出國報告（出國類別：實習）

參加亞非農村發展組織（AARDO）永續農業發展訓練計畫出國報告

Training Programme on “Sustainable Agricultural Development”

21 October – 10 November 213

Seongnam & Daegu, R O. Korea

服務機關：行政院農業委員會農業試驗所
姓名職稱：鄧汀欽 研究員
派赴國家：大韓民國
出國期間：102 年 10 月 21 日至 102 年 11 月 10 日
報告日期：103 年 1 月 13 日

公務出國報告摘要

頁數：共 40 頁

報告名稱：永續農業發展訓練計畫

（Training Programme on“Sustainable Agricultural Development”）

主辦機關：行政院農業委員會

聯絡人/電話：鄧汀欽研究員/ 04-23317514

出國人員：行政院農業委員會農業試驗所 鄧汀欽研究員

出國類別：實習

出國地區：大韓民國京畿道城南市及慶尚北道大邱廣域市(Seongnam & Daegu, Korea)

出國期間：民國 102 年 10 月 21 日至 11 月 10 日

報告日期：民國 103 年 1 月 10 日

分類/目： F0/綜合（農業類）

關鍵詞：亞非農村發展組織(Afro-Asian Rural Development Organization, AARDO)、農林畜產食品部(Ministry of Agriculture, Food and Rural Affairs, MAFRA)、農村振興廳(Rural Development Administration, RDA)、農食品公務員教育院(Food and Agriculture Officials Training Institute, FATI)、韓國國際協力團(Korea International Cooperation Agency, KOICA)、慶北國立大學(Kyungpook National University, KNU)、國際農業訓練院(International Agricultural Training Center, IATC)

內容摘要：

2013 年 10 月 21 日至 11 月 10 日由農委會推薦赴韓國參加亞非農村發展組織(AARDO)、韓國國際協力團(KOICA)及韓國慶北國立大學國際農業訓練院(IATC-KNU)合辦之永續農業發展訓練計畫。主要的課程都由位在大邱廣域市的 IATC-KNU 規劃與授課，少部份由位在水原市直屬韓國農林畜產食品部(MAFRA)的農食品公務員教育院(FATI)辦理。訓練課程包括 11 節課：1.新村運動、2.韓國農業政策與現況、3.農業機械、4.水資源管理、5.害物管理、6.雜草管理、7.糧食安全、8.設施栽培、9.採後處理、10.韓國農業發展、11.韓國糧食政策等，1 節專題演講：先進國家現行農業政策與亞非洲國家未來的農業政策，1 節各國國情報告(Country report)，及 1 節分組討論心得報告(Action plan)，另外有 2.5 天進行教學參訪(Study visit)，4 天觀光考察旅行(Field trip)。本次活動參加的 17 位學員分別來自埃及、印度、迦納、約旦、黎巴嫩、馬來西亞、模里西斯、奈及利亞、阿曼、蘇丹、葉門及我國等 11 國。

參加亞非農村發展組織(AARDO)
「永續農業發展訓練計畫」出國報告

目 次

壹、前 言

「永續農業發展訓練計畫」(Training Programme on“Sustainable Agricultural Development”)是由亞非農村發展組織(AARDO)發起並召集會員國參加，2006、2008、2010、2012 年已各舉辦過一次，每次都交由韓國外交部的國際協力團(KOICA)聯合辦理。本屆訓練的主要課程於 102 年 10 月 24 日至 11 月 6 日在大邱(Daegu)，由慶北國立大學(KNU)下屬國際農業訓練院(IATC)負責規畫與傳授，部份課程於 11 月 7 日至 8 日移訓至水原市(Suwon)直屬農林畜產食品部(Ministry of Agriculture, Food and Rural Affairs, MAFRA)的農食品公務員教育院(Food and Agriculture Officials Training Institute, FATI)協同辦理。由 KOICA 協助與會代表行前聯絡、抵達和返程交通接送及相關庶務工作，課程內容包括 11 節課題，1 節專題演講，1 節各國國情報告(Country report)，及 1 節分組討論心得報告(Action plan)，另外有 2.5 天進行教學參訪(Study visit)，4 天觀光考察旅行(Field trip)。參與訓練的國家分別來自埃及、印度、迦納、約旦、黎巴嫩、馬來西亞、模里西斯、奈及利亞、阿曼、蘇丹、葉門及我國等 11 國，共 17 位學員代表參加。吾人此次赴韓參加訓練，要感謝農業試驗所及農委會的推薦後被 AARDO 接受，由其資助往返機票及在韓的食宿費用，韓國 KOICA、IATC-KNU 及 FATI 安排食宿、交通及訓練課程。

貳、目 的

1953 年韓戰結束後，南韓整個農業環境的基礎設施如灌溉系統等都被破壞，滿目瘡痍下由於政府在施政計畫中發展了很多農業技術，如藉由推廣改種高產品種水稻‘統一’及運用省工栽培技術，完成了綠色革命(Green revolution)，使南韓在 1970 年代實現了米主食的自給自足的理想。又在 1980 年代，利用溫室栽培技術造成多種作物全年都可生產，完成了白色革命(White revolution)的理想。2000 年以後，農業永續發展成為各國農業部門一個重要的政策，南韓目前進行的項目包括園藝和草藥研究，應用生物技術降低生產成本和勞動力、改進育種效率、環境和安全研究，及農業工程改進等。在過去的 60 年中，南韓取得了相當大的農業發展及奇蹟般的經濟成長，積累了大量的作物栽培專門技術與農村發展的經驗知識。現在，韓國欣然願意把過去的經驗與專門技術來與其他國家分享，此訓練計畫藉由以下幾個方面，提供關於永續農業發展的知識和信息：1.提高作物產量的栽培技術；2.生產環境友好(Environment- friendly)農作物的栽培管理技術；3.韓國現有關於環境友好型農業的栽培技術和農業政策 (KOICA, 2013) 。

吾人則藉參加訓練班，由上課課程、專題介紹及實地參訪的方式來體驗韓國在農業發展的轉變，認識其永續農業發展的歷程、現況及未來。並從農業各領域專家的介紹與實地體驗，學習其農業技術與友善環境農業政策之執行現況。參訓期間透過各國

學員的國情報告及專題討論之經驗分享，增加彼此間的瞭解，提升對永續農業的國際視野，解決國內永續農業發展面臨問題，及因應未來國際競爭，規劃適當國際合作的發展策略。

參、內 容

一、活動行程

日期/時間	活動行程	主辦
10 月 21 日(一)	自桃園國際機場啟程至南韓仁川國機場、首爾城南市入住 ICC-KOICA	KOICA
10 月 22 日(二) 09:00~16:00	韓國國際協力團(KOICA)正式報到 KOICA 新生訓練	KOICA
10 月 23 日(三) 09:00~12:00 13:00~16:00 16:00~	移地訓練抵達大邱 KOICA 認識環境 從城南市移訓到大邱廣域市 Check-In (Inter-burgo EXCO 旅館)	IATC-KNU
10 月 24 日(四) 09:00~11:00 11:00~12:00 13:30~16:30 18:30~20:30	開訓典禮 / 國情報告 Country Report 慶北國立大學報到，認識環境 開訓典禮 國情報告 歡迎晚宴	IATC-KNU Kim, Jong-Sang
10 月 25 日(五) 09:00~12:00 13:30~16:30	上課 Lecture 1: Rural Development Through Saemaul Undong in Korea Lecture 2: Agricultural Status and Development Strategy in Korea	IATC-KNU Kim, Kil-Ung 金吉雄 Lee, Soo-Hwa
10 月 26 日(六) 09:00~12:00 13:30~16:30	觀光與考察旅行 釜山 (世峰樓 APEC 舊址、海雲台、水族館等) 國際市場、釜山塔	IATC-KNU Kim, Yoon-Ha 金潤夏
10 月 27 日(日)	無公務行程	
10 月 28 日(一) 09:00~12:00 13:30~16:30	上課 Lecture 3: Agricultural Machinery and Mechanization in Korea Lecture 4: Irrigation Water Management	IATC-KNU Koo, Young-Mo 具永謨 Chung, Sang-Ok 鄭相玉

