葡萄及百香果耕作制度與生產技術調查[1]

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摘　要

臺灣葡萄與百香果種植面積分別為 2,474 ha 與 894 ha，合計 3,368 ha，產值分別為 69 與 13 億元，合計 82 億元。本調查透過訪談方式，完成百香果與葡萄生產技術與耕作系統資料，作為後續建立防範及提高供應韌度技術之依據，以進行災害調適因應。百香果災害型態主要種類為颱風與豪雨，葡萄為颱風、豪雨及低溫。百香果與葡萄灌溉水源為溪谷水或地下水，行銷方式為盤商、拍賣與直銷，二者以設施栽培模式產量與價格相對較穩定。結果顯示，面臨天然災害仍有穩定收益之農友栽培經驗為 11-20 年，栽培面積達 1 ha 以上。近年來，面對極端天氣衝擊、農業技術斷層及勞力缺乏之際，導入設施及智慧化生產技術將是趨勢，亦是未來值得持續研究之方向。

關鍵字：氣候變遷、農作物、減災、韌性農業、生產系統

前　言

隨氣候變遷導致極端天氣影響加劇，世界各國許多城市受到天然災害衝擊已超過防治極限(8)。依聯合國政府間氣候變遷專門委員會(Intergovernmental panel of climate change, IPCC)於 2021 年 8 月 9 日公布第六次評估報告(簡稱 IPCC AR6)，提到未來氣候因 CO_2 與其他溫室氣體排放，在 21 世紀全球暖化幅度將超過 1.5 ℃(3)。當全球溫度上升 1 ℃，單日極端降雨發生強度將增加 6.7%，發生頻率增加 30%(14)。另一方面，聯合國糧食及農業組織(Food and Agriculture Organization of the United Nations, FAO)2020 年報告指出，全球人口於 2050 年將達到 98 億，糧食需求增加 60-70%(23)。雖然 21 世紀是人類糧食生產有史以來最充裕的時代，仍存有糧食供應不足的問題，而糧食危機比戰爭更嚴重且可怕，因為歷史已驗證人民因飢荒而引起戰亂，政府如何使糧食穩定均衡供應，是重要且有效的管理方式(2)。

農業是一種特別脆弱的經濟事業體系，相當依賴天氣及氣候條件，適應氣候變遷對農業的未來是一個關鍵因素(38)。面臨氣候變遷帶來溫度、雨量、海平面上升及極端天氣事件發生，如何減少其對農業生產的衝擊，穩定糧食自給率為當前刻不容緩之議題。「韌性農業」(Resilient agricultural)是以不斷變化的環境具生存及發展能力為中心，當氣候、經濟及市場等產生變化，農業始終必需具有

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[29,30,35,38,41,45]。而在開發中國家可持續食品供應系統與安全，透過韌性農業操作是至關重要的方式[20,29,44,45]，另一種方式則是透過農業保險降低生產風險[25]。

耕作制度(Cropping system)為種植作物的類型與順序及用於種植的操作技術，其目的是為了提高作物最大產量[16,47]。臺灣果樹作物栽培面積約 18.2 萬 ha，產值達 957.8 億元，其中葡萄與百香果面積合計為 3,369 ha，產值達 82.2 億元，面積與產值分別占 1.9 與 8.6%[12]，為本場轄內具特殊耕作模式之重要經濟果樹。該二果樹栽培因技術持續改良、產期調節技術發達及育成新品種，品質、產量及產值相當穩定。惟近年氣候變遷引起極端天氣頻率及強度增加，此二作物雖可進行產期調節，仍難免受到衝擊。尤其 2021 年至 5 月下旬，臺灣面臨 56 年以來最嚴峻水情，持續乾旱缺水造成百香果天然災害損失，而葡萄或多或少亦受到一些影響，尤其 5 月高溫乾旱造成後期轉色不良。因此，透過調查及分析此二作物分布、耕作制度與地理位置等因素，期能對極端天氣進行調適，提高或穩定供應韌度。

材料與方法

一、訪談場域

本場轄區臺中市、彰化縣及南投縣重要果樹百香果及葡萄果園。

二、方法

(一)訂定訪談大綱

透過本場百香果、葡萄專家及農業試驗所農業經濟研究室研究人員共同討論，確立百香果與葡萄韌性農業訪談大綱。訪談內容為災害損失情形評估、災害發生歷程的因應作業及防減災資源或災後援助系統(詳如附錄)。

(二)調查方法-個案研究與選定

參考陳等人[7]利用個案研究法，深入瞭解遭遇不良天候時，仍可穩定生產的農友之關鍵成功因素及經驗。然後依訪談大綱與南投縣埔里鎮產銷班5位百香果農友；彰化縣大村鄉、溪湖鎮、埔心鄉與二林鎮、南投縣信義鄉與水里鄉、臺中市新社區等產銷班共20位葡萄農友進行面對面訪談，過程以文字記錄，再進行資料分析。

