行政院國家科學委員會專題研究計畫成果報告

作業耕種約定、交易成本
及台灣農場經營效率

計畫類別： ☑ 個別型計畫　　　　□ 整合型計畫

計畫編號： ＮＳＣ　８８－　　　－　　　－

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個別型計畫：計畫主持人：

處理方式： ☑ 可立即對外提供參考
（請打✓）　□ 一年後可對外提供參考
　　　　　　□ 兩年後可對外提供參考

執行單位： 中興大學經濟系

中華民國　88 年　7 月　31 日

國科會計劃「作業耕種約定、交易成本及台灣農場經營效率」

壹、研究動機與目的

農業之生產與自然資源之賦予相關，不過農場之生產效率卻與管理者之能力以及生產之相關制度，更為相關。過去文獻在探討制度與生產效率關係時，多以租佃制度為主題。分析上則以自耕或租佃農場之效率差異性探討為重點。管理者能力對生產效率之影響，亦為另一研究重點。

在台灣租佃制度因受耕者有其田政策之實施，租佃制度幾已不存在。尤其是在「三七五減租條例」內明定，地主如果要賣田地，則承租之佃農有優先議價權利；地主要將田地賣給他人亦得付佃農一筆補償金（約占賣價之 30~50%）。不論此法是否合理，在三七五減租條例未廢除前，農民都不願意以契約方式將田地讓佃方承租。大多數農戶會以農耕之作業為類，以雇工方式分別請人代工。例如，無法自己做之作業，則請人代插秧或整地，而分別付給工資；又如施肥、除草等作業則自己做而不請人。以稻米生產為例，農民多請人插秧、整地、收割及烘乾，其他如中耕除草、施肥、噴藥等則以家工自理。這些作業別之安排似與機械替代人工之現況有關，機械替代人工可能性高之

作業，請人作之比例會較高。就制度之特性而言，這一種作業安排方式，事實上亦為一種新的耕作契約或稱安排，亦為一種新耕作制度。

在這種新耕作制度下，過去文獻上用以估計生產函數或衡量效率方式，已不太適用。因為每一個農戶因其管理理念或生產因素供需不同，他們之作業別安排亦不相同。（例如：甲農戶在插秧、收獲上請人代工，乙農戶則僅在收獲上請人代工；丙農戶則全部作業皆請人做）。因此，過去利用農場全年資料（不分作業別）之生產效率、分析，皆會產生未考慮作業別或耕作制度特性之缺失，所衡量之效率亦會產生偏誤。

鑑此，本研究將建立一種能考慮作業別契約特性之分析架構，並以民國 87 年之全國農戶抽樣調查方式，親訪各農戶，收集稻米生產各作業別之契約安排及成本收益資料，用以探討各種作業別安排與生產效率之關係。我們將以下列方向為研究重點：

1. 瞭解農戶在各作業別下之耕作選擇，及探討影響各作業別選擇之因素。
2. 建立分析農戶作業選擇之理論及實証模式。
3. 檢視影響各農戶效率差異之因子係因制度安排不同？或因其他經濟、社會因子？

貳、樣本資料分析

鑑於台灣地區目前的農場經營，普遍存在著耕種作業別之文字契約或口頭約定之形成，為探討這種耕種作業別約定的存在與發展，並衡量這種耕種作業別約定對農場經營效率的影響程度，本研究進行個體農場之實地調查，調查資料將提供農場主選擇個別作業約定之原因及條件，並可經初步統計分析，搜集分析所需要之耕種作業別約定之生產成本與利潤等相關資料，進行經營效率之實証之測定。

調查區域分配：

本調查涵蓋台灣北部（宜蘭縣、桃園縣、新竹縣）、中部（苗栗、台中、彰化、南投、雲林等縣）、南部（嘉義、台南、高雄、屏東等縣）及東部（花蓮縣及台東縣）四個區域，共 14 個縣，計 40 個鄉鎮，每一鄉鎮皆抽樣 10 戶，依各耕種作業別委託代耕的程度及農場規模符合設定比例等條件進行抽樣，原抽樣總戶數為 400 戶，而實際有效戶數為 368 戶，其中北部 49 戶，中部 195 戶，南部 104 戶，東部 20 戶，詳見附錄之表一（本章之表格全部彙總至附錄表格中，表一係指育苗階段，表二係指整地階段，表三係指插秧階段，表四係指中耕階段，表五係指割稻階段，表六係指烘乾階段；各表下細表的表示如同表一之 1 等）。

原始資料基本分析：

本問卷依稻作生產 6 個作業別（育苗、整地、插秧、中耕、割稻、烘乾），調查其作業方式、選擇作業方式的原因及條件、以及各項費用及成本資料。（本調查限定以去年（87 年）第二期稻作生產的情況作答）。

一、 育苗階段

1.外購秧苗之理由、來源及其選擇因素

本調查資料顯示，有 83.97%的稻農直接向他人購買秧苗，而不自行生產秧苗，其最主要的理由是「沒有育苗設備」（75.4%），其他理由依次為「自家人力不足」（46.28%）、「自己育苗太辛苦」（22.98%）、「育苗技術不夠好」（17.15%）、「外購秧苗品質較好」（8.74%）及「外購秧苗成本較便宜」（8.41%）等。（參考表一之 1 及表—之 1-(1)）

以各區域來看，外購秧苗比例最高者為南部（94.23%），最低者為北部（53.06%）。至於外購秧苗理由的排序，則各區域及總樣本的情況大致上相似。

在秧苗購買來源方面，無論總樣本或各區樣本，均以本鄉育苗中心為主要購苗來源，外鄉育苗中心及附近農家則次之。選擇購買來源之三個主要因素，為距離、品質及長期往來的信用，北部樣本

戶最重視品質因素，中部及南部樣本戶以長期往來關係為第一考量，東部樣本戶則有一半以上農戶最重視距離因素。（參考表一之 1-(3)至 1-(5)）

2.秧苗自行生產

(1) 種子的來源及選擇因素

種子的來源除了北部以農會為占最高比例（47.83%）以外，其他區域及全體樣本戶來看，則以自給（前期留下）占種子取得的最主要來源。選擇種子來源的條件中，概以服務（送貨到家）及種子品種要求為前二大考量因素。（參考表一之 2-(3)至 2-(5)）

(2) 育苗機器設備

自行生產秧苗的農家，大部分擁有自己的育苗用耕耘機及播種機，向附近農家租用者所占比例分別只有 1.69%及 5.08%。（參考表一之 2-(6)-A21 及表一之 2-(6)-B21Z）

在自行生產秧苗的農戶（59 戶）中，其中有 13 戶（占 22.03%）有賣苗給其他農家，且賣出之種苗數量占全部生產秧苗的平均比例為 53.89%，顯示這些農戶兼作育苗中心。以各區域賣出種苗數量是占總生產秧苗的比例來看，北部為 22%，中部為 84.6%，南部為 33%，東部為 50%。（參考表一之 2-(11)-A211Z 及表一之 2-(11)-A211）