10 月 29 日(二) 09:00~12:00 13:30~16:30	上課/專題演講 Lecture 5: Practical Application of Natural Enemies for the Control of Greenhouse Pests Special lecture (from AARDO): Recent Agricultural Policies and in Advanced Countries and the Future Agricultural Policies in Afro-Asian Countries	IATC-KNU Lee, Kyeong-Yeoll 李敬烈 Bhatt, M. S.
10 月 30 日(三) 09:00~12:00 13:30~16:30	上課/教學參訪 Lecture 6: Weed management for Increasing Crop Yield Study visit 軍威郡農業技術中心	IATC-KNU Shin, Dong-Hyun 申東賢 Kim, Yoon-Ha 金潤夏
10 月 31 日(四) 09:00~12:00 13:30~16:30	上課/教學參訪 Lecture 7: Food Hygiene and Safety by Good Agricultural Practices Study visit 京農 Kyungnong 農藥公司	IATC-KNU Kwon, Joong-Ho 權重浩
11 月 1 日(五) 09:00~12:00 13:30~16:30	觀光與考察旅行 盈德郡 (Yeongdeok)再生能源中心 浦項市浦項鋼鐵公司 (POSCO)	IATC-KNU Kim, Yoon-Ha 金潤夏
11 月 2 日(六) 09:00~17:30	觀光與考察旅行 世界遺產慶州歷史遺蹟地區、國立博物館、佛國寺等	IATC-KNU Kim, Yoon-Ha 金潤夏
11 月 3 日(日)	無公務行程	
11 月 4 日(一) 09:00~12:00 13:30~16:30	上課/教學參訪 Lecture 8: Greenhouse Design and Environmental Control in Korea Study visit (龜尾市 Kumi 花卉公司 Venro-type greenhouse)	IATC-KNU Lee, Hyun-Woo 李賢雨
11 月 5 日(二) 09:00~12:00 13:30~17:30	上課/教學參訪 Lecture 9: Post-harvest technology of Rice in Korea Study visit 高靈郡(RPC; Rice Processing Complex)	IATC-KNU Park, Kyung-Kyoo 朴京圭

11 月 6 日(三)	分組討論心得報告 / 教學評量 / 結訓典禮	IATC-KNU
09:00~12:00 12:00~13:30 13:30~16:00 16:00~16:30 18:00~20:00	分組討論心得報告 午餐 教學評量 結訓典禮 惜別晚宴	Kim, Jong-Sang
11 月 7 日(四)	移訓/上課/教學參訪	IATC-KNU
09:00~12:00 13:00~13:30 13:30~15:30 15:30~18:00 18:00~20:00	從大邱移訓至水原市 開幕式 Lecture 10: Development of Agricultural Administration of Korea 體驗教學製作韓國泡菜(辛奇 Kimchi) 歡迎晚宴	農食品公務員教育院 (FATI)
11 月 8 日(五)	上課/教學參訪	FATI
09:00~10:30 10:30~12:00 12:00~13:30 13:30~	Lecture 11: Food strategy of Korea Study visit (農村振興廳, RDA) 歡送午宴 回駐 KOICA	
11 月 9 日(六)	觀光與考察旅行 首爾(南塔公園、南大門市場、明洞「亂打」秀)	KOICA
11 月 10 日(日)	回程	

二、訓練紀要

10 月 21 日（一）(桃園、仁川、首爾、城南)

從台中前往桃園國際機場，搭乘大韓航空 KE692 班機於當地時間下午 4 時 55 分抵達仁川國際機場(Incheon International Airport)，由韓國國際協力團(KOICA)駐機場櫃臺協助，搭上巴士直達首爾城市機場轉運站(CALT)，轉搭乘 KOICA 特約計乘車前往首爾市郊的城南市 KOICA 總部(圖 1)，順利入住 ICC (International Cooperation Center)(圖 2)，在內可購得電話卡及利用 Internet 對外連絡。

10 月 22 日（二）(城南市 KOICA 總部)

09:00 於 KOICA 總部的 ICC 會議室正式報到，就座後由各國參訓學員進行自我介紹(圖 3)，共有 17 位學員分別來自埃及、印度、迦納、約旦、黎巴嫩、馬來西亞、模里西斯、奈及利亞、阿曼、蘇丹、葉門及我國等 11 國(圖 4)。隨後進行新生訓練，項

目包括 KOICA 說明此項訓練的目的，介紹 KOICA，以及韓國當地的食衣住行需注意的事項，並聘老師教導韓語會話。

圖 1. KOICA 總部(人類共榮碑)。

圖 2. ICC-KOICA。

圖 3. KOICA 正式報到及學員自我介紹。

圖 4. 參訓學員 17 位分別來 11 個國家。

10 月 23 日（三）(城南-大邱)

上午停留在 KOICA 園區內自由活動 (圖 5)。午餐後動身移訓到大邱廣域市，由慶北國立大學國際農業訓練院(KNU-IATC)安排入住 Inter-burgo EXCO 商務旅館(圖 6)。

圖 5. KOICA 園區

圖 6. 移訓大邱住 Inter-burgo EXCO 旅館

10 月 24 日（四）(大邱慶北國立大學國際農業訓練院)

上午 08:40 集合由旅館專車接送至慶北國立大學的農業生命科學大學院(College of Agriculture and Life Science)(圖 7)，其中的國際農業訓練院(The International Agricultural Training Center, IATC)負責本屆永續農業發展訓練計畫的主要課程的規劃與授課，IATC 的主管是 Dr. Kim, Jong-Sang(圖 8)。報到後先至校園認識環境，午餐前完成開訓典禮(圖 9)。午後進行各國國情報告(Country report)，報告項目是主辦單位指定的以下幾項：作物生產、氣候、現有作物生產技術 (包括土壤與肥料管理、作物栽培水份管理、作物病毒病害與相關害物防治、農產品採收後處理技術等)、農業技術的缺口、農業政策的缺口、及未來的遠景。吾人代表台灣上台報告(圖 10)，報告內容詳如附錄 1。

圖 7. 慶北國立大學農業生命科學大學院

圖 8. IATC 負責人 Dr. Kim, Jong-Sang

圖 9. 在 IATC-KNU 舉辦開訓典禮

圖 10. 國情報告(Country report)

10 月 25 日（五）(大邱慶北國立大學國際農業訓練院)

上午 09:00~12:00 第一堂課，講題是「韓國新農村運動造成的農村發展(Rural Development Through Saemaul Undong in Korea)」，講者金吉雄教授(Dr. Kim, Kil-Ung)(圖 11)曾參與著名水稻品種“統一”的育成與推廣。下午 13:30~16:30 講題「韓國農業現況與發展策略 (Agricultural status and development strategy in Korea)」講者 Dr. Lee, Soo-Hwa (圖 12)是美國密蘇里大學經濟學博士，過去曾獻策給南韓政府用以改進農村發展，目前以經濟層面致力研究森林生態與保育發展。


圖 11. 金吉雄教授 (Kim, Kil-Ung)


圖 12. Dr. Lee, Soo-Hwa

10 月 26 日（六）(釜山)

上午 09:00 由大邱前往釜山觀光與考察旅行(圖 13)， Dr. Kim, Yoon-Ha(金潤夏)是訓練班的輔導員，由其領隊協同兩位助理及兩位在校生，以專車巴士帶領所有學員前往釜山，車抵釜山即有專業的英語導遊接手後續的全程嚮導。參觀世峰樓 APEC 舊址 (圖 14)、海雲台、水族館等地，午後參訪國際市場、釜山塔等地。釜山為南韓第二大城，發展迅速，沿途車輛太多，市區及高速公路嚴重塞車，回到大邱已晚間 08:30。


圖 13. 釜山的高樓群


圖 14. 世峰樓 APEC 舊址學員合影

10 月 27 日（日）(大邱)

本日無公務行程，停留於旅館房內，以手提電腦經 Internet 聯繫國內並處理一些公務與私事，午後至旅館對面的大邱工商展覽館參觀，並前往購物買得一些禦寒衣物。

10 月 28 日（一）(大邱慶北國立大學國際農業訓練院)

上午 09:00~12:00 講題「韓國農業機械化與動力化 (Agricultural Machinery and Mechanization in Korea)」，講者是具永謨教授(Dr. Koo, Young-Mo)， 課程內容包括永