(三)耕作制度與生產技術調查表

另與本場相關研究人員討論，設計百香果與葡萄耕作制度與生產技術調查表，項目為耕作制度、生產技術、應用地區、面積(ha)、產期、產量(ton·ha^{-1})、市場(行銷方式或管道)及水源等基本資料，透過訪談相關鄉鎮(市)農會推廣人員及產銷班班長獲取資訊，另由臺北農產運銷股份有限公司交易行情查詢網查詢百香果與葡萄交易數量(kg)及金額(NT·kg^{-1})[13]。災害種類由近10年(2012-2021)行政院農業委員會(簡稱農委會)公告系統查詢與行政院農業委員會農糧署(簡稱農糧署)提供之百香果及葡萄農業天然災害現金救助情形與種類。推廣潛力經查詢百香果與葡萄近10

年農業天然災害現金救助情形，再由本場研究人員分析災害發生區域及生產技術後，10年內總救助次數0-3次為低災害頻率低風險，具高推廣潛力。4-6次中度災害頻率風險中等，推廣潛力為中等。7次以上為高災害頻率高風險，推廣潛力低。

(四)資料分析

將訪談之個人、韌性農業等構面、紀錄重點、事件及感受[7]，連結前述關鍵成功因素及經驗要素整體分析與詮釋，完成百香果及葡萄提高韌性之耕作制度與生產技術調查表。

結果與討論

一、個案基本資料

百香果訪談對象以南投縣為主，平均年齡為 45 歲，葡萄包含南投縣、彰化縣及臺中市，平均年齡為 51 歲。百香果與葡萄從農人員學歷至少為國中，從農經驗分別為 11-15 年及 15-20 年。百香果栽培者平均面積達 2.4 ha，葡萄為 1.1 ha，均為自有或承租土地耕作。百香果與葡萄均為個人經營、聘請臨時工及加入產銷班，惟百香果南投及臺中目前多為露天栽培，僅彰化縣少數採用溫網室設施栽培，葡萄則有露天及溫室設施之模式(表一)。

表一、訪談對象基本資料
Table 1. The basic data of interviewees

Category	Passion fruit	Grape
Age(year, AVG)	45	51
Education level	At least junior school	At least junior school
Farming experience (year)	11-15	15-20
Land location	Nantou	Nantou , Changhua and Taichung.
Total area(ha, AVG)	2.4 (own and rent)	1.1(own and rent)
Operation model	Independent operation	Independent operation
Planting pattern	Open field	Open field or Greenhouse
Temporary worker	Yes	Yes
Agriculture production and marketing group	Yes	Yes

二、耕作制度與生產技術調查

百香果主要栽植於南投縣埔里鎮，其次水里鄉與臺中市新社區約 31 ha，近幾年彰化縣開始零星栽植[12]，採網室或溫室方式栽種。耕作制度均為全年作，差別為南投與臺中地區一年採收 3 批次，自 6 月持續採收至 12 月，為目前中部地區主要栽培模式，產量為 20-37 ton·ha^{-1}，銷售方式為

拍賣、盤商及直銷等方式。彰化地區因採用網室或溫室設施栽培，與主產區埔里鎮產期錯開，調節產期為 1-6 月，採收 1-2 批次，第一批次為農曆年節前後，第二批為梅雨季節前，目前僅少數農友進行試種，遭遇災害僅 3 次具高推廣潛力(表二)。另一方面，南投縣與臺中市灌溉水源主要為溪谷水，又更新栽培為 1-2 月，栽植過程中容易遭受寒流(12-2 月)、豪雨(5-10 月)、颱風(7-10 月)及乾旱(1-5月)等天然災害，影響層面不同，例如寒流使幼苗生育緩慢或不整齊，颱風與豪雨導致著果不良或落果，乾旱造成開花著果銳減等問題。近年災害種類亦發生變化，2021 年 3-5 月乾旱缺水而辦理天然災害現金救助(表二)。另南投縣與臺中市近 10 年天然災害現金救助各達 5 次，因此推廣潛力中等，主要為颱風、風災雨害與豪雨(表二)，依訪談結果宜導入遮雨設施(表三)。

百香果生長適溫為 15-30 °C，因此臺灣中部以南均可廣泛種植[5,11]，近年百香果種植區域出現往彰化縣、高雄市及屏東縣擴散趨勢[1,12]，可有效調節產期及分散風險。而南投縣與臺中市易受強降雨極端天氣影響，且此二區域 1-3 月苗期常有 15 °C 以下低溫使生長遲緩，需藉由設施投入以解決相關問題(表三)；彰化地區以採用溫網室栽培，產期提前為1-5月，夏季高溫期無法生產，因為百果花芽分化適溫為 25/20 °C，溫度高使花芽分化不良，果實轉色差且果粒較小[4,6]，而且溫度高於 30 °C 或低於 15 °C，開花顯著降低[34]，濕度 60-80%影響授粉及受精[23]，因此，採用溫網室設施栽植百香果，其內部溫濕度管理仍需持續加強，以建立合適之栽種制度。