二、　整地階段

1.　請人代耕整地

以整地作業來看，全部樣本戶顯示，請人代耕的比例為70.38%，遠高於自行整地者，為 29.62%；但在不同區域間則有差異，如北部區域自行整地農戶的比例（69.39%），即高於請人代耕整地者（30.61%），而中部、南部及東部則均為請人代耕的比例較高，唯東部兩者的差距不大，此種差異可由請人代耕整地的原因窺其一現已。北部區域請人代耕的主要理由是自家人力不足（66.67%）及自行整地太辛苦（53.33%）兩個理由居首，而家中無整地械（33.33%）的理由較次之。中部、南部及東部區域則因家中無整地機械的理由，均遠超過自家人力不足的理由，此調查結果顯示，北部農戶因人力不足而多自購整地機械，故自行整地的比例較高，而中、南部及東部則相對地為人力較多，但資本（即設備）較不足，較傾向於請人代耕整地。（參考表二—1 及表二—1-(1)）

提供代耕整地者概皆以附近農家（76.83%）及本鄉農家（68.34%）居多，以區域別來看，中、南及東部均請附近農家及本鄉農家代耕整地為主，而北部農戶則請附近農家及代耕隊代耕整地的比例同為 40%，顯示代耕隊在北部的需求較高，而中部農戶中亦有 9.68%請代耕隊代為整地。（表二之 1-(3)及 1-(4)）

代耕整地供給者的選擇，大多基於長期往來的信用（約 67%），其次的理由則在各區域之間不同，北部區域著重技術（53%）及服務（46%），中部及南部區域較考慮距離遠近（55%以上），東部地區則較考慮信用好壞（54%）的因素。（表二之 1-(5)）

2. 自行整地

自行整地的農戶，幾乎都擁有自己的耕耘機（占 97.25%），且均未將其耕耘機提供他人整地使用，也有 87.16%的自行整地農戶未至其他農家幫忙整地。（表二之 2-(3)及 2-(4)、2-(5)）

三、 插秧階段

1. 請人代耕插秧

請人代耕插秧在全部樣本戶中，占 77.66%，若以各區域來看，中部及南部代耕插秧的比例分別高達 82.99%及 87.50%，而北部及東部代耕比例則較低，分別為 44.9%及 55%。（表三之 1）

請人代耕插秧而不自行插秧的理由，各區域及總樣本戶均以無插秧機為主要理由，其他理由依次為自家人力不足、自己插秧太辛苦等。而各區域中，只有北部，其有 22.73%的受訪戶認為請人插秧成本較便宜，其他區域之受訪戶均不以成本差異，視為請人代耕與

否的考慮因素，此點或有進一步探討的需要。（表三之 1-(1)）

以代耕插秧供給方面來看，南部及東部依序可由附近農家、本鄉農家、外鄉農家及本鄉育苗中心尋求代耕插秧，而中部地區提供代耕的來源以附近農家（68.32%）及本鄉農家（65.84%）為最主要，依次為本鄉育苗中心（21.2%）、外鄉農家（16.15%）、代耕隊（13.66%）等；而北部地區仍以附近農家為最主要來源（59.09%），而代耕隊的提供（54.55%）為第二大可能來源，值得特別注意，其他來源依次為本鄉農家、本鄉育苗中心等。

以去年第二期稻作的實際插秧方式來看，北部地區請人插秧的受訪戶中，最多數請附近農家代為插秧，占 40.91%，依次為代耕隊（22.73%）、本鄉育苗中心（18.18%）等，其主要理由依次為長期往來關係、對方信用度及技術等；若以前三大來源來看，則中部、南部及東部地區，請人代耕插秧均以附近農家居首，依次為本鄉農家及本鄉育苗中心，而值得注意的是，在中部地區請人插秧受訪戶中有 10.56%由代耕隊插秧，居第四大來源，而南部及東部受訪戶中，則均無委託代耕隊的情況。中、南及東部受訪戶選擇其代耕插秧者的理由，其考量因素依次為長期往來關係、距離較近、技術及信用等因素。（表三之 1-(4)及三之 1-(5)）

2. 自行插秧

在全部受訪戶中，有 22.34%（共 82 戶）為自行插秧，其中有 74 戶（90.24%）擁有自己的插秧機，自行插秧的受訪戶沒有插秧機者，卻無向人租用插秧機的資料，必須進一步瞭解。（表三之 2-(3)C203Z）

全部自行插秧受訪戶中，約有 23.17%農戶有到其他農家幫忙插秧工作，約 6%農戶會將插秧機提供他人插秧使用。（表三之 2-(4)C204Z 及表三之 2-(5)C205Z）

四、 中耕階段（包括噴藥、施肥、除草）

1. 噴藥

（1）請人代為噴藥

在各區受訪戶中，中部請人噴藥的比例（18.46%）最高，依次為南部 10.58%、北部 4.08%，而東部為 0%。可見，此噴藥作業大部份農戶為自行操作。

在委託他人噴樂的受訪戶中，其不自行噴藥的理由，北部農戶是因自家人力不足（100%）及無噴藥設備（100%）；中部農戶除考量自家人力不足（61.11%）因素，亦因噴藥工作者險性高（55.56%）及因家中無噴樂設備（44.4%）等因素而請人代為噴樂；南部地區

不自行噴藥的首要理由則為噴藥危險性高（63.64%），而依次為自家人力不足（54.55%）及無噴藥設備（18.18%）等因素。（表四之1-(4)）

請人噴藥的可能及實際來源，乃以附近農家及本鄉農家為主，且其選擇均以價格便宜為最主要理由（95.92%），依次為長期往來（59.18%）及距離近（38.78%）等因素。（表四之 1-(6)及 1-(7)）

(2) 自行噴藥

Q1：此整理表中漏列「(9)本期是否有至其他農家幫忙噴藥」之調查結果。

Q2：自行噴藥需添置設備嗎？

2. 施肥

與噴藥作業相同的是，大部分農戶以自行施肥為主，各區自行施肥農戶所占比例均在 95%上，而北部 49 個受訪戶全數為自行施肥；少數請人幫忙施肥的農戶，其理由主要都是自家人力不足，而且受委託者多為附近農家（72.73%），本鄉育苗中心（18.18%）次之；選擇理由為信用良好、長期往來關係及距離近等因素。

表四之 2-(9)「是否至其他農家幫忙施肥」漏列。

3. 除草

本作業亦以自行除草（96.45%）為主，極少數不自行除草者，其主要理由均為自家人力不足，且委託附近及本鄉農家代耕除草為主，故距離近為最重要的選擇因素，長期往來關係（30.77%）則次之。本調查資料顯示，自行除草的受訪戶並未到其他農家幫忙除草。（表四之 3-(1)，3-(3)，3-(4)，3-(5)，3-(6)，3-(8)）

摘要：中耕階段的三個作業（噴藥、施肥及除草）有若干相同處。由調查資料可知，此三個作業均以自行操作為主，若有委託他人的情況，理由主要都是自家人力不足，而以附近及本鄉農家為主要委託對象，選擇委託對象的首要因素，噴藥作業方面最重視價格因素，施肥方面則信用及長期往來因素並重，而除草方面則以距離近為最主要考量。