續農業的環境農業機械化與自動化的必要性，介紹現有韓國境內各式各樣的農機(圖 15)，及主要的農機製造廠:1) DaeDong: www.daedong.co.kr， 2) KukJe Machinery : kukje21.co.kr，3) ASIA Agricultural Machinery : www.asiakor.com， 4) LS Mtron : www.lsmtron.co.kr，5) TYM (Dong Yang Moolsan) : www.tym.co.kr。

下午 13:30~16:30 講題「灌溉水管理 (Irrigation Water Management)」講者鄭相玉教授(Chung, Sang-Ok) (圖 16)，內容先介紹作物栽培的各種給水方式，再講述植物生長水分需求與供給的理論基礎，演化出適時適量的水份管理模式，可應用在節水栽培及自動化與合理化灌溉，立下永續農業經營的基礎。


圖 15. 韓國製的作物苗自動嫁接機


圖 16. 鄭相玉教授(Chung, Sang-Ok)

10 月 29 日（二）(大邱慶北國立大學國際農業訓練院)

上午 09:00~12:00 講題「運用天敵防治溫室害蟲 (Practical Application of Natural Enemies for the Control of Greenhouse Pests)」，講者是李敬烈教授 (Dr. Lee, Kyeong-Yeoll) (圖 17)，李教授曾發表一些蟲媒病毒的相關報告，尤其是番茄捲葉病毒的分生鑑定，可是本次上課只提到溫室害蟲及其防治，內容包括殺蟲劑衍生的問題及利用害蟲的各式天敵所達成的生物防治效果。課程中介紹了世界各國現有商品化的生物防治資材，包括韓國 SESIL 的產品。利用熊蜂(Bumblebee)在設施栽培過程中授粉，有其效益，SESIL 已商業化生產出售。

下午 13:30~16:30 由 AARDO 提供的專題演講題目:「先進國家現行農業政策與亞非地區國家未來的農業政策 (Recent Agricultural Policies and in Advanced Countries and the Future Agricultural Policies in Afro-Asian Countries)」講者 Dr. Bhatt, M. S. (圖 18)是印度 Jamia Millia Islamia 大學經濟學教授，演講內容包括農業的重要，先進國家與開發中國家的農業現況比較，國際農產品貿易問題，歐盟與美國的農業政策對開發中國家的影響，歷來農業談判的來龍去脈等，最後對未來提出建言：為了糧食安全，在 WTO 架構下，允許開發中國對小農適度的保護。

圖 17. 李敬烈教授(Lee, Kyeong-Yeoll)　　圖 18. Dr. Bhatt, M. S.

10 月 30 日（三）(慶北國立大學國際農業訓練院；軍威郡農業技術中心)

上午 09:00~12:00 講題「雜草管理以增加作物產量 (Weed management for Increasing Crop Yield)」，講者是申東賢教授(Dr. Shin, Dong-Hyun) (圖 19)，課程內介紹在農業中雜草的定義、雜草的生物學特性、園藝作物生產中的雜草及其防除方法、殺草劑的選擇性和作用方式、抗殺草劑雜草及其管理、安全使用殺草劑及其對環境的影響，另提出在永續農業的概念下，如何經營雜草管理亦有論述。

下午 13:30~16:30 由金潤夏博士帶領至「軍威郡農業技術中心(Agriculture Technology Center in Gunwi County)」進行教學參訪，由會長主持簡報後 (圖 20)，前往實驗室參觀土壤分析試驗，配合政府環境友善農業政策合理化施肥的項目，協助境內農地的土壤調查。至其農機廠參觀，內有保養良好的各式農機皆由政府補助價購，再開放由會員租賃使用或以代耕方式協助農務作業，其中有大蒜播種機如圖 21。結束後轉到附近一處農場，由年輕的農民繼承祖業經營杏鮑菇量產，視其規模、設備、材料與產品樣式都與台灣如出一轍 (圖 22)，未來在國際市場的競爭將不可避免。

圖 19. 申東賢教授(Shin, Dong-Hyun)　　圖 20. 軍威郡農業技術中心

圖 21. 大蒜播種機

圖 22. 杏鮑菇栽培場

10 月 31 日（四）(慶北國立大學國際農業訓練院；京農農藥公司)

上午 09:00~12:00 講題「以良好農業規範達成食品衛生與安全(Food Hygiene and Safety by Good Agricultural Practices)」，講者權重浩教授 (Dr. Kwon, Joong-Ho) 是食品科學系教授 (圖 23)。從食品衛生及安全的角度介紹 GAP(Good Agricultural Parctice, 良好農業規範)，GMP(Good Manufacture Practice, 良好製作規範)及 HACCP(Hazad Analysis and Critical Control Points, 食品汙染源分析及臨界點控制)的意義及其驗證(Certification)系統。

下午 13:30 由權重浩教授帶領至「京農(Kyungnong)農藥公司」進行教學參訪(圖 24)，南韓京農集團在製造販售農用藥劑之餘，對於農藥毒理也投資研究，試圖盡量減少強毒性農藥的應用，另外對於農藥殘留的分析檢驗也不餘遺力，以善盡財團對環境保護之責。

圖 23.權重浩教授(Kwon, Joong-Ho)

圖 24. 京農(Kyungnong)農藥公司進行教學參訪

11 月 1 日（五）(盈德郡；浦項市)

上午從大邱出發開始兩天一夜的觀光考察旅行，11:00 抵盈德郡(Yeongdeok)再生能源中心(圖 25)。除室內的能源教育場地外，風車建於山巔海邊，遠離住家聚落，不但噪音不擾人，周邊還開發成公園，由地方政府收門票營運，創造三贏局面。

下午 13:30~16:30 至浦項鋼鐵公司(POSCO)進行考察參訪(圖 26)，廠區填海造地形成，在其博物館中感佩其「鋼鐵即國力」、「資源有限，創意無線」、及「精魂」等名言。離開浦項後夜宿慶州「現代 (Hyundai)」觀光旅館。

圖 25. 再生能源中心(盈德郡，Yeongdeok)

圖 26. 浦項鋼鐵公司(POSCO)，浦項市

11 月 2 日（六）(慶州市)

09:00 抵慶州市區，全日進行觀光參訪包括世界遺產慶州歷史遺蹟地區(圖 27)、慶州市國立博物館(圖 28)、佛國寺等地點，假日關係遊人如織。惟觀其歷史文物除與宗教或皇室有關的外，保存(展示)的並不多。但深秋的自然景觀頗有特色，因此若以歷史典故搭配秋色，藉此包裝有機農產品去發展休閒農業應有可為。傍晚仍在塞車的交通狀況下回至大邱。

圖 27．世界遺產慶州歷史遺蹟地區

圖 28．慶州市國立博物館

11 月 3 日（日）(大邱)

本日無公務行程，停留於旅館房內，以手提電腦整理受訓心得，同時準備分組討論的簡報資料。分組討論吾人與埃及、馬來西亞及奈及利亞的學員同組，所分配到的

題目是：農產品採收後處理技術暨其加值效應 (Post-harvest technology and value addition of agriculture product)，利用 Internet 從國內擷取一些資料，完成報告的初稿。

11 月 4 日（一）(慶北國立大學國際農業訓練院；龜尾市 Kumi 花卉公司)

上午 09:00~12:00 講題「韓國溫室設計與環境控制 (Greenhouse Design and Environmental Control in Korea)」，講者李賢雨教授(Dr. Lee, Hyun-Woo)(圖 29)。課程內容包括設施栽培的沿革、溫室設施的結構安全、溫室內的環境控制(溫度、濕度、光度、二氧化碳等)。李教授目前積極在協助蒙古建設農用溫室，是有經驗且實作型的學者。

下午 13:30~16:30 至「龜尾市 Kumi 花卉公司」(圖 30)進行教學參訪，主要是參觀 Venro-type greenhouse。但吾人更有興趣看其大規模栽培且全年生產菊花供應日本切花市場的運作，其中如架設管路進行環境增溫，並隨菊花的生長調整加熱管的高度 (圖 31)；利用可重疊的菊花育苗箱，可節省空間及方便機械操作；成苗定植於溫室內畦面，可節省人力與物力；採收時以輸送帶運送連根拔起的植株，由機器切除根系，裝束整理後即置入特製集貨載具(圖 32)等。雖然 Kumi 公司規模龐大，但其銷售日本市場的菊花品種都非自己的品種，最後還是淪為替日本代工生產而已。