葡萄為中部地區重要溫帶果樹，由表四顯示主要栽植於彰化縣大村鄉、溪湖鎮、埔心鄉、埔鹽鄉、二林鎮、員林市及永靖鄉；南投縣信義鄉、水里鄉及草屯鎮；臺中市新社區，以露天栽培 1 年 2 收為主，另有 1 年 1 收秋果及利用設施生產之春果[5]。目前葡萄仍以露天栽培居多，以彰化縣大村鄉 374 ha 最多，其次為臺中市白毛台 233 ha、南投縣信義鄉 194 ha、彰化縣溪湖鎮 128 ha 及臺中市新社區大湳約 100 ha，其餘地區介於 8-94 ha 之間，水源為地下水與溪谷水，產量約 25-36 ton·ha^{-1}，銷售方式包含盤商、拍賣及直銷(表四)。另南投縣信義鄉與水里鄉採用 1 年 1 收秋果模式，採收期為 10-11 月，可有較高之價格(圖一)，面積將近 100 ha(表四)。近 10 年彰化縣、臺中市及南投縣葡萄天然災害現金救助達高 33 次，與雨量有關占 10 件(表二)。而臺中市天然災害現金救助達 17 次，自 2012 年起 3-4 月鋒面影響，進一步訪談得知鋒面主要為低溫，2016 年寒流亦為低溫，推廣潛力低，為提高供應韌度建議採用捲揚溫室設施，降低極端天氣之衝擊(表二及三)。

利用溫室設施栽培主要集中於彰化縣溪湖鎮、大村鄉及埔鹽鄉等地，面積約 430 ha，因一年採收一次，產量明顯偏高，達 25 ton·ha^{-1} 以上，銷售以盤商為主，溪湖鎮則有部分進入拍賣市場(表四、圖一)。溫室設施生產期為 10 月中旬至 6 月上旬，雖然近 10 年彰化縣葡萄災損次數達 8 次，進一步分析實際災損僅 2015 年 8 月颱風與 2016 年 1 月寒流，災害相對於露天栽培較少且供應韌度較高，具高推廣潛力之栽培模式。惟葡萄採溫室栽培模式，生育初期 11-2 月為臺灣低溫短日期，有低溫寒害風險，果實成熟期為 3-5 月，遭遇高溫將影響果粒轉色，因此，輔導變更改為捲揚式溫室、導入人工智慧控制及調整整枝模式進行無子化葡萄生產(表四)。

百香果於 25/20 °C 左右花芽分化較穩定，20-30 °C 間著果率較高[6,11]。圖二顯示，目前百香果

產量主要集中於 6-11 月，12 月交易量銳減，依百香果果實品種及發育習性，授粉後約 60-80 天成熟[6]，臺灣 7-9 月為高溫期，日溫動輒 30 °C 以上，溫度可能不利於花芽分化與開花著果，因此 11 月後產量開始下降。對所有作物而言，開花授粉為對極端溫度最敏感之物候期，而且發育期間之極端溫度也將影響後續產量[28]。2021 年因 1-5 月下旬降雨量偏少，持續乾旱造成埔里鎮大坪頂百香果開花著果銳減 20%以上，農委會公告南投縣為辦理百香果 2021 年 3-5 月高溫乾旱農業天然災害現金救助地區[9]。又百香果根系為鬚根，長時間降雨或強降雨易積水之園區導致根發育受影響，嚴重者使土壤病害發生，造成植株死亡，顯示百香果為對水分敏感之作物[6]。近幾年百香果產區出現位移現象，高屏地區面積約 100 ha，產期自 2 月下旬至 6 月[1]。中部彰化地區利用網室或溫室設施栽培，面積逐漸增加，由表三顯示產期為 12-5 月，此時期遭遇主要災害種類為寒流。本場目前刻正研究於低溫期以 LED 燈進行夜間燈照處理，並加強整枝模式、開發微噴霧降溫系統，以穩定著果及供應韌度。