五、 割稻階段

在全部受訪戶中，大多數農戶（占 92.39%）為委託他人割稻，少數（28 戶，占 7.61%）自行割稻的農戶中，有 27 戶自己有割稻機，有 1 戶租用割稻機。（參考表五之 1，E1Z，表五之 2-(3)a，b）。自行割稻的農戶中 46.43%有到其他農家幫忙割稻（表五之 2-(4)），且只有 1 戶有將割稻機提供他人使用（表五之 2-(5)）。

委託他人割稻的農戶，其不自行割稻最主要理由均為無割稻機械（92.65%），自家人力不足（50.59%）次之，而由北部區域調查資料中反映了自行割稻的雇工不易尋得及成本高，亦為影響割稻作業方式的重要考量因素。（赤五之 1-(1)）

委託割稻對象的選擇，北部地區依序為附近農家（39.47%）、代耕隊（31.58%）、本鄉農家（10.53%）及本鄉育苗中心（7.89%）等，其考量的理由以長期往來（71.05%）及信用度（52.63%）為最主要，服務態度（39.47%）、技術（26.32%）、距離（26.32%）及價格（15.79%）次之。中部地區委託割稻的來源，依序為附近農家（41.08%）、本鄉農家（22.16%）、代耕隊（15.68%）及外鄉農家（10.27%）等，選擇理由主要為長期往來（67.57%）、距離近（42.7%）以及信用（15.68%）、技術（14.59%）等因素。南部地區受訪戶中，無委託代耕隊者，其他調查結果的排序，與中部地區同。東部地區委託附近農家者最多（63.16%），其次為外鄉農家（21.05%），本鄉農家再次之（15.79%），此選擇的理由以長期往來（52.63%）因素最主要，其次為信用度（31.58%）及價格（31.58%），再次為服務態度（26.32%）及距離（15.79%）因素。（表五之 1-(4)及五之 1-(5)）

六、 晒乾或烘乾階段

自行烘乾比例最高的區域為南部（71.15%），其他依次為中部

（55.38%）、北部（48.98%）及東部（20%）；而不自行烘乾理由的排序，在各區域之間大致相同，均以無烘乾機械為最主要，其次為自家人力不足，再次為請人烘乾技術較佳及成本較低。此項調查結果與氣候因素關係密切，南部氣候炎熱，自行晒乾較容易，故亦較無必要自行購買烘乾機械，而北部及東部氣候多雨而潮濕，若無法自己購置烘乾機械或不符成本效益，則傾向請人代為烘乾。

以受訪戶在本期實際作業方式來看（表六之 1-(4)）東部地區由附近農家（43.75%）及農會（43.75%）代為烘乾為主；南部委由本鄉農家（40%）及附近農家（40.23%）為主，本鄉農家（25.29%）及農會（18.39%）次之；而北部委託烘乾最主要對象為附近農家（36%），農會居次（28%），糧商再次之（24%）。決定委託烘乾對象的因素，由重要性高低排序，東部地區為長期往來（50%）、價格（43.75%）、信用度（31.25%）及距離（31.25%）因素；南部地區為長期往來（63.33%）、距離（46.67%）及信用度（23.33%）等；中部地區排序與南部同；北部地區以長期往來為主要考量，其次為信用度及距離等因素。（表六之 1-(4)及表六之 1-(5)）。

參、分析模式

一. Switching Regime Regression Model（SRRM）

根據上節分析，每位農民面對不同作業之執行時，他可以選擇到底要「自己做」或「請人做」，這個選擇則是根據一些成本及其他考量而定。若此，我們可以設定一個包括三條方程式的 SRRM 分析模式，即一個包含二條成本函數方程式以及一條決策標準式(criterion function)。

我們可以「整地」作業舉例說明。假設第 i 個農民的「整地」選擇以成本為主要考量，則他只能在「自己做」或「請人做」等兩種體制（Regime）中選擇其中之一種：

(1) Regime 1：$C_{1i}^{H} = b_1^{'} X_{1i}^{H} + m_{1i}$ 　如果是選「請人做」

(2) Regime 2：$C_{2i}^{S} = b_2^{'} X_{2i}^{S} + m_{2i}$ 如果是選「自己做」

其中C_{1i}^{H}是第 i 個農民「請人做」所需成本；C_{2i}^{S}是第 i 個農民「自己做」所需成本。X_{1i}^{H}，X_{2i}^{S}是C_{1i}^{H}及C_{2i}^{S}成本函數式之自變數向量。b_1及b_2為相對於X_{1i}^{H}，X_{2i}^{S}之參數。

第 i 個農民之「整地」作業選擇之決策，則視兩個選擇項之成本差異（C_{2i}^{S}—C_{1i}^{H}），以及其他考量（Zi）（如：制度、習慣性、當地自然資源供需限制）等而定。這個選擇決策可以下式表示：

(3) CFi $= r'Z_i + d(C_{2i}^S - C_{1i}^H) - m_i = r^*Z_i^* - m_i$

式(3)為決定農民是否屬於那一種體制之決定式，如果 CFi≧0 則第 i 個農民會選擇「請人做」，即只有C_{1i}^H是可以觀察到的；同樣地，如果 CFi＜0，則他會選擇「自己做」，亦即只有C_{2i}^S是可以觀察到的。因此，式(3)為 SRRM 模式在 Switching 時的根據（criterion)。每一位農民只能在也只會有式(1)或式(2)之選擇中，取其中一種。

二. 估計

上述 SRRM 模式之估計可參照 Lee(1978)及 Willis and Rosen(1979)的兩階段估計法，依此估計而得的結構式參數具有一致性（Maddala，1983，頁 237-239)。估計程序如下：

1. 利用 PROBIT 縮減式（reduced form）來估計式(3)，其中式(3)的成本差異項（C_{2i}^S - C_{1i}^H）將被式(1)及式(2)中之自變數取代。
2. 利用第一步估計之縮減式式(3)估計參數（r*)，建立反比例變數（inverse mill ratio)，

   $W_{1i} = f(r^*Z_i^*)/\Phi(r^*Z_i^*)$ 及

   $W_{2i} = f(r * Z_i^*)/[1-\Phi(r^*Z_i^*)]$。
3. 將 W_{1i} 及 W_{2i} 分別代入式(1)及式(2)，視為兩式之自變數之一。

再估計式(1)及式(2)，可分別估計 $\hat{b}_1^{i}$ 及 $\hat{b}_2^{'}$，亦可計算得 $\hat{C}_{1i}^{H} = \hat{b}_1^{'} X_{1i}^{H}$ 及 $\hat{C}_{2i}^{S} = \hat{b}_2^{'} X_{2i}^{S}$。

4. 將第 3 步估計而得之 $\hat{C}_{1i}^{H}$ 及 $\hat{C}_{2i}^{S}$ 取代內生變數 C_{1i}^{H} 及 C_{2i}^{S}，再重新估計此結構式（即式(3)）。

三. 效率之定義

本文所定義之效率與一般文獻上常用之技術效率或價格效率不同。我們關心的是農民到底有沒有做了錯誤或不恰當之決策，因而造成了損失。例如，如果農民應選擇「請人做」但卻選擇了「自己做」，則因此而造成之成本增加部分，即成為「不效率」部分。反之，如果他選擇了正確選擇，則無「不效率」。

