將剪葉的區域用圍籬圍起來。經過 2 週後，農民巡視該區域，觀察後發現因為植物補償效應的關係，剪葉區和未剪葉的對照區未呈現顯著差異。季末亦比較剪葉和未剪葉區的收成產量。農民以當地方言（如他加錄語的 Makabawi 和越南語的 Phuc Hoi，意指「恢復」）替植物補償效應命名。

**類比技巧：**描述卵寄生行為。

類比技巧常用於管理訓練，以已知情況的典型特色為基礎，尋找與這些特色的相似之處並用以進行心理刺激。卵寄生是稻蟲的重要死亡因素，大多數的農民不清楚寄生的生態觀念，這是因為他們難以觀察寄生行為也看不太到微小的膜翅目寄生生物。因此，該寄生生物在當地語言中並沒有名稱。我們用類比的方法，將已知的蜜蜂與寄生生物做聯想，視其為益蟲，需要保護益蟲不受農藥危害。農民因而稱呼寄生生物為「小蜂」。這種類比技巧也在電視節目系列中採用，用來幫助農民理解並採取行動，恢復越南的稻米生態系統多樣性 (Heong 等, 2014)。

**認知遊戲：**對高估螟蟲造成的產量損失作挑戰

認知方法常用於心理學範疇，挑戰、修正適應不良的想法、信念和印象。稻農一般會高估蟲害造成的損失，因而噴灑不必要的農藥，希望能避免損失。研究發現認知練習有助於計算因螟蟲造成的白穗症狀所導致的產量損失，因而有效幫助稻農調整認知偏差 (Escalada & Heong 2004)。在參與該練習後，農民減少為控制

螟蟲而灑的農藥量達 22%，預期農藥花費減少 45%。對照組的農民沒有減少噴灑的量，預期的農藥花費只減少 14%。參與練習的農民降低了 27% 的白穗症預期損失，但對照組沒有降低的現象。從農民的蟲害防治花費和對損害的認知兩方面的降幅也可觀察到相同的趨勢。練習組分別降低 43% 和 54%，而對照組則降幅較小，為 22% 和 31%。相較於對照組，參與練習的農民有較多的信念降幅。此參與式練習具有延伸應用的潛力，可擴大訓練並利用大眾傳播節目教育農民植物補償的機制。

## 擴及數百萬人的高成本效益媒體策略

### 多媒體宣傳

多媒體宣傳已被用來鼓勵湄公河三角洲的稻農修改他們一直以來的想法和害蟲防治措施，以及種子和肥料的投入 (Huan 等, 2008)。當地將相關宣傳活動定名為「Ba Giam Ba Tang」，意即「三減三增 (Three Reductions, Three Gains)」。此活動利用傳單、海報、佈告欄、廣播廣告時段等媒介，在芹苴 (Can Tho) 和前江 (Tien Giang) 兩省宣傳。兩省的農民務農手法都有顯著的改變，農藥噴灑量下降了 13 - 33%，種子用量下降 10%，氮肥使用率下降 7%，使用農藥的農民比率下降 11%。修正偏好高投入的態度後，讓農民更為支持此種作法。報告顯示，在上述三層面有顯著減量的農民也改變了對產量損失的看法。在芹苴和前江省的宣傳有顯著的加乘效應，刺激了許多省政府和農業與農村發展部 (Ministry of Agriculture and Rural Development) 提供更多資源，重製在各地使用的材料和宣傳程序，最終擴及越南中部和南部超過 3 百萬的農民。

### 廣播肥皂連續劇

一齣用娛樂 - 教育程序製作的廣播肥皂劇，促成了越南稻農在害蟲防治的態度和措施上有正向轉變 (Heong 等, 2008)。自肥皂劇播出後，農民的農藥噴灑自播出前的一季 1.9 次下降至一季 1.3 次 (31%)，同時也觀察到農民態度上的轉變。此外，農民也減少了他們的氮肥 (7%) 和種子使用量 (9%)，在後測階段，有收聽肥皂劇的農民比起未收聽的農民，在農藥、氮肥、種子的用量上都有較大幅的減量 (分別是 60%、9%、33%)，在農民秉持的態度上也有相應的改變，改為偏好合理的使用農藥、肥料和種子。我們也發現娛樂 - 教育程序提供了一個溝通平台，讓專業技術人員和創意藝術家互動，使專業技術資訊得以簡化，並整合進戲劇劇本中。

## 恢復稻田生物多樣性的電視節目系列

一齣運用娛樂－教育原則的電視連續劇在越南的永隆電視台 (Vinh Long Television) 播放後，促使稻農的想法和害蟲防治措施發生改變 (Heong 等, 2014)。在播放完畢兩個月後進行的評估調查顯示，農民的農藥噴灑、氮肥使用、種子使用率皆有顯著下降 (19%、6%、12%)。除此之外，比起未收看節目的族群，收看節目的族群中有顯著更多的農民相信有益生態工程的意見，且信念指標分數高出約 14%，代表他們對生態工程手法的態度正向增加。雖然有意願採用生態工程方法的農民增加了 9%，仍然有兩層障礙需要突破。

該齣電視連續劇成功啟發了農民的生態信念和採取生態工程方法的契機。這可能是歸功於娛樂－教育的內容和計畫過程中有重要利害關係人與合作夥伴的參與。透過決策理論、社會學工具和六階段參與程序，與當地利害關係人間的高品質合作因而得以實現。