葡萄為對氣候與風土(*terroir*)敏感之作物，研究聚焦氣候變遷對葡萄產區、果實組成分及釀酒品質影響，暖化增加葡萄糖含量、降低花青素及酸度，導致發酵停滯或變緩慢，進而影響釀酒業者損失，此外，結合栽培技術使某些品種成熟期延遲將近 15 天[17,18,19,20,21,31,37,42,43,46]。葡萄為全球廣泛栽培之果樹，產值相當高，近幾年氣候變遷導致全球暖化速度加劇，依 IPCC AR6，提到未來氣候因 CO_2 與其他溫室氣體排放，在 21 世紀全球暖化幅度將超過 1.5 °C，研究指出葡萄產區可能往南北半球更高緯度區域移動，因此，依「巴黎協定」將全球暖化溫度控制在上升 2 °C 以下，以作為葡萄提高韌度之長期目標[37,41]，與此同時，氣候變遷造成全球暖化已是事實，義大利嘗試利用修剪方式，進行‘Pinot Noir’一年二收模式，可生產果實進行不同葡萄酒品質釀製之模式[40]。葡萄在亞熱帶與熱帶地區呈現，似常綠果樹周年生長，且不須很高的低溫需求，可藉由使用化學藥劑打破休眠[15,21]，暖化或許可提高彰化地區冬季修剪及催芽萌芽率，但暖化對葡萄花芽分化與萌芽後新梢是否有花序值得持續觀察。臺灣葡萄栽培面積雖然僅 2,300 餘 ha，分布於中部地區苗栗縣、臺中市、南投縣及彰化縣，利用地理位置條件，結合修剪催芽、設施及夜間燈照等方式進行產期調節，幾乎可周年生產鮮果，惟產期仍以 6 月 12 月為大宗，交易價格以 3-5 月最高(圖一)，此時期為溫室設施主要產期。臺灣自 1972 年開始發展設施生產葡萄，至 2002 年結合夜間燈照技術，為溫室葡萄進入穩定經濟生產之關鍵[10]。但面對極端天氣如持續高溫(35 °C 以上)、強降雨及乾旱等對葡萄萌芽、花芽分化、病蟲害相及果實品質等影響，仍需持續調查以建立相關資料，除了栽培技術調整改良，耐候性品種選育亦為重要工作。

常見耕作制度為單一作物、混植、連續耕作及輪作等 12 項，但多以玉米或水稻等糧食作物為模型[16,32,47]。而就百香果及葡萄等果樹而言，均為藤蔓性果樹，臺灣種植百香果有病毒病危害因素，需每年進行更新種植無病毒苗[6]。葡萄採用一年二收等產期調節生產模式[5]，因高產量植株容易衰弱，約 10-15 年更新種植，但耕作制度仍屬於單一作物型。另一方面，研究利用衛星觀測數據為作物系統分析依據，可包含作物面積、種植模式、栽培作業曆、作物生長活力及土壤類型等(Cropping

system)；但作物評估意見往往忽視主要限制因素及對當地環境適應能力，進行評估適應策略方法的開發，同時需考慮互補的適應與規模，才能將相關訊息提供予相關作物栽培或管理決策者[37]。氣候變遷已造成作物產區位移，需即時、合適且具成本效益的適應策略，並透過徹底規劃當地條件，以有效降低生產風險[45]。另由訪談過程發現，面對天然災害受訪者仍有較穩定之收益，與地理位置、栽培經驗及防災資訊取得等有關(附件訪談資料)，可及早進行防減災措施，降低災損。此外，土壤為作物生產之根本，維持土壤的健康才能持續穩定生產[32,46]。

在葡萄及百香果栽種方面，或許可結合地理資訊系統(Geographic Information System, GIS)建置更完整的土壤資訊(料)，建立合適的耕作制度調查尺度，藉由資訊建立快速調整生產技術，並利用合適的農法對抗氣候變遷，以達到提高此二作物供應穩定性或提高韌性。研究指出葡萄結合人工智慧判斷葉面病害[33,36,39]；利用神經網絡圖學習修剪規則[24]，由表三及表四顯示，面對極端天氣衝擊，導入設施及智慧化生產技術將是趨勢，亦是未來值得持續研究之方向。

表二、2012-2021 年百香果及葡萄天然災害現金救助一覽表

Table 2. The natural disaster cash assistance of passion fruit and grape from 2012 to 2021

Crops	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Passion fruit	Taichung /rain and typhoon/Jun.	Nantou /typhoon /Jul. Taichung /typhoon/Jul.		Changhua /typhoon/Aug. Taichung /typhoon/ Aug. to Sep. Nantou /typhoon/Sep.	Taichung /typhoon, wind and rain/Sep. Changhua /typhoon, wind and rain/Sep.	Nantou / torrential rain/Jun. Taichung / torrential rain/Jun.		Nantou /torrential rain/Aug.		Nantou /High temperature and drought/Mar. to May Changhua /torrential rain/Aug.
Grape	Taichung /front/Apr. Taichung /torrential rain and typhoon/Jun.	Taichung /continuous rain/Apr. Nantou /typhoon/Jul. to Aug. Taichung /typhoon/ Jul. to Aug.	Changhua /front/Mar. to Apr. Taichung /front/Mar. to Apr. Nantou /front/ Mar. to Apr.	Taichung /front/ Mar. to Apr. Changhua /typhoon/Aug. Taichung /typhoon/Aug. to Sep. Changhua / typhoon/Sep.	Nantou / cold snap/Jan. Changhua / cold snap/Jan. Taichung /cold snap/Jan. Taichung /Low temperature/Feb. Nantou /hail/May Nantou /typhoon, wind and rain/Sep. Changhua /typhoon/Sep. Taichung / typhoon/Sep.	Taichung /front /Apr. Nantou /torrential rain/Jun. Changhua /torrential rain/Jun. Taichung /torrential rain/Jun.	Taichung /front/Mar.	Taichung /front/Mar. Changhua /torrential rain/Jun.	Nantou /front/Mar. Taichung /front/Mar.	Taichung /front/Mar. Nantou / torrential rain/Jun. Taichung / torrential rain/Jun. Changhua / torrential rain/Aug.