但問題是，什麼是「應」選擇項？是根據什麼法則？在本文中，我們提出兩種決策法則：

1. 最低成本法則（minimum cost criterion, MCC）

第 i 個農民「整地」決策，視「自己做」與「請人做」兩者所需成本而定，依最低成本法則（MCC)，農民之最適選擇為兩者之最低，此選擇之成本為最小；即

(4) $C_i^{\min} = \min(C_{1i}^{H}, C_{2i}^{S})$

根據式(4)，如果$C_{1i}^{H} \le C_{2i}^{S}$，則農民將選 Regime1（即「請人做」）；反之，則選 Regime2（即「自己做」）。

2. 非最低成本法則（non-minimum cost criterion, NMCC）

通常農民之決策不僅止於最低成本考慮，因為他們常受制於當時之生產制度、習性、生產因素供需平衡現況及其他因素，而無法選擇最低成本下之組合。這種考慮及其他非成本面之決策行為，文獻上亦有討論。

不過，本文將以 Z 向量變數表示這些非成本考量之變數。在決策中加入 Z 變數向量，即可寫成如上節之式(3)決策式。

根據式(3)之 NMCC 法則，農民之最適選擇，即視 CF_i 值之正負號而定。如果 $CF_i \geqq 0$，則農民應選 Regime 1（即「請人做」）；相反地，如果 $CF_i < 0$，則應選擇 Regime 2（即「自己做」）。

根據上述兩種決策法則，我們將試定義下列 3 種「無效率」來源：

1. “來自於非最低成本行為之無效率”，此無效率部分即上述兩種法則下之最適成本差異。例如，如果根據 NMCC 第 i 個農民應選擇「請人做」，即其最適成本$C_i^* = C_{1i}^{H}$。此時，如果他根據 MCC 所選擇亦為「請人做」，即最低成本$C_i^{\min} = C_{1i}^{H}$，則$C_i^* - C_i^{\min} = 0$，表示並無「來自於非最低成本行為之無效率」。但如果，$C_i^* = C_{1i}^{H}$，但$C_i^{\min} = C_{2i}^{S}$，

則無效率部分即為$C_i^* - C_i^{\min}$，這無效率即為”來自於非最低成本行為之無效率”。

2．“來自於錯誤選擇之無效率”。我們定義：如果第 i 個農民實際的選擇，與他根據式(3)NMCC 最適選擇下之結果相同，則他的選擇為「恰當」。但如果實際之選擇，不同於 NMCC 最適選擇，則我們稱他有「選擇錯誤」。而兩者選擇下之成本差異，即視為「來自於選擇錯誤之無效率」部分。

舉例說明之，如果 NMCC 下之最適選擇為「請人做」即$C_i^* = C_{1i}^H$，而他亦實際上選擇了「請人做」，即$C_i^A = C_{1i}^H$，則選擇正確，且沒有無效率部分，即$C_i^* - C_i^A = 0$。反之，如果$C_i^* = C_{1i}^H$，但他實際卻選擇自己做，即$C_i^A = C_{2i}^S$，此時$C_i^* - C_i^A \neq 0$；此成本差距即視為”來自於錯誤選擇之無效率”。

3．總無效率（overall inefficiency）

依代數分解方式，我們可以將上述兩種「無效率」加總成為一個特定的效率值，此值恰好為真實成本與最低成本間之成本差距，我們將之定義為「總無效率」值。即總無效率＝來自於錯誤選擇之無效率＋來自於非最低成本行為之無效率。

(5) $C_i^A - C_i^{\min} = (C_i^A - C_i^*) + (C_i^* - C_i^{\min})$

四. 實証分析：以整地作業為例

Cultivation Arrangements and Rice Farm Efficiencies in Taiwan

Cultivation Arrangements and Rice Farm Efficiencies in Taiwan*

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Cultivation Arrangements and Rice Farm Efficiencies in Taiwan

by

Mei-Ying Huang
Cliff Huang
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Abstract

In this paper, we develop a switching regime regression model to analyze Taiwanese rice farmer's decision on cultivation arrangement of field-plowing practice. We found that a farmer's decision on the choice of self-plowed or hired-service can be regarded as a non-minimum cost behavior which depends upon both cost and non-cost concerns. Among those non-minimum concern variables, aging, education level, availability of machinery and the status of farming are found to be significant factors that determine farmers' choice. The inefficiency of farmer's field-plowing arrangement can be decomposed into two components: wrong selection and non-minimum cost concerns. Empirical results indicate that 12% of inefficiency is due to farmer's wrong selection and 88% of inefficiency is due to the non-minimum cost concerns.

1. Introduction

Research examing the impact of institutional arrangement on farming efficiency has been abundant in the agricultural and economic development literature.. The most popular institutional arrangement analyzed in previous studies is the tenancy arrangement, e.g., share cropping. However, share cropping is almost absent in the farming sector in Taiwan. Owing to some legal restrictions on farmland' s rental and sale, the farmland owners in Taiwan are reluctant to entrust their land to tenants fully.[1] Instead, they make oral cultivation arrangements or (informal) contracts with other farmers, who perform only some practices in the production process for farmland owners. This cultivation arrangement by practice may be regarded as a new type of institutional arrangement.

In the case of rice farming, the production process includes a sequence of practices such as field plowing, seeds sowing and seedlings, mid-term management (weeding, pesticide spraying and fertilizer application), and harvesting. Since the substitution of labor by machinery has long been promoted by the government due to the shortage of farm labor, the machines used for each practice have been well developed and applied in rice production. The small scale of farming per farm (on average one hectare) and shortage of farm labor also provide incentives for young farmers to offer their labor and/or machine services by practice to those who needed. According to the recent agricultural census, a large percentage of farmers hired labor and machinery service, instead of self-cultivation, on cultivation practices such as field plowing, sowing, seedlings and harvesting. In practice, hired service is offered in

[1] According to The 375 Farm Rent Reduction Law Postulated in 1949, tenants will have first priority to purchase if their land lords want to sell the farm land. Tenants will be paid compensation, about 30-50% of farm land price once their land lords sold the land.

a package of labor and machinery, and is paid on a per hectare basis. Therefore, a farmer will have two choices for his cultivation arrangement on each practice. He may choose to do it by himself or to entrust it to some one and pay service change. The latter type of cultivation arrangement has been quite popular for the last two decades in Taiwan, but it is very different from institutional arrangements studied in the literature.

In this paper, we attempt to investigate the farmer's choice behavior on these cultivation practice arrangements. We identify major determinants of such farmers choice. To serve these purposes, we have developed a switching regime regression model in this paper. The data generated from an author's survey on rice farming in 1999 is employed for empirical analysis. Finally, inefficiencies due to in appropriateness of farmer's decisions on such cultivation arrangement for field plowing practice also empirically computed.

2. DATA

A personal interview survey to 400 Taiwanese rice farmers, under a stratified random sampling process, has been undertaken in January-March of 1998. Usable samples in this paper is 348. In the survey, individual farmer's decisions on different cultivation practices of rice production were asked. Reasons for their choices were also investigated. Production costs by practice as well as respondent personal and his farm characteristics were collected for analysis.