圖 29.拜訪李賢雨教授 (Lee, Hyun-Woo) 家庭

圖 30. Kumi 花卉公司(龜尾市)

圖 31. 溫網室設計隨菊花的生長調整加熱管的高度

圖 32. 特製切花集貨載具

11 月 5 日（二）(慶北國立大學國際農業訓練院；高靈郡 RPC 碾米廠)

上午 09:00~12:00 講題「韓國稻米採收後處理技術 (Post-harvest technology of rice in Korea)」，講者是朴京圭教授(Dr. Park, Kyung-Kyoo)(圖 33)。上課內容包括 09:00~10:30 在講堂以“Rice harvest system in Korera”為題上課，10:40~11:00 至實驗室進行稻米含水量的測試，11:00~11:50 試驗比較各種碾米方式的優缺點。

下午 13:30~15:00 由朴教授帶隊至高靈郡(Koryung)一貫作業碾米廠(Rice Processing Complex, RPC)進行教學參訪(圖 34)。15:20~16:30 參觀附近 k-water (韓國水資源公社)的一些水利設施。

圖 33. 朴京圭教授(Park, Kyung-Kyoo)

圖 34. 一貫作業碾米廠 (RPC)

11 月 6 日（三）(慶北國立大學國際農業訓練院)

上午 09:00~12:00 分組討論心得報告，本組題目是：農產品採收後處理技術暨其加值效應 (Post-harvest technology and value addition of agriculture product) (圖 35)，其餘 3 組分別是：1. 新村運動對 AARDO 會員國農村發展的啟示(Saemaeul movement and rural development in AARDO member countries), 2. 水資源管理及農業發展(Water resources management and agricultural development), 及 3. 病蟲草害管理與有效應用農藥(Control of insects, weeds and efficient use of pesticides)。討論會主持人是 Dr. Kim, Jong-Sang。下午 13:30~16:30 教學評量及結訓典禮(圖 36)，所有學員均順利完成課程取得證書。18:00~20:00 惜別晚宴。

圖 35. 分組討論心得報告

圖 36. 結訓典禮後學員講師合照

11 月 7 日（四）(水原市農食品公務員教育院)

上午 09:00~12:00 移訓至水原市，農食品公務員教育院(Food and Agriculture Officials Training Institute, FATI) (圖 37)。下午 13:00 開幕式後，隨即由 Dr. Oh, Se-Ik (圖 38)以「韓國的農業行政發展(Development of agricultural administration of Korea)」為題上課。15:30~18:00 體驗教學製作韓國泡菜(辛奇 Kimchi)。18:00~20:00 歡迎晚宴。

圖 37. 農食品公務員教育院(FATI)　　圖 38. Dr. Oh, Se-Ik

11 月 8 日（五）(水原市農食品公務員教育院；城南市 KOICA)

上午 09:00~10:30 上完本訓練計畫的最後一課：「韓國的糧食策略(Food strategy of Korea)」，離開農食品公務員教育院，至其對面的農村振興廳(Rural Development Administration, RDA)參訪，RDA 負責南韓所有農業科技研發，轄有國家農業科學院(National Academy of Agricultural Science, NASS)、作物研究所(National Institute of Crop Science, NICS)、園藝暨藥草研究所(National Institute of Horticultural & Herbal Science, NIHHS)、及動物科學研究所(National Institute of Animal Science, NIAS)。其結果必然可觀，但行程僅安排到成果展示室觀其簡報，看其成果模型。惟其中 RDA 強調其與國際合作的關係(圖 39)及微型植物工廠(圖 40)的展示都令人印象深刻。午後全車回駐城南市 KOICA 總部，繳交評量表及接受離營教育後，學員解散各自打包準備賦歸。

圖 39. 與 RDA 有國際合作關係的國家或機構　　圖 40.植物工廠模型

11 月 9 日（六）(首爾市；城南市 KOICA)

由 KOICA 的輔導員加上 2 位外文系學生義工陪同至首爾觀光旅行，參觀南塔公園、南大門市場、明洞「亂打」秀等。

11 月 10 日（日）(城南；首爾；仁川；桃園)

上午搭乘 KOICA 安排的計乘車前往首爾的 CALT，轉搭至仁川國際機場的大巴士，搭乘大韓航空 KE693 班機，於台北時間下午 5 點 55 分返抵桃園國際機場，結束為期 21 日之訓練。

肆、心得及建議

大韓民國政府的農部(Ministry of Agriculture)在 2008 年為糧農林漁部(Ministry for Food, Agriculture, Forestry and Fisheries)，2013 年 3 月調整為農林畜產食品部(농림축산식품부，Ministry of Agriculture, Food and Rural Affairs, MAFRA)，移出漁業及食品安全的業務，而其轄下的農食品公務員教育院(Food and Agriculture Officials Training Institute, FATI)也在此時作了業務調整(Anonymous, 2014)。另旁屬 MAFRA 的農村振興廳(농촌진흥청，Rural Development Administration, RDA)也作了業務調整，RDA 在農業科技研究方面類似我們農業試驗所，但其涵括動物科學研究，2013 年在業務調整時把國際農業技術協力中心(ITCC)的教育訓練業務解除了。因此本次訓練計畫已非由 RDA 主導，而課程內容少了專業技術的見習，對學員來講殊為可惜。但也為政府疼惜研究人員，令其專業研發工作而慶幸。不可諱言南韓的農業科技長足進步，部份已讓我難望其項背，如南韓發行的學術刊物“The Plant Pathology Journal”已列名 SCI (Impact Factor: 0.667 WoS)及 “Korean Journal of Horticultural Science and Technology” (Impact Factor: 0.331 WoS)，這是我們多年來力拼卻無法達成的目標。

韓國外交部(외교부，Ministry of Foreign Affairs, MOFA)也是在 2013 年政府改組時解除通商的業務，從外交通商部(Ministry of Foreign Affairs and Trade, MOFAT)改回為外交部(Anonymous, 2014)。其下屬機關韓國國際協力團(KOICA)專司國際合作事宜，惟 KOICA 每年編列預算有計畫主辦或協辦各類國際訓練及技術合作個案，除籠絡國際人心外確有助益於提昇邦誼，更有效提昇其國家的國際地位。KOICA 在其總部設立國際合作中心(ICC)，其功能類似高級商務旅館兼有住宿房、餐廳、會議室、教室、電腦室、銀行、商店、洗衣間、穆斯林祈禱室、室外健身設備、網球場、運動場等各項設備齊全，且都呈滿載運轉狀，吾人停留在此期間可遇到各行各業來自世界各國的學員，一般學員來韓受訓從 ICC-KOICA 得到對南韓的印象都是正面的(鍾瑞永，2006；林明瑩，2010)，且在受訓期間對 KOICA 提供的服務也是充分滿意，尤其是能滿足多數伊斯蘭教穆斯林的需求，殊屬不易。往後國內若要舉辦類似的國際活動，專業的外交人員之

參與是必要的。

位於大邱廣域市的慶北國立大學(Kyungpook National University, KNU)在世界大學排行 501，相對於台大 80，興大 601 (QS World University Rankings)，雖非頂尖也是有績效的大學。1988 年於其農業暨生命科學大學院(College of Agriculture and Life Science)成立國際農業訓練院(The International Agricultural Training Center, IATC)，主要任務在與有關國際組織執行合作項目及與國外進行農業技術交流，特別是以開發中國家為對象。由直屬外交部的 KOICA 財務支援，自 1990 年以來已有來自 43 個國家的 147 名學員參加了 IATC-KNU 的教育訓練項目。這些訓練計劃的目的是提供基本農業知識及適用於各種作物生產的實用技能，大部分的訓練課程和實驗都由慶北國立大學的教師提供(IATC-KNU, 2014)。IATC-KNU 在 2012 年首次與 KOICA 合作承辦 AARDO 的 “Sustainable Agricultural Development”的訓練計畫活動，今年是第二次辦理，但首次有台灣來的學員，講師們對台灣的農業相當關切，課堂上互有往來。看到慶北國立大學農學院前以漢字所題「農為國本」的立碑(圖 41)，表示國家應對農業的重視，也顯示農學院在 KNU 的地位。可是在此受訓期間，除在教室內上課以外，鮮有機會進入實驗室、溫室或實驗農場與研究人員交流，實為一大憾事。同樣是 AARDO 主辦的 “Sustainable Agricultural Development”訓練計畫，由農村振興廳的國際農業技術協力中心(ITCC-RDA)承辦時，就有較多的技術觀摩與實習機會(鍾瑞永，2006；林明瑩，2010)。雖然如此，整體訓練課程、參觀旅行、及在校活動的安排都顯示出 IATC-KNU 所有師生的熱誠，此點值得國內主辦類似活動時之借鏡。