資料來源：行政院農業委員會農糧署

表三、百香果耕作制度與生產技術調查表

Table 3. The cropping systems and cultivation techniques of passion fruit.

Crop	Cropping system	Production technique	A location field	Area (ha)	Production period	Yield (ton · ha^{-1})	Market	Water source	Advantage	Disaster types	Promotion potential	Promotion limited	Probably promotion area	Improve experiments
Passion fruit	Annual	Open field	Puli, Nantou,	554	Jun. to Dec.	37.0	Auction market, wholesaler, direct sale	Valley water	3 crops per year and risk spreading	Cold snap (Dec. to Mar.), torrential rain (May to Oct.), typhoon (Jul. to Oct.) and drought (Apr. to May)	Medium	High cost of insect and disease control	North and central Taiwan	Import facility and water-saving irrigation system
	Annual	Open field	Shuili, Nantou,	18	Jun. to Dec.	28.1	Auction market, wholesaler, direct sale	Valley water	3 crops per year and risk spreading	Cold snap (Dec. to Mar.), torrential rain (May to Oct.), typhoon (Jul. to Oct.) and drought (Apr. to May)	Medium	High cost of insect and disease control	North and central Taiwan	Import facility and water-saving irrigation system
	Annual	Open field	Xinshe, Taichung	13	Jun. to Dec.	20.3	Auction market, wholesaler, direct sale	Valley water	3 crops per year and risk spreading	Cold snap (Dec. to Mar.) and torrential rain(May to Oct.) typhoon (Jul. to Oct.) and drought (Apr. to May)	Medium	High cost of insect and disease control	North and central Taiwan	Import facility and water-saving irrigation system
	Annual	Net-house	Fuxing, Changhua	0.2	Feb. to May	24.0	Wholesaler , direct sale	Groundwater	1-2 crops per year and risk spreading	Cold snap (Dec. to Mar.) and torrential rain (May to Oct.)	Medium	High temperature in summer	South and central Taiwan	Training model and decrease temperature system
	Annual	Medium level greenhouse	Xihu, Changhua	5	Jan. to Apr.	25.0	Wholesaler , direct sale	Groundwater	1-2 crops per year and risk spreading	Cold snap (Dec. to Mar.) and Typhoon (Jul. to Oct.)	High	High temperature in summer and typhoon	Central Taiwan	Training model and decrease temperature system

表四、葡萄耕作制度與生產技術調查表

Table 4. The cropping systems and cultivation techniques of grapevine.

Crop	Cropping system	Production technique	A location field	Area (ha)	Production period	Yield (ton · ha^{-1})	Market	Water source	Advantage	Disaster types	Promotion potential	Promotion limited	Probably promotion area	Improve experiments
Grape	Annual	One crop per year under greenhouse	Xihu, Changhua	350	Medium Feb. to Jun.	28.0	Auction market, wholesaler, direct sale	Groundwater	1.Reduce rain damage, pests and diseases, stable yield and price. 2.No typhoon from Mar. to May.	Cold snap (Dec. to Feb.) and high temperature (Apr. to May)	High	High cost for facility	Xihu	Medium level greenhouse (捲揚式溫室), AI, new training system and seedless production technique.
	Annual	One or two crops per year under greenhouse	Dacun, Changhua	40	Early Mar. to May	30.1	Wholesaler, direct sale	Groundwater	1.Reduce rain damage, pests and diseases, stable yield and price. 2.No typhoon from Mar. to May.	Cold snap (Dec. to Feb.)	High	High cost for facility	Dacun	Medium level greenhouse, AI, new training and pruning technique.
	Annual	One crop per year under greenhouse	Puyan, Changhua	20	Late Mar. to May	28.0	Wholesaler, direct sale	Groundwater	1.Reduce rain damage, pests and diseases, stable yield and price. 2.No typhoon from Mar. to May.	Cold snap (Dec. to Feb.) and high temperature (Apr. to May)	High	High cost for facility	Puyan	Medium level greenhouse, AI, new training and pruning technique.
	Annual	One crop per year under greenhouse	Puxin, Changhua	10	Late Mar. to May	28.0	Wholesaler, direct sale	Groundwater	1.Reduce rain damage, pests and diseases, stable yield and price. 2.No typhoon from Mar. to May.	Cold snap (Dec. to Feb.) and high temperature (Apr. to May)	High	High cost for facility	Puxin	Medium level greenhouse, AI, new training and pruning technique.