2.1 Rice Cultivation Arrangements: Case of Field-plowing

Farmer's preference between self-cultivation or hired-service are shown to be different in different cultivation practices. Survey results showed that high percentage of farmers chose hired-service for practices such as field-plowing (71%), seedlings (78%) and harvesting (92%), whereas more than 90% of farmers sprayed pesticides and fertilizers and 57% of farmers dried their grains by themselves. In a small farming society like Taiwan, the average farm size is only around one hectare. However, owing to the well development of farming machinery for small scale paddy and the shortage of farm labor in recent decades, high (almost 100%) mechanization has been found for the former three practices of rice production. Nevertheless, investment on machinery will be irrational for a small farm if that machine is only applied at his own farm field. Therefore, machine sharing or service entrusted arrangements seem to be naturally and economically plausible ways to reduce machinery cost. Our survey results indicated that hired-service (a combined machine and labor service) has been quite popular for rice cultivation practices such as field-plowing, seedling and harvesting.

In rice production, field-plowing is the necessary practice before one can sow seedles in the paddy. Almost all plowing practice in paddy are completed by farming tillers or tractors in Taiwan in recent decades. However, only 37% of sample farmers own tiller machines or tractors for field plowing, other farms thus need hired service. In our survey, we found that about 71% of respondents chose hired-service but self-plowed for field-plowing. Factors that influence farmers choice are however different individually. Among those farmers who hired plowing service, Table 1 showed that 76% of them regarded "Lack of tiller or tractor" as the top reason for not self-plowed, this is followed by the reason "Lack of family labor" with 46% of them. The "Self-plowed is too hard to work " is the 3rd ranked reason for not self-plowed. Respondents other reasons such as "Service quality of hired-service is better than that of self-plowed" and "Hired-service is cheaper than self-plowed" are shown to be insignificant concerns, with only 2% of respondents. Therefore, Table 1 seems to imply that constraints on machine or family labor supply as well as farmer aging problem are factors more important than cost and work quality concerns in rice farmers choice for field plowing arrangement.

2.2 Sample Statistics

Differences in farm and personal characteristics between those respondents hiring plowing service and those self-plowed can be seen in Table 2. Table 2 indicated that those self-plowed farms operate about twice as large in farming scale (including self-own and rental farm land) than those hired plowing services farms. In addition, the former seemed to have lower percentage of "Farm income to farm household income" (RFINC) and "Rice income to farm income "(RRICEF) than the latter, which implied that self-plowed farms are relatively more full-time farming oriented than hired-plowing service farms.

In terms of machinery supply, Table 2 showed that only 13% of hired-service farmers owned tillers or tractors, whereas most of self-plowed farmers own at least a machine[2]. Family labor supply is approxied by population size of farm household (currently reside in the farm). Table 1 also showed that the self-plowed farms have larger size of family members than hired service farms, which implies relatively sufficient supply of family labors for self-plowed farms. The average plowing costs (ATC) per 0.1hecta for hired-service or self-plowed are quite close in mean value, yet significantly larger variance of average cost can be observed in self-plowed farms than that of hired-service farms. Such large variance would imply a wide range of

[2] Among those 13% of farmers who owned machines, some of them yet still chose to hire service rather than self-plowed. We found that "Lack of family labor "or" Self-plowed is too hard to work" to be main reasons for not self-plowed even if they own the machine.

farming efficiency differences for self-plowed farms in our sample. In current practice, farmer will pay a lum sum payment to a combined package of labor and machinery service for hiring a plowing service. Thus, cost shares of labor or machinery services are not known for hired-service farms. But for self-plowed farms, the cost shares for labor and machinery are 42% and 58% respectively.

In terms of respondent's personal characteristics, we observed that the mean value of respondent's age is 58 years old, which indicated an aging potential problem in Taiwanese rice farming. By comparing those two sub-samples, We find that those self-plowed farmers are relatively younger that those hired-service farmers. For those farmer over 65 year old (AGE65), we find that those aging farmers chose more hired-service than self-plowed. Our survey also showed education year of sample farmers is only average about 7 years. Yet, relatively higher education are still found to those hired-service farmers than self-plowed farms. Also in Asian country like Taiwan, part-time farming is a popular way of farming. However, in our sample we found that most respondents are working only at farm, only less than 20% of them are having non-farm job, (NFJOB) irrespective of his choice on field-plowing. Table 1 also includes four regional dummy variables (NORTH, EAST, SOUTH, CENTRAL) representing sample distribution among regions. These dummies are used to capture regional specific characteristics in Taiwan rice farming.

3. Modeling Choice of Field-plowing Arrangements

3.1 A Switching Regime Regression Model

The behavior of farmer's choice of cultivation arrangement for the field plowing practice can be described by a switching regime regression model with two regression equations and one criterion function that determines which of these two equations is applicable. These two equations however represent respondents two alternatives for plowing arrangements.

Consider the i[th] farmer who needs to plow his field before sowing the rice seedlings. He could either plow the field by himself or hire plowing service offered by other farmers. Therefore, the i[th] farmer's plowing behavior can be classified into one of two regimes by a cost function setting.

$$\text{Regime 1}: \; C_i^H = \beta'^H X_i^H + u_i^H \qquad \text{for hired- service} \qquad (1)$$

$$\text{Regime 2}: \; C_i^S = \beta'^S X_i^S + u_i \qquad \text{for self-plowed} \qquad (2)$$

where C_i^H is the service charge of the i[th] farmer paid if hired other farmer's, plowing service; C_i^S is total cost needed for self-plowed if plowed field by the i[th] farmer himself; X_i^H and X_i^S are vectors of variables employed on the cost function of plowing practice for regime 1 and 2, respectively. β^H and β^S are corespondent parameters for X_i^H and X_i^S. Farmer's decision on hired service (Regime 1) or self-plowed (Regime 2) dependent upon the following criteria function.

$$CF_i = r'Z_i + \delta(C_i^S - C_i^H) - \varepsilon_i \qquad (3) \quad \text{, or}$$

$$CF_i = r^* Z_i^* - \nu_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)'$$

Where Z is the vector of variables other than X^H and X^S; Z^* is a vector with variables Z, X^S and X^H; r and r^* are parameters correspondent to Z and Z^*.

Equation (3) implies that the i[th] farmer decision on field-plowing arrangement depends on Z vector of factors as well as the factor of cost difference between self-plowed and hired-service ($C_i^S - C_i^H$). Factors in Z vector thus can be regarded or those variables other than cost factors. And since the i[th] farmer will choose either self-plowed or hired-service, thus only one of C_i^H or C_i^S is observed for each individual i, depending on whether $CF_i \geq 0$ or $CF_i < 0$. That is, Regime 1 (hired-service) is chosen if $CF_i \geq 0$, and Regime 2 (self-plowed) is chosen if $CF_i < 0$. Equation (3), with cost different factor, represents a structural form criterion function, whereas Equation (3)' represents a reduced form model of the criterion function.