所有課程中以“Saemaul Undong in Korea”最令人印象深刻，除 Lecture 1 以此為主題外，Lecture 2 農業發展，Lecture 9 稻米，Lecture 10 農政，及 Lecture 11 糧食等課題，上課老師莫不津津樂道這個在南韓相當成功的「新農村運動」。其實質內容即經過土地改革及農村社區再造，使南韓由貧窮肌餓的環境下達到自給自足，甚至經濟高度發展的狀況。南韓以新農村運動的成果為傲，講師們滿腹熱血欲將此制度推廣至開發中國家，因此來韓受訓此課程必不可免，觀歷屆台灣來此受訓的學員之出國報告已有完整的描述(鍾瑞永，2006；林明瑩，2010；黃昭興、林淑華，2013)，茲不再贅述。惟從技術層面來看這個運動的成功，因為高產水稻品種‘統一’的育成及推廣，造成南韓的綠色革命(Green revolution)，主食自給自足後人民溫飽社會安定，才得以奠定後來經濟發展的基礎。由此驗證「農為國本」的真諦，也發現農業科技報國之道，農業在未來仍是重要產業，農業科技的成果可能成為改變歷史的革命火種，農業要永續經營也必須要靠農業科技的不斷創新。

相對於綠色革命，南韓也相當自豪於目前的農業白色革命(White revolution)，即溫網室設施栽培的成功。田間常可看到綿延不絕一棟棟的溫網室設施 (圖 42)，主要目的用來克服冬季的低溫與降雪，使蔬菜作物能全年生產，冬天的新鮮蔬菜不再仰賴進口。設施栽培因有其經濟效益且在政府補助下，目前在南韓境內方興未艾，甚至於在南部

的濟州島已有利用溫網室栽培熱帶作物百香果的產業。南韓長期以來針對熱帶作物的研究從不懈怠，目前溫帶地區的農業生態受設施栽培及氣候變遷效應的影響在南韓已經浮現。事實上熱帶作物產品在南韓有較高的售價，而熱帶作物生產在台灣有較優質的技術經驗及品種材料，雙方應可進一步合作開發。至於南韓的溫室建構改進，主要都在增溫增日照，與台灣的目標相反，較無可取之處。

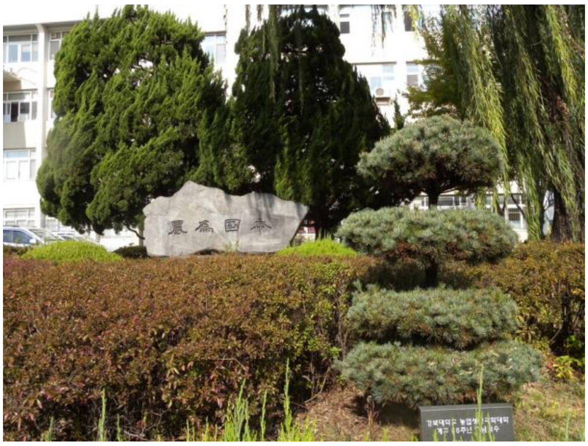

圖 41. 慶北國立大學農學院前以漢字所題「農為國本」的立碑

圖 42. 溫網室設施使蔬菜作物能全年生產，所謂白色革命

為了農業的永續發展，供給消費者安全優質的農產品、促進友善環境的耕作、降低肥料及農藥的使用量、提昇認證體系的效率都已是南韓政府的農業政策目標，也是現在世界各國農業的主流，與我國推動的安全農業政策類似。本次訓練活動以永續農業為主軸，權重浩教授的課題「以良好農業規範達成食品衛生與安全(Food Hygiene and Safety by Good Agricultural Practices)」，內容即強調從生產、加工、貯藏到分銷的糧食安全之重要性，也揭露各階段為害糧食安全的生物、物理及化學因子及其來源。因此在生產、分銷及消費時如何避開污染源，達成食品的安全與衛生，就需有 GAP(Good Agricultural Parctice)，GMP(Good Manufacture Practice)或 HACCP(Hazad Analysis and Critical Control Points)的措施及其驗證(Certification)系統。GAP 的目的兼顧護消費者與生產者的健康，涵括土壤、水份、作物生產、植物保護、畜牧、動物保護、採收、加工、貯藏、能源及水份管理、人類福祉安全及健康、野生動物及生態景觀等多方面。因此顧及生物、環境與土地關係的作物綜合管理 (Integrated Crop Management, ICM)系統或病蟲害綜合管理 (Integrated Pest Management, IPM)系統都是達成農業永續所必要的。在 GAP 規範下農事操作時應注意事項都有其標準，因此能夠回溯追蹤的生產履歷(Traceability)制度就可補強健康農產品的驗證系統。南韓從 2006 年開始農產品 GAP 驗證，目前已有 3% (105 項作物)的 GAP 標準執行中，預計 2015 年達到 10%。另外 HACCP 則是以科學方法檢測污染源並設法防止以保證食品安全，1995 年南韓立法實施，至 2012 年 8 月已有 8645 家公司產品申請報驗，其機制類似我食品衛生管理法。HACCP 是高品質食品生產管理的一環，與衛生標準操作程序(Sanitation Standard Operating

Procedures, SSOP)併立，但須具備上述 GAP 的先決條件。有關食品安全法中也有 GHP (Good Hygiene Practices)來避免食物生產及消費鏈中微生物的污染，但檢視在傳統韓國餐廳用餐時一般民眾並無「公筷母匙」的觀念，因此對此政策的實際成效還需進一步觀察。另一方面經此課題吾人也體認到以往論及永續農業時僅知以生產者立場來詮釋是不夠的，未來在生產、管制、消費都需要兼顧，尤其是目國人對食品安全甚為敏感之際。

綜合整體訓練過程，由上課內容可普遍瞭解韓國永續農業發展的實力與決心。藉參訪農業技術推廣中心、農藥公司農藥殘留毒性檢驗、Kumi 花卉公司大型溫室設施、及高靈郡一貫作業碾米廠，可深入基層認識韓國農業技術推廣的運作模式、農業研究成果實際應用的程度、及安全農業政策受重視及執行的情形。觀光考察旅行多利用週末時間，參觀釜山海雲台及 APEC 舊址(紀念館)、盈德郡再生能源中心、浦項市浦項鋼鐵公司(POSCO)、世界遺產慶州歷史遺蹟地區及首爾市區。此行處處都感受到韓國的經濟活力與未來的競爭力，尤其是在與國際競爭的方面，韓國以感念過去是接受援助者現在想要回饋世界的心態，積極爭取舉辦國際活動，結果已立竿見影不但大幅提高其外交地位也從中獲取龐大經濟利益。吾人以之為鏡，檢視彼此的農業政策及發展方向，去蕪存菁持續我方在永續農業發展的優勢。尤其在國際合作或競爭方面，我方得要見賢思齊積極參與國際活動，全面提升各階層的國際觀，才不致被邊緣化。

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一、國情報告(Country report)

TAIWAN (ROC)

COUNTRY REPORT

by

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TAIWAN (ROC)

Country Report

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Contents

Introduction

Taiwan is situated in the South China Sea, about 180 kilometers off the southeast coast of mainland China. Although more than two thirds of the island consists of rugged mountains, its lowlands with a mostly subtropical climate which provides a year-round growing season. Most of the lowlands lie along the west coast of the island, and that is where most of the people live. Dense subtropical and temperate forests cover much of the mountainous interior (Chungyang Mountains), in spite the lumbering had been suspended by the government, they are still threatened by the farmers seeking to clear them for crops. Taiwan's economy has changed from agriculture to industry, farming only accounts for a very small portion of the GNP (3%, down from 35% in 1952). Before 1945, Taiwan’s farming was based mainly on rice and sugarcane. Today the agricultural base is greatly diversified. Although rice remains the single most important crop and the mainstay of the people's diet, many other crops have become significant for both the domestic market and for export. These include many kinds of vegetables, fruits and ornamentals. As a result, Taiwan's relative self-sufficiency in food has been declining, with increased imports of certain commodities, especially wheat, corn, soybean, cotton and some varieties of fruits. In the future, drastic changes will happen in this agricultural system. The stress is not only placed on the quantity of food but also on the quality. The decrease of arable land area, the global warming and extreme weather, the incursions of new pests, the shortage of laboring, and difficulties with international trade pose a great challenge to the government.