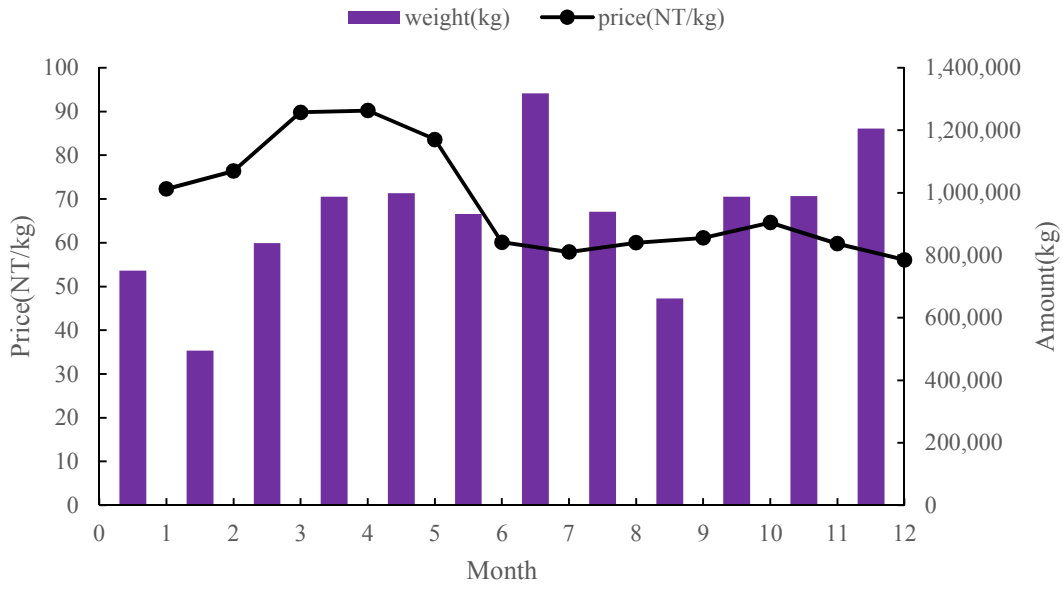
Crop	Cropping system	Production technique	A location field	Area (ha)	Production period	Yield (ton · ha^{-1})	Market	Water source	Advantage	Disaster types	Promotion potential	Promotion limited	Probably promotion area	Improve experiments
	Annual	One crop per year under greenhouse	Yongjing, Changhua	10	Late Mar. to medium May	28.0	Wholesaler, direct sale	Groundwater	1.Reduce rain damage, pests and diseases, stable yield and price. 2.No typhoon from Mar. to May.	Cold snap (Dec. to Feb.) and High temperature (Apr. to May)	High	High cost for facility	Yongjing	Medium level greenhouse, AI, new training and pruning technique.
	Annual	One crop per year under greenhouse	Erlin, Changhua	2	From medium Apr. to May	25.0	Wholesaler, direct sale	Groundwater	1.Reduce rain damage, pests and diseases, stable yield and price. 2.No typhoon from Mar. to May.	Cold snap (Dec. to Feb.) and high temperature (Apr. to May)	High	High cost for facility	Erlin	Medium level greenhouse, AI, new training and pruning technique.
	Annual	Two crops per year in the open field	Dacun, Changhua	374	First crop in late May to end Jun. and second in Dec.	35.0	Wholesaler, direct sale	Groundwater	1.Two crops per year to reduce risk. 2.The first crop in Jul. to reduce typhoon damage. 3.Second crop good color in winter.	Cold snap (Dec. to Feb.), heavy rain (May to Jun), Typhoon (Jul. to Oct.) and high temperature (Aug. to Oct)	Medium	Weather and labors	Erlin	Introduce simple rain shelter(簡易遮雨設施), new training and pruning technique.
	Annual	Two crops per year in the open field	Xihu, Changhua	128	First crop in late May to end Jun. and second in Dec.	30.0	Wholesaler	Groundwater	1.Two crops per year to reduce risk. 2.The first crop in Jul. to reduce typhoon damage. 3.Second crop good color in winter.	Cold snap (Dec. to Feb.) and high temperature (Apr. to May)	Medium	Weather and labors	Xihu	Introduce simple rain shelter, new training and pruning technique.