3.2 Estimation Procedure

Two-stage estimation procedure of Lee (1978) and Willis and Rosen (1979) is appropriately adopted for consistent estimation of the structural equation (3), see Maddala (1983, pages 237-239) for details. Estimation procedures can be briefly described as the following steps:

1. Estimate the reduced form criteria function, equation (3)', by a PROBIT ML model which the cost difference $(C_i^S - C_i^H)$ is replaced by variables used in cost functions, i.e, X^H and X^S; and CF_i is replaced by D_i, $D_i = 1$ if Regime 1 actually chosen and $D_i = 0$ if Regime 2 actually chosen.

2. Construct the inverse mill ratio variables, $W_i^H = \boldsymbol{f}(\hat{r}^* Z_i^*) / \boldsymbol{F}(\hat{r}^* Z_i^*)$ and $W_i^S = \boldsymbol{f}(\hat{r}^* Z_i^*) / \left[1 - \boldsymbol{F}(\hat{r}^* Z_i^*)\right]$, by using $\hat{r}^*$ estimated from the step 1.

3. Estimate equation (1) and equation (2) by OLS with the incorporation of W_i^H and W_i^S as regressors in equation (1) and equation (2), respectively, and obtain OLS estimates of $\hat{\boldsymbol{b}}'^H$, and $\hat{\boldsymbol{b}}'^S$. And then compute $\hat{C}_i^H = \hat{\boldsymbol{b}}'^H X_i^H$, and

$\hat{C}_i^S = \hat{b}'^S X_i^S$.

4. Re-estimate the structural equation (3) by using a PROBIT ML method after substituting the estimates of the endogenous variable $\hat{C}_i^H$ or $\hat{C}_i^S$ in the cost difference variable ($C_i^S - C_i^H$) of equation (3).

5. Compute $C\hat{F}_i = \hat{r}' Z_i + \hat{d}(C_i^S - C_i^H)$ and check the sign of $C\hat{F}_i$ to determine optimal decision of the ith farmer for field-plowing arrangement.

4. Measurement of Inefficiency

Since farmer's choice on plowing arrangement depend not only on cost difference $(C_{2i}^S - C_{1i}^H)$ but also on other factors (Z_i), the importance of these factors on farmer's choice can be examined by the significance of their corresponding parameters (r' and d). It should be noted that the optimal decision resulted from equation (3) may not be a minimum cost decision. In fact, the rules of minimum cost can only partial influence farmer's choice on field-plowing arrangement since the cost difference is only one of the factors in equation (3). The Z factors in equation (3) represent concerns other than minimum cost in farmer's decision. Therefore, farmer's decision based on this criterion (equation (3)) could be regarded as a non-minimum cost behavior. However, equation (3) could be reduced to a regular minimum cost behavior if $r^* = 0$. That is, the value of CF_i depends only on cost difference variable.

4.1 Selection criterion/rule

Followed the preceeding discussion, we assume individual farmer's plowing arrangement may be based on two decision rules, which can be regarded as his choice selection criterion.

Selection criterion I: Non-Minimum cost rule

If the i[th] farmer's plowing arrangement concerns not only cost factors but also other factors (such as Z factors) as in the equation (3), then his optimal decision will depend on the sign of CF_i. That is,

Choose Regime 1 (Hired-service), if $CF_i \geq 0$;

Choose Regime 2 (Self-plowed), if $CF_i < 0$.

By this "non-minimum" (NMINC) cost rule, the cost of optimal choice (C_i^*) will equal to the expected cost of the regime chosen by the CF_i value. For example, if $CF_i > 0$, then Regime 1 is chosen, which implies $C_i^* = \hat{C}_i^H$. On the other hand, Regime 2 of Self-plowed is chosen if $CF_i < 0$. In this case, $C_i^* = \hat{C}_i^S$. It should be reminded again that C_i^* may not be the $C_i^{\min}$.

Selection criterion II: Minimum cost rule

If the i[th] farmer's decision on self-plowed or hired-service depends only upon the "Minimum Cost" (MINC) rule, then his decision can be described as:

$$C_i^{\min} = \min(\hat{C}_i^H, \hat{C}_i^S)$$

$\hat{C}_i^H$ (or $\hat{C}_i^S$) is the i[th] farmer's expected costs if he chooses hired-service (or self-plowed) arrangement for field plowing practice. MINC rule assumes factors other than cost factor can be ignored in farmer's decision. By this minimum cost criterion, Regime 1 will be chosen if $\hat{C}_i^H \leq \hat{C}_i^S$ or $\hat{C}_i^H - \hat{C}_i^S \leq 0$; and thus

$C_i^{\min} = \hat{C}_i^H$. On the other hand, Regime 2 is chosen if $\hat{C}_i^H > \hat{C}_i^S$ or $\hat{C}_1^H - \hat{C}_i^S > 0$. $C_i^{\min} = \hat{C}_i^S$ for the self-plowed case.

4.2 Inefficiencies in Decision

Inefficiency defined in this paper is somewhat different from those commonly used in productive or cost efficiency literature. The cost inefficiency that we focused here is due to farmer's inappropriate choice on field plowing arrangement. If the ith farmer's actual decision on plowing arrangement is different from his optimal choices based on the selection criteria (NMINC or MINC), then we say his actual decision is "inappropriate". Such inappropriate in decision may cause the cost actual paid be deviated from the optimal cost based on selection rules, which will be defined as "Inefficiency in decision". Corresponding to our two selection criteria. We have the following inefficiencies to be defined in this paper.

Inefficiency Due to Wrong Decision

The optimal choice of plowing arrangement in this paper is assumed to base on the NMINC rule. Therefore if the regime which the ith farmer actually chosen is the same as the regime predicted from CF_i of equation (3), then he is making the "right" decision. Otherwise, he is making "wrong" decision. Such cost of wrong decision can be expressed as the difference between cost of farmer's actual regime selected C_i^A and cost of his optimal choice, C_i^* or $C_i^A - C_i^*$. This cost difference is defined as "Inefficiency due to wrong decision".

Inefficiency Due to Non-minimum cost concern

The NMINC criterion tends to incoperate some environmental, resources or human physical constrained factors into decision rule. By incorporating additional factors other than cost variables in equation (3), The NIMINC criterion is a more general and practical rule than the MINC criterion. The incorporation of these constrains in decision making will make the cost of optimal decision (C_i^*) deviated from the minimum cost ($C_i^{\min}$). Thus, the difference between the cost of optimal choice by the NMINC criteria C_i^* that by the MINC criteria ($C_i^{\min}$) can be regarded as "the inefficiency due to non-minimum cost concern".