Crop production

About 822,000 hectares of land is arable for crop production. The output of agriculture produces valued at 179.1 billion NT dollars which accounted for 4.7 billon US dollars in 2008. Among all, fruit crops contributed 36% of the total value, followed by vegetables (28%), rice (18%), flower crops (7%), special crops (6%), upland crops (4%), and other crops (3%) as shown in Figure 1. The updated data of planted area and production of each crop commodity in 2012 are also listed in Table 1.

Rice

Rice is the staple food in Taiwan. About 260,000 hectares of paddy field was used to grow rice annually with an output of about 1.2 million tons of brown rice. The total production value exceeded 31.4 billion NT dollars in 2008.

Upland crops

The cultivation of upland crops occupies approximately 58,000 hectares of land with a total production value of 7.3 billion NT dollars. More than twenty crops, including peanut, corn, sweet potato, adzuki bean, forage corn, sorghum, millet, mungbean, and Job’s tears are cultivated in Taiwan. On the other hand, over 35,000 hectares of land are grown special crops, including tea, health food, medicinal herbs, and aromatic plants. The total production value of 8.2 billion NT dollars indicates the high economical potential of special crops in the future.

Fruit

More than twenty fruit crops are grown over 210,000 hectares of farmland in Taiwan. The total production, 2.6 million tons of fruits, valued at 68.1 billion NT dollars. By utilizing different varieties and the techniques of forcing culture, banana, pineapple, papaya, guava, grape, and wax apple can be harvested year-round.

Vegetable

More than 100 vegetable crops are cultivated on 153,000 hectares of land in Taiwan. The total production exceeded 2.61 million tons valued at 48.5 billion NT dollars. Some vegetable crops which are prone to price fluctuations periodically, such as garlic, Welsh onion, cabbage, Chinese cabbage, and cauliflower are enforced to planned production to keep the balance between yield and demand.

Flower

The production area of flower crops is about 13,000 hectares in Taiwan. The output value exceeded 11.8 billion NT dollars. Specialized production zones for export are set up for major crops of *Phalaenopsis*, *Oncidium*, *Anthurium*, Prairie Gentian, spray-type chrysanthemum, and oriental orchid.

Seed and seedlings

The annual production value of seed and seedling industry exceeds 12 billion NT dollars in Taiwan. Seed production of Brassicaceae, Solanaceae and Cucurbitaceae crops valued at 1.5 billion NT dollars while the production of seedlings by tissue culture techniques valued at 1.1 billion NT dollars.

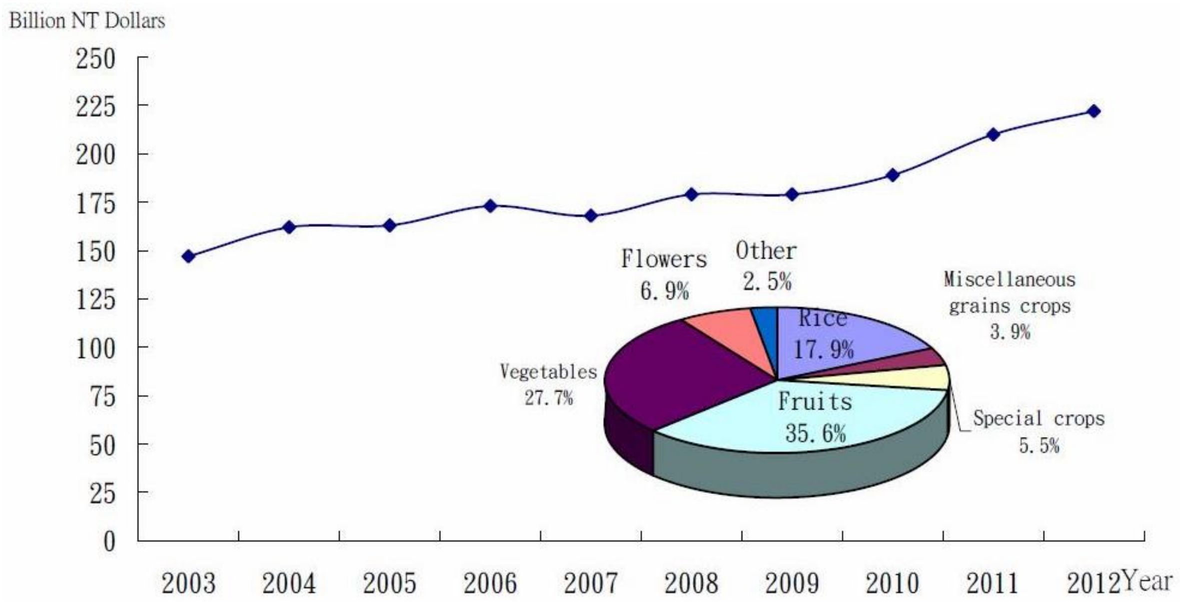

Figure 1. Economic values yielded by crops grown in Taiwan, 2003-2012. The ratio for NT Dollars to US dollars was about 1/38.

Source:

http://www.afa.gov.tw/content_en.asp?a=2&pcatid=1&ycatid=1&lcatid=147

(Agriculture and Food Agency, Council of Agriculture, Executive Yuan, R.O.C.)

Table 1 Planted area and yield production of various crops in Taiwan, 2012

Crop	Planted Area (ha)	Yield Production
Paddy Rice	260 762	1 700 229 m. t.
Corn	16 650	105 184 m. t.
Peanuts	19 430	56 845 m. t.
Sorghum	2 028	3 564 m. t.
Adzuki Beans	6 904	10 698 m. t.
Soybeans	80	159.221 m. t.
Other Coarse Grain	2 853	8 462 m. t.
Sweet Potatoes	9 560	220 514 m. t.
Sugarcane	8 720	577 517 m. t.
Tea	13 486	14 902 m. t.
Tobacco	703	1 642 m. t.
Sesame	831	620 m. t.
Cash Vegetables	97 733	2 051 197 m. t.
Yearlong Vegetables	28 106	324 404 m. t.
Cucurbits, Strawberries	17 336	317 297 m. t.
Fruit	189 875	2 668 055 m. t.
Forage Crops	10979	769735 m. t.
Green Manure Crops	252 566	4 302 734 m. t.
Bulbs	2	25 m. t.
Herbaceous Flower Seeds	8	4 m. t.
Cut Flowers	3 401	81 805000 dozens
Orchid	662	69 654000 bowls
Nurseries	7 547	3 217 118000 NT$
Potted Flowers	866	1 000 180000 NT$

Climate

The island of Taiwan has an area of 35,883 km^2 lies across the Taiwan Strait. The East China Sea lies to the north, the Philippine Sea to the east, the Luzon Strait directly to the south and the South China Sea to the southwest. Taiwan's highest point is Yu Shan at 3,952 meters that makes it the world's fourth-highest island.

Both of continent and ocean climate patterns affect the climate of Taiwan: northeast cold monsoon originated from Siberia continent high pressure in winter and the southwest warm monsoon from the Pacific Ocean high pressure in summer. Such special patterns as well as central mountains topography created the different seasons and the diversified regional climate in this island.