Crop	Cropping system	Production technique	A location field	Area (ha)	Production period	Yield (ton·ha^{-1})	Market	Water source	Advantage	Disaster types	Promotion potential	Promotion limited	Probably promotion area	Improve experiments
	Annual	Two crops per year in the open field	Puxin, Changhua	94	First crop in Jun. and second in Dec.	36.0	Wholesaler, direct sale	Groundwater	1.Two crops per year to reduce risk. 2.The first crop in Jul. to reduce typhoon damage. 3.Second crop good color in winter.	Cold snap(Dec. to Feb.) and heavy rain (May to Jun)	Medium	Weather and labors	Puxin	Introduce simple rain shelter, new training and pruning technique.
	Annual	Two crops per year in the open field	Erlin, Changhua	35	First crop in Jun. and second in Dec.	35.0	Wholesaler, direct sale	Groundwater	1.Two crops per year to reduce risk. 2.The first crop in Jul. to reduce typhoon damage. 3.Second crop good color in winter.	Cold snap (Dec. to Feb.) and high temperature (Apr. to May)	Medium	Weather and labors	Erlin	Introduce simple rain shelter, new training and pruning technique.
	Annual	Two crops per year in the open field	Puyan, Changhua	20	First crop in Jun. and second in Dec.	25.0	Wholesaler, direct sale	Groundwater	1.Two crops per year to reduce risk. 2.The first crop in Jul. to reduce typhoon damage. 3.Second crop good color in winter.	Cold snap (Dec. to Feb.) and high temperature (Apr. to May)	Medium	Weather and labors	Puyan	Introduce simple rain shelter, new training and pruning technique.
	Annual	Two crops per year in the open field	Yuanlin, Changhua	18	First crop in Jun. and second in Dec.	25.0	Wholesaler, direct sale	Groundwater	1.Two crops per year to reduce risk. 2.The first crop in Jul. to reduce typhoon damage. 3.Second crop good color in winter.	Cold snap (Dec. to Feb.) and high temperature (Apr. to May)	Low	Weather and labors	Yuanlin	Introduce simple rain shelter, new training and pruning technique.

Crop	Cropping system	Production technique	A location field	Area (ha)	Production period	Yield (ton · ha^{-1})	Market	Water source	Advantage	Disaster types	Promotion potential	Promotion limited	Probably promotion area	Improve experiments
	Annual	Two crops per year in the open field	Yongjing, Changhua	8	First crop in Jun. and second in Dec.	25.0	Wholesaler, direct sale	Groundwater	1.Two crops per year to reduce risk. 2.The first crop in Jul. to reduce typhoon damage. 3.Second crop good color in winter.	Cold snap (Dec. to Feb.) and high temperature (Apr. to May)	Low	Weather and labors	Yongjing	Introduce simple rain shelter, new training and pruning technique.
	Annual	Two crops per year in the open field	Xinyi, Nantou	194	First crop in Jul. and second in Dec. to Jan.	32.0	Auction market, wholesaler, direct sale	Valley water	1.Two crops per year to reduce risk. 2.First crop in Jul. and second in Dec. to Jan. which is different from Changhua . 3.Temperature varies during day and night in Nov. that second crop with good color.	Cold snap (Dec. to Mar.), high temperature (Mar. to Aug.) and heavy rain (Jun. to Sep.)	Medium	Weather, labors and lands	Xinyi	Medium level greenhouse, training, pruning and seedless production technique
	Annual	One crop per year in the open field	Xinyi, Nantou	80	One crop per year from Oct. to Nov.	22.0	Auction market, wholesaler, direct sale	Valley water	1.During Oct. to Nov. to harvest which is different from other areas. 2.Temperature varies during day and night in Sep. that is good for coloring.	Cold snap (Dec. to Mar.), high temperature (Mar. to Aug.) and heavy rain (Jun. to Sep.)	Medium	Weather, labors and lands	Xinyi	Medium level greenhouse, training and pruning technique