Overall Inefficiency/ Inefficiency due to Deviation from MINC decision

If the i[th] farmer does not have or can ignore those constraints just mentioned above, his optimal decision would base on the MINC rule. The cost difference between he actually paid and expected cost of the MINC regime is defined as "Inefficiency due to deviation from MINC decision", $C_i^A - C_i^{\min}$. Such inefficiency can also be regarded as the "overall inefficiency", since by algebra, it can be further decomposed into "Inefficiency due to wrong decision" and "Inefficiency due to non-minimum cost concern". Or,

$$C_i^A - C_i^{\min} = (C_i^A - C_i^*) + (C_i^* - C_i^{\min})$$

5. Empirical Results

5.1 Variable Description and Parameter Estimation

Variables used for estimating cost functions of field-plowing practice include total labor and machine cost, acreage plowed, and prices of inputs and regional dummy variables. In the cost function setting as equation (2) or Regime 2, dependent variable is the total cost for self-plowed, independent variables include wage rate (PL), price of machinery service (PM) and acreage plowed (ACREA) as output variable in the cost function. Since there is no explicit wage for family labor, the market price for hiring labor is adopted as the wage rate for family labor. Price of machinery service is computed by dividing the sum of machinery depreciation and fuel expense by acreage plowed (self-own and rental lands). However, for hired-service (Regime 1), farmer is asked to pay a lumsum payment at per hectare base. It is thus impossible to decompose that payment into labor or machinery costs. Therefore, in equation (1), independent variable only includes acreage plowed (ACREA) variable. The NORTH and EAST regional dummy variables were also included in both equation (1) and (2). This is because respondents in northern region own more tillers than farmers in other regions, whereas labor wage is found to be relatively low in eastern region than that in other region. The inclusion of these two variables may capture some regional effect.

The variable used in the criterion functions, equation (3) and (3)', include respondent as well as his farm's characteristics, other constrained variables (Z) and cost difference variable $(C_i^S - C_i^H)$. The Z factors include: farmer's age over 65 (AGE65), farmer's education (EDU), household size (HSIZE), machine self-owned (OWNMCH) ratio of farm income to total household income (RFINC). Farm's acreage plowed (ACREA), and regional dumies for northern region (NORTH) and eastern region (EAST). The expected impact of these variable or farmers choice are discussed in what follows.

The expected sign of farmer's age over 65 (AGE65) to his choice of hired-service is positive. This is because that aging farmer tends to hire service, not self-plowed, as hand work would become burdensome to aging farmers. Respondent with higher education would have better chance to obtain non-farm job with higher pay, which implies higher opportunity cost for self-plowed. The EDU, thus, would have positive expected sign to the choice of hired-service. Household size reflects the condition of family labor supply in the farm. A farm with relatively abundant of family labor supply would tend not to hire service. Thus, HSIZE would expect to have a negative sign to the choice of hired-service.

Similarly, a farm which owns tiller or tractor (OWNMCH) would have higher tendency for self-plowed to reduce machinery cost invested. It is also reasonable to assume that a farm with a higher ratio of farm income to total household income, a relatively full-time farmer, would have higher probability in self-plowed. Therefore, RFINC would have a negative expected sign to the choice of hired service. Those farmers with larger farm land may enjoy scale economy, thus may invest and devote more in farming. The ACREA thus is expected to have negative sign on the choice of hired-service. Lastly, regional factors are used to represent regional specific resources (manpower or machinery supply) conditions in this study. It was indicated that farmers located at northern Taiwan often suffered shortage of farm labor, which induced more machinery investment to substitute labor. They (NORTH) however have relatively high probability in self-plowed their farm land. The EAST regional dummy is included because production cost for field-plowing practice were found to be relatively lower than other regions. They are included in the estimation of cost function as well as criterion function.

To avoid the sample selection bias, the proposed two-stage estimation procedure in preceding section is used. Consistent estimation of equations (1) and (2) needs to incorporate inverse mill ratios (W_i^H and W_i^S) calculated from estimates of the reduced form criterion function, equation (3)' . The results of parameter estimates of equations (1) and (2) are shown in Table 3. The results showed that both cost functions for self-plowed and hired service fit quite well. In addition, variables are in correct signs. The EAST dummy also showed its significant negative expected signs in both equations. The bias adjustment variables W^H and W^S are however not significant in both equations.

The results of PROBIT ML estimation for structural form of criterion function, equation (3), are shown in Table 4. Estimated parameter for cost difference variable $(\hat{C}^S - \hat{C}^H)$ is significant with expected positive sign. If his expected cost for self-plowed is higher than that for hired-service, one will have higher probability to choose hired-service. Such result also implies that cost difference between choices of self-plowed and hired-service is an important concern in farmer's decision on field-plowing practice. Table 4 also indicated that all Z factors were in correct signs. Among them, AGE65, EDU, OWNMCH, and RFINC are shown to be important factors in farmer's decision. These results seem to indicate that major determinants of Taiwanese farmer's decision on field-plowing practice arrangement include both cost and non-minimum cost concerns. Among those non-minimum cost concerns, aging, education level, availability of machinery as well as the status of farming (i.e., full-time farm) are significant factors.

5.2 Decomposition of Inefficiency Estimates

Inefficiency of Taiwanese rice farmer's decision on field-plowing practice arrangement comes from preceedingly mentioned two sources: "Inefficiency due to wrong decision" and "Inefficiency due to non-minimum cost concerns". And the sum of these two inefficiencies is defined as "overall inefficiency". Table 5 shows the results of these three types of inefficiencies in mean values. The results showed that only 12% of the total cost inefficiency comes from farmer's wrong decision resulted from the inconsistency between farmer's actual regime selection and optimal decision selected based on NMINC criterion. This observation implies that Taiwanese rice farmer's decisions on field-plowing arrangement are quite close to our proposed choice decision model which incorporating both cost and non-minimum cost concerns into their decisions. Most of inefficiency (88% of total inefficiency), however resulted from farmer's non-minimum cost concerns. It was those non-minimum cost variables that kept farmers away from simple way of cost minimization decision (MINC) rule.

It is also interested to find in the lower part of Table 5 that the number of farmers committed inefficiency in decisions are different by inefficiency sources. About 12% of sample farmers who committed their inefficiency due to wrong decision, whereas 22% of sample farmers committed their inefficiency due to non-minimum cost concerns. In addition, 28% of sample farmers who had committed inefficiency from either wrong decision or non-minimum cost concern. Since, these two inefficiencies may be offseted mathematically, as a result, overally about 21% of sample farmers actually had his decision deviated from the simple minimum cost criterion.

6. Concluding Remarks

In this paper, we develop a switching regime regression model to analyze Taiwanese rice farmer's decision on cultivation arrangement of field-plowed. We found that rice farmer's actual decision on the choice of self-plowed or hired-service depended upon both cost and non-cost concerns of farmers. Empirical results showed that cost inefficiency would be insignificant if rice farmers followed such double concerns decision rule in determining their choices toward field-plowing arrangement. Results also indicate that most of inefficiency in decisions were due to the non-minimum cost concerns. Among those non-minimum concern variables, aging, education level, availability of machinery and the status of farming are found to be significant factors that determine farmers' choice. Further investigation of these factors are thus necessary and important in improving efficiency of rice farmers decision on field-plowing.

The empirical model used in this paper can be extended to analyze those agricultural productions with multiple stage of production practices. In case of rice production, it will be interested to investigate on decisions of other cultivation practices such as seedlings, pesticide spraying, harvesting, etc. Careful examination of hypothesis of non-minimum cost behavior for different stage of rice production practice would also induce some meaningful policy implications on the efficiency use of input resources.