When it rains in the winter is mainly due to the impact of the northeast monsoon in the northeastern part of the windward side. The North Taiwan has a rainy season from January through late March while other regions are less rainfall in this season even in south-central region where is almost no precipitation. Spring weather is full of moist southwest airstream and that always cause “meiyu” in May which is the major water source in whole year. From summer to autumn, typhoon often causes heavy rain that is also an important water source in Taiwan.

Tropic of Cancer (23°26’16” N) across the south of Taiwan; mainly, the climate in this island is marine tropical. The entire island experiences hot, humid weather from June through September. Because the southern parts do not affected by extended winter monsoon, there is more abundant sunshine and less temperature variation during the winter. For example, the average summer temperatures are both 28 ℃ - 29 ℃ in Taipei and Kaohsiung; however, in winter the average temperature in Taipei is only about 16 ℃, but in Kaohsiung still up to 19 ℃- 20 ℃. In addition, the observed maximum temperature in Taipei is 38.8 ℃, comparatively higher than 37.2 ℃ in Kaohsiung.

Besides, some of the extreme weather events often encountered in Taiwan, they are: typhoon, heavy rainfall, chilling, hailstone and drought.

Current development in crop production technologies

For the continuous progress and competitiveness of agriculture industry, research projects of various crop production are conducted yearly. The ongoing technical developments include the following items: improvement of cultivated varieties and cultural practices, post-harvest treatments, plant tissue culture, reasonable fertilization techniques, soil management, organic culture measures, safety of agricultural production, agricultural mechanization and automation, biofertilizer development, pollution control, waste recycle, electronic marketing system, healthy food, food processing, etc.

- How to control the soil and fertilizer management

Crop production could only occur in areas where the soil resources will support the plant growth. The only way to do this is to locate the soil resources that are available. And towards this end, a long-term soil survey in the country is conducting . The key components of the soil survey include: 1) inventory of the properties of the soil (such as texture, drainage, fertility, pH, etc.) and their spatial distribution over a given area; 2) classification of soil types based on a standard set of physical and chemical characteristics; 3) delineation of compiled soil survey information on base maps; and 4) soil survey interpretation to predict the potentials and limitations of each soil, and estimate productivity and input requirement with different management systems. As such, the soil survey information can be used to plan the land development, improve the soil, maintain soil fertility, develop irrigation system, and implement fertilization programs.

For the sustainable utilization of soil resources and the integrated soil fertility management, the progressive tasks are as follows. 1) diagnosis and improvement of soil fertility; 2) improvement of nutrient diagnostic methods; 3) long-term monitoring of soil fertility and nutrient dynamics in different cropping systems and soil management; 4) investigation of nutrient utilization efficiency and fertilizer requirement for different crops in the soil-crop-environment system; 5) study for resolving crop physiological disorders in specific regions; and 6) establishment of nutrient management-based safe production technologies.

For sustainability of farm land, Taiwan farmers were encouraged to use of organic fertilizers and bio-fertilizers or plant green manures. The use of bio-fertilizers, 10,621 hectares of land were grown with legumes or cucurbits, addition to Rhizobium, Mycorrhizae, or phosphate- solubilizing bacteria were applied to substitute some of chemical fertilizers. Good quality composts were distributed to 20,225 hectares of farm lands. In winter, 46,502 hectares of farm lands planted green manures, such as rape and Berseem clover. This issues has integrated efficiency in maintaining soil fertility, decreasing the use of chemical fertilizers, beautifying the rural landscapes, enhancing sightseeing potential, increasing the honey sources, and decreasing the pressure of overproduction of winter vegetables.

- How to control water management for crop cultivation

Plentiful clean and nutrient-rich river water and that through irrigation facilities provide for rice cultivation in Taiwan. Due to these water resources and irrigation systems, several distinctive rice varieties are produced, and that make Taiwan one of the lowest-latitude areas producing high-quality japonica rice. Nearly drainage waters from irrigated lands and effluent from city sewage and industrial waste water impact water quality. A number of trace elements are found in water which can limit its use for irrigation since salts can affect both the soil structure and crop yield. We are devoting to research to reconcile agricultural productivity and environmental integrity. The study involves impacts of water pollution, soil pollution, industrial and agricultural wastes recycled on farm land. Moreover, precision farming for water-saving cultivation and breeding new crop variety with drought-resistance are in process. Although in Taiwan the water for agricultural using is sufficient now, we still prepare above strategies for coping with climate variability.

- How to prevent crops from viral disease related with pest and insect attack

The natural environment and agricultural system of Taiwan have a great impact on the types and patterns of pests (diseases, insects, weeds, rodents, birds, slugs, etc.) The overall high temperature during the whole year provides favorable conditions for survival and growth of these pests. Although the warmth climate and abundant rainfall also favor the proliferation of parasites and natural enemies of insects and antagonisms of pathogens, the high humidity and high temperature account for the rapid spread of some epidemics. The intensive farming system which leads to soil exhaustion and the consequential profuse use of fertilizer is a catalytic factor for the occurrence of many pests. Due to a drastic increase in acreage of horticultural crops, new disease and insect pests have subsequently emerged.

Besides chemical measures for pest control in the agricultural system, physical control, biological control, cultural control, and regulatory control are adopted by Taiwan farmers for economical reasons. Naturally, integrated pest management (IPM), a system that combined all pest control tactics, has been implemented in Taiwan. To meet the social requirements and consumers' responses the IPM programs are expanding, especially those emphasize on reducing pesticide use, ensuring a safe food supply, and conserving the water and wildlife. Lots of research projects concerning low-pesticide application, development of bio-pesticides, natural enemies, microbial antagonism, transgenic plants, resistance breeding, closed cultivation, and healthy seedling systems are conducted by research institutes and universities around the island. From the plant virological aspect, some results derived from these projects contributing to IPM programs are presented as follows.

Integrated control of virus diseases

A total of 16 viruses have been reported to infect cucurbitaceous crops in Taiwan, but the majority is: *Cucurbit aphid-borne yellows virus*, *Cucumber mosaic virus*, *Papaya ringspot virus*, *Zucchini yellow mosaic virus*, *Watermelon silver mottle virus*, *Cucurbit chlorotic yellows virus*, *Squash leaf curl Philippine virus*, and *Cucumber green mottle mosaic virus*. They are sap-transmissible or transmitted by aphids, thrips, whitefly or seed, respectively. According the results of investigation, *Maize dwarf mosaic virus*, *Maize stripe virus* and *Sugarcane mosaic virus* are the prominent viruses in the diseased cornfields. *Turnip mosaic virus* is the main virus affecting Cole crops.

Tobacco mosaic virus, *Tomato mosaic virus*, *Potato virus Y*, and *Cucumber mosaic virus* are the most economically important viruses on tomato and peppers. Five viruses are known to infect potato: *Potato virus A*, *Potato virus M*, *Potato virus S*, *Potato virus X*, and *Potato virus Y*. *Allium* crops are affected by three major viruses: *Garlic common latent virus*, *Shallot latent virus*, and *Onion yellow dwarf virus*. Considerable yield losses due to these viruses have been reported. Many of these viruses are transmitted by insects and are thus difficult to control by chemicals. Nevertheless, farmers apply insecticides regularly to control insect vectors. Non-chemical control of insects by the use of reflective mulches is already practiced on a few crops, including peppers and melons. The production by local institutes of virus-free planting materials through meristem tip culture followed by efficient virus indexing methods has considerably increased yields of potato, sweet potato, bamboo shoot, Welsh onion and garlic in Taiwan.

Virus-free seedling propagation system

Viruses can be transmitted through vegetative propagation from mother plants to their offspring that contributing to be the primary inoculum in the field. These diseases are impossible to be controlled by conventional pesticides. The development of special pathogen free (SPF) seedling propagation system was established in early 1970s to mass-produce virus-free seed potatoes. A four level propagation system has been set up: virus-free tubers are obtained through tissue culture and then indexed with antibodies against viruses. Foundation seed potatoes were further propagated in isolated areas. Selected farmers were then authorized to run a seed potato nursery. The system had been carrying out for 40 years and proved to be effective in controlling virus diseases of potato. Today, there are at least nine different crops implementing with the similar system to produce SPF seedlings, there are sugarcane, garlic, citrus, passion fruit, bamboo shoot, banana, sweet potato, beans, and some ornamental crops.