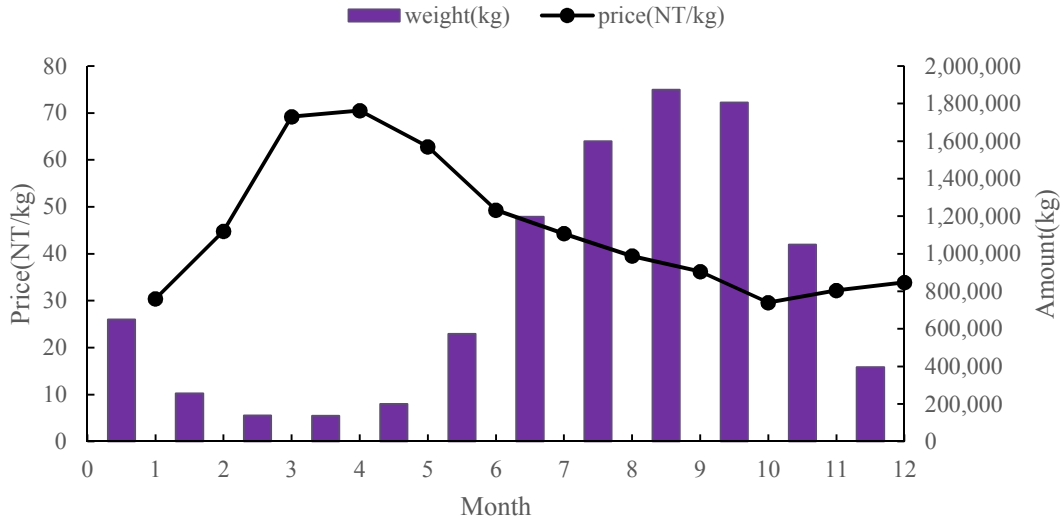
Crop	Cropping system	Production technique	A location field	Area (ha)	Production period	Yield (ton · ha^{-1})	Market	Water source	Advantage	Disaster types	Promotion potential	Promotion limited	Probably promotion area	Improve experiments
	Annual	Two crops per year in the open field	Shuili, Nantou	20	First crop in Jul. and second in Dec. to Jan.	34.0	Auction market, wholesaler, direct sale	Valley water	1.Two crops per year to reduce risk. 2.First crop in Jul. and second in Dec. to Jan. which is different from Changhua . 3.Temperature varies during day and night in Nov. that second crop with good color.	Cold snap (Dec. to Mar.), high temperature (Mar. to Aug.) and heavy rain (Jun. to Sep.)	Medium	Weather, labors and lands	Shuili	Medium level greenhouse, training and pruning technique
	Annual	One crop per year in the open field	Shuili, Nantou	14	From Oct. to Nov.	25.0	Auction market, wholesaler, direct sale	Valley water	1.During Oct. to Nov. to harvest which is different from other areas. 2.Temperature varies during day and night in Sep. that is good for coloring.	Cold snap (Dec. to Mar.), high temperature (Mar. to Aug.) and heavy rain (Jun. to Sep.)	Medium	Weather, labors and lands	Shuili	Medium level greenhouse, training and pruning technique
	Annual	Two crops per year in the open field	Caotun, Nantou	29	First crop in Jul. and second in Dec. to Jan.	32.0	Wholesaler, direct sale	Valley water	1.Two crops per year to reduce risk. 2.First crop in Jul. and second in Dec. to Jan. which is different from Changhua.	Cold snap (Dec. to Mar.), high temperature (Mar. to Aug.) and heavy rain (Jun. to Sep.)	Low	Weather, labors and lands	Caotun	Medium level greenhouse, training and pruning technique

Crop	Cropping system	Production technique	A location field	Area (ha)	Production period	Yield (ton · ha^{-1})	Market	Water source	Advantage	Disaster types	Promotion potential	Promotion limited	Probably promotion area	Improve experiments
									3.Temperature varies during day and night in Nov. that second crop with good color.					
	Annual	Two crops per year in the open field	Xinshe (Baimaotai), Taichung	233	First crop in Jul. and second in Dec. to Jan.	30.0	Wholesaler, direct sale	Valley water	1.Two crops per year to reduce risk. 2.First crop in Jul. and second in Dec. to Jan. which is different from Changhua. 3.Temperature varies during day and night in Nov. that second crop with good color.	Cold snap (Dec. to Mar.), high temperature (Mar. to Aug.) and heavy rain (Jun. to Sep.)	Low	Weather, labors and lands	Xinshe (Baimaotai)	Medium level greenhouse, training and pruning technique
	Annual	Two crops per year in the open field	Xinshe (Danan), Taichung	100	First crop in Jun. and second in Nov. to Dec.	35.0	Wholesaler, direct sale and hypermarket	Valley water and groundwater	1. Two crops per year to reduce risk. 2. First crop in Jun. and second in Nov.	Cold snap (Dec. to Mar.), high temperature (Mar. to Aug.) and heavy rain (Jun. to Sep.)	Low	Weather and labors	Xinshe (Danan)	Medium level greenhouse, training, pruning and seedless production technique



圖一、2020 年葡萄交易量及價格。

Fig. 1. The trading volume and market price of grape in 2020.



圖二、2020 年百香果交易量及價格。

Fig. 2. The trading volume and market price of passion fruit in 2020.

資料來源：臺北農產運銷股份有限公司交易行情查詢網。

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Investigation on Cropping System and Production Technology of Grape and Passion Fruit[1]

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ABSTRACT

The area of grape and passion fruit planted in Taiwan was 2,474 and 894 ha, respectively, total was 3,368 ha. The output value was 6.9 and 1.3 billion NT, total was 8.2 billion NT. This survey is to analyze the production technology and cropping system of grapes and passion fruit conduct the disasters adjustment as a response to the subsequent establishment of prevention and improvement technologies for supply resilience. The results showed that farmers who still had stable income in the face of natural disasters have 11-20 years of cultivation experience and cultivation area more than 1 ha. The main type of disaster on passion fruit was typhoon and extremely heavy rain, the grape was typhoon, extremely heavy rain and front. The irrigation water source for passion fruit and grape were valley water or groundwater, and the marketing methods were auction market, wholesaler and direct sale. The output and price of the two were relatively stable in the facility cultivation model. In recent years, the extreme weather effects, unconnected technical faults in agriculture and lack of labors, the introduction of facilities and smart production technologies will be the trend. This is also a direction worthy of continued research in the future.

Key words: Climate change, crops, disaster reduction, resilient agriculture, cropping systems

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