Breeding for Resistance to Viruses

The resistance gene derived from wax gourd line ‘TVI4204’ conferred the immunity to virus infection of cucurbits is very unique and commercially valuable. Using molecular assisted selection (MAS) will dramatically save the time for disease-resistance screening. Screening varieties to resist to pathogens and collecting genes to confer immunity from diseases are very helpful for breeding projects, especially for viral disease control. Some virus-resistant varieties (or lines) of cucurbitaceous crops were be bred.

- Post-harvest technology for commercialize of agricultural products

The postharvest handling research is focusing on the improved technologies for long shelf life and desired shipping quality of fruits, vegetables and flowers so as to facilitate the marketing and export, to stabilize the price during the concentrated production season, and to increase the farmers' incomes. The major achievements in the recent years include: long-range sea shipment technology for lychee, which is able to keep bright red peel color for 40 days with 95% marketability; countermeasures for pineapple postharvest black rot caused by *Ceratocystis paradoxa* and pineapple black heart caused by chilling injury; avocado storage and soft maturing technologies to supply quality fruits during winter and spring lean seasons; technology to regulate amaryllis blooming time with 70% uniformity to match with special festivities; technology of low-temperature quality maintenance of Indian jujube fruit, which lowers chilling injury and improves marketability to more than

70%; low-temperature storage of pitaya for exportation; pre-treatment, fumigation and sea shipment technologies of Oncidium cut flower to preserve quality for exportation; pre-treatment and packaging of Phalaenopsis seedlings for sea shipment to EU and North America markets and reduce seedling rot and shipping cost; new aeration cartons for sea shipment of Phalaenopsis seedlings to enhance export quality; and export preservation treatment and packaging technology of water bamboo to improve flavor and quality after export shipping. Some of the above-mentioned achievements are being commercialized and widely used.

Weakness of agricultural technology

Natural disaster relieves

Agricultural production in Taiwan is subjected to natural disasters such as typhoons, torrential rain, low temperature, and others. In order to minimize the suffering of the farmers and to provide assistance for recovery and re-plantation, the regulation for natural disaster relieves has been implemented since 1991. Disaster relieves include cash aid, special case subsidy, and low-interest loan. The degree of loss is determined by the ratio between the damaged production area of a single crop and the total production area in the county, or between the damaged area of a single crop and the total damaged production area of the township. The amounts of special case subsidies depend on the actual damages of the disaster area. However, inconsistent damage assessments due to weakness of field-evaluation techniques often caused public grievances.

Weakness of agricultural policy

National Food Security

To meet the national food security need for stable food and to ensure farmers' profit, rice has been purchased at guaranteed prices from growers since 1974. As being a WTO member, Taiwan imports 94,068 tons of brown rice each year to replenish the food stock. With the guaranteed price system for domestic rice as well as the imported rice, the stock is ensured to reach the security level which is set at an amount enough for three-month consumption. The stock is periodically released to the military, prisons, and schools for consumption. The rice is also used for brewing. In addition, Taiwan provides overseas charity aids with the rice stock to many countries each year. The government also releases the rice stock if natural disasters and abnormal price fluctuation at the market. Under this environment, rice growers have to overcome the impacts of the imported rice by themselves.

Pesticide management

Pesticide usage and sale in Taiwan were not well managed in the past years, however, strict regulations for pesticide use had been enforced by the Council of Agriculture. The law stipulates the registration, application, testing, export, import, manufacture, labeling, packing, storage, formulation, distribution, advertisement and sale of pesticides. Before any chemical can be registered, it must pass the field efficacy tests as well as the toxicology and residue analyses conducted by Taiwan Agricultural Chemicals and Toxic Substances Research Institute (TACTRI) and/or other government authorized agencies and then approval by the Taiwan Plant Protection Technology Review Committee. Accordingly, the amounts of pesticides permitted and released in Taiwan are decreasing and the recommendatory technologies for plant protection are increasing. In 2012, out of 14,888 samples of vegetable, fruit, rice, and tea were tested for pesticide residues, 14,129 samples (94.9%) were not violate the regulations. However, the consumers are not completely satisfied with current situation of pesticide management in Taiwan.

Development of organic agriculture

Due to consumer awareness, health concern and environmental issues, COA has established necessary regulations and laws for developing organic farming in 2007. COA is the accreditation body and Taiwan Accreditation Foundation (TAF) has been authorized as the only compliance assessment organization for Accreditation body by COA. TAF manages all organic certification bodies, including production, procession, package, and distribution certification, then approved by COA. Till May 2013, COA has approved 14 certified bodies, the total area of organically certified cropping in Taiwan is 5643 ha and the number of certified organic farms is 2662, which include rice (1747 ha), vegetable (1812 ha), fruit (718 ha), tea (415 ha), and others (952 ha). The extension of organic area is not as expected due to consumer and growers' attitudes. For strengthening consumers' confidence and protecting consumers' right, COA establishes examination plans for quality and labeling of organic products every year. And growers' attitudes will determine the future of organic agriculture in Taiwan.

Future perspectives

Pesticide management for healthy agriculture

Training of farmers in the use of pesticides more properly, economically, safely, and efficiently is the primary job of extension workers. Farmers are advised to delay harvest and to attend educational classes if their produces are high in pesticide residues. To encourage the farmers to grow their products with properly chemical application, the "Good Agricultural Product (GAP)" certification system is available. The whole agricultural processing are monitored by government agents and the final products are sampling for residue analysis to meet the requirements of GAP certification. The examination of pesticide residues on vegetables and fruits is regularly carried out in the field and wholesale markets. In this situation, consumers would like to afford the higher price for GAP goods because their safeties are guaranteed.

Adaptation for climate change

Global warming due to anthropogenic greenhouse gas effects is projected to raise average global temperature by 1.1-6.4℃ and the sea level by 51-91 cm by the year 2100. It may cause an increase in frequency and scale of extreme weather, resulting in mass extinction and migration of terrestrial animals and plants over the next 45 years. In agro-ecosystems, the increase in concentration of atmospheric carbon dioxide would urge the photosynthesis and water use efficiency of plants thus raising the production of crops; yet on the other hand, such lavish growth of plants would also attract more pests, pathogens, and/or weeds that may cause crop losses to offset the yield gain by increased carbon dioxide. The climate change and extreme weather may be the major factors for severe outbreaks of some diseases in recent years. For example, a typhoon not only brings strong winds and torrential rains but also damages plants, making the injured plants more vulnerable to attack by pathogens. In Taiwan, the most common outbreaks of diseases after each typhoon are anthracnose, bacterial leaf blight of rice, bacterial soft rot, citrus canker, *Fusarium* wilt, *Phytophthora* rot and viral diseases. Results of plant diseases surveyed in Taiwan are used as examples for discussion of climate change on occurrence, emergence, resurgence, and redistribution of plant pathogens. Climate change affects plant diseases and their management that include: shifts in the distribution of host and pathogen, alteration of growth stages and growth rates of inocula, changes in the host-pathogen interactions, altered crop losses, and changes in the efficacy of control strategies. Thus, a thorough understanding of dynamics of plant diseases in relation to climate changes is of paramount importance in order to adapt strategies for successful management of plant diseases, including breeding for disease resistance.

Conclusion

Challenges

- Highly liberalized trade, accelerating climate change, food crisis and environmental resource contention.
- Smallholder farming patterns lack sufficient economic benefit.
- Most of the agricultural budget used for statutory benefits and subsidies (such as farmers' subsidy, administrative food policy and fallow and subsidy, fertilizer subsidy etc.,)

Respond Aggressively

- Taiwan's agricultural products and technology should not be limited to the domestic market; it should be replaced with an active, innovative strategy to strengthen Taiwan's agricultural brands and sell to the international markets.
- To innovate and extend the value chain, expand the traditional way of thinking, to seek cross-border cooperation and value-added services and open up new business opportunities.
- To replace the previous welfare policy with counseling and additional advanced technology, to develop an efficient energy-saving and

environmentally-friendly business model , assisting a new generation of agricultural operators to work together to create new agriculture value .

Long-term Vision

To build a good agricultural environment with a dynamic, highly competitive industry and a stable income to farmers.

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