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Table 1. Respondent Responses to "Why Didn' t You Plow Field by Yourself ?" (Multiple choices)

Reason to choose	% of respondents [a]
Lack of owned Tillers or Tractors for field-plowing	76%
Lack of family labor	46%
Self-plowing field is too hard to work	19%
Cost of hired-plowing service is cheaper than cost of self-plowed	2%
Service quality of hired-plowing is better than that of self-plowing	2%
Others	4%

a. Only those who employed hired-plowing service were asked to answer the question.

Table 2. Sample Statistics: Mean and Standard Deviation

Variable	Definition	Full-sample (348)	Hired-service (248)	Self-plowed (100)
Farm Characteristics:				
ACREA	Cultivated acreage(0.1ha)	13.48 (14.54)	10.42 (9.07)	21.07 (21.32)
RFINC	Farm income/ farm household income (%)	46.98 (20.44)	44.71 (20.10)	52.63 (20.28)
RRICEF	Rice income/ farm income (%)	74.99 (31.25)	73.78 (31.75)	78.07 (29.77)
OWNTILL	Owned tiller or tractor=1, otherwise=0	0.37 (0.48)	0.13 (0.34)	0.93 (0.25)
HHSIZE	Household population size (people)	3.67 (2.10)	3.51 (2.08)	3.98 (2.10)
ATC	Average plowing cost, including labor and machine costs (NT$/0.1ha)	NA	1067.66 (118.24)	1056.15 (599.51)
CSLABOR	Labor cost share (%)	NA	NA	41.36 (24.40)
CSMACH	Machinery cost share (%)	NA	NA	58.10 (24.18)
Respondent Characteristics:				
AGE	Respondent's age (year)	58.26 (11.39)	59.29 (11.17)	55.71 (11.60)
AGE65	Respondent's age over 65=1, otherwise=0	0.26 (0.44)	0.29 (0.46)	0.18 (0.38)
EDU	Respondent's education year	7.00 (3.34)	6.92 (3.48)	7.17 (2.98)
NFJOB	Have non-farm job=1, otherwise=0	0.17 (0.37)	0.17 (0.38)	0.15 (0.36)
NORTH	Locate at Northern region=1, otherwise=0	0.13 (0.34)	0.06 (0.24)	0.31 (0.46)
EAST	Locate at Eastern region=1, otherwise=0	0.05 (0.23)	0.04 (0.20)	0.08 (0.28)
SOUTH	Locate at Southern region=1, otherwise=0	0.28 (0.45)	0.30 (0.46)	0.24 (0.43)
CENTRAL	Locate at Central region=1, otherwise=0	0.53 (0.50)	0.60 (0.49)	0.36 (0.48)

Table 3. Cost Function Estimation by the Switching Regime Regression Model

Variable	Equation(1)	Equation(2)
Constant	6.9955	1.7564
	(283.3412)[a]**	(2.2461)**
Log(ACREA)	0.9905	0.8741
	(86.3283)**	(16.8123)**
Log(PL)		0.5087
		(3.9175)**
Log(PM)		0.4525
		(9.5651)**
EAST	-0.0978	-0.2553
	(-2.2095)**	(-1.8218)*
NORTH	0.0354	-0.1023
	(0.9500)	(-1.1795)
W^H	-0.0198	
	(-0.7824)	
W^S		-0.0468
		(-0.4793)
Observations	248	100
Adjusted R^2	0.9697	0.8012

a. Figures in parentheses are t-ratios.

*. Variable to be significant at α=0.10.

**. Variable to be significant at α=0.05.

Table 4. Estimation of Choice Function of Farmer's Field-Plowing : PROBIT Model

Variable [b]	Parameter Estimates
Constant	1.7649 (2.7333)[a]
AGE65	0.7445 (2.3156)**
EDU	0.2621 (2.0081)**
Log(HSIZE)	-0.1101 (-0.5012)
OWNMCH	-2.5059 (-9.5008)**
RFINC	-1.3370 (-2.2690)**
LOG(ACREA)	0.0405 (0.2293)
EAST	0.5101 (1.1432)
NORTH	-0.5483 (-1.8905)*
$\hat{C}^S - \hat{C}^H$	1.6253 (3.5656)**
Observations	348
LR Statistic	248.9282
McFadden R^2	0.5963

a. Figures in Parentheses are asymptotic t-values.

b. Dependent variable D_i=1 if Regime 1 (hired-service) is selected; D_i=0 (self-plowed) if Regime 2 is selected.

*. Variable to be significant at α=0.10.

**. Variable to be significant at α=0.05.

Table 5. Inefficiencies of Rice Farmer's Decision on Field-Plowing

			Inefficiency Due to		
	Overall Inefficiency		Wrong Decision		Non-Minimum Cost Concern
	$C_i^A - C_i^{min}$	=	$C_i^A - C_i^*$	+	$C_i^* - C_i^{min}$
Mean (Inefficiency Share)	0.0467 (100%)		0.0053 (12%)		0.0413 (88%)
Standard Deviation	0.1286		0.1242		0.1029
Percentage of Farmers Committed Inefficiency	21%		12%		22%
			→	(28%)[a]	←

[a] There is 28% of sample farmers who either committed inefficiency due to wrong decision or due to non-minimum cost concern.

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一、育苗階段

1.是否向他人購買秧苗?(問卷第3頁;A1Z)

	北部		中部		南部		東部		
	戶數	百分比	戶數	百分比	戶數	百分比	戶數	百分比	戶數
向他人購買秧苗	26	53.06	170	87.18	98	94.23	15	75.00	309
秧苗自行生產	23	46.94	25	12.82	6	5.77	5	25.00	59
Total	49	100.00	195	100.00	104	100.00	20	100.00	368

1-(1)為什麼不自行生產秧苗？(複選)(A101)

	北部		中部		南部		東部		
	戶數	百分比	戶數	百分比	戶數	百分比	戶數	百分比	戶數
自家人力不足	13	50.00	76	44.71	46	46.94	8	53.33	143
自己育苗技術不夠好	9	34.62	27	15.88	14	14.29	3	20.00	53
自己育苗太辛苦了	7	26.92	40	23.53	21	21.43	3	20.00	71
外購秧苗品質較好	7	26.92	11	6.47	9	9.18	0	0.00	27
外購秧苗成本較便宜	5	19.23	14	8.24	5	5.10	2	13.33	26
家中無育苗設備	21	80.77	122	71.76	78	79.59	12	80.00	233
其他	4	15.38	16	9.41	4	4.08	0	0.00	24
向他人購苗戶數	26	100.00	170	100.00	98	100.00	15	100.00	309

1-(3)您知不知道在哪裡可以買到秧苗？(複選)(A103)

	北部		中部		南部		東部		
	戶數	百分比	戶數	百分比	戶數	百分比	戶數	百分比	戶數
附近農家	7	26.92	81	47.65	31	31.63	9	60.00	128
本鄉農家	14	53.85	51	30.00	25	25.51	5	33.33	95
外鄉農家	2	7.69	21	12.35	19	19.39	2	13.33	44
本鄉育苗中心	17	65.38	121	71.18	67	68.37	10	66.67	215
外鄉育苗中心	9	34.62	56	32.94	31	31.63	3	20.00	99
農會	0	0.00	3	1.76	0	0.00	0	0.00	3
其他	0	0.00	1	0.59	0	0.00	0	0.00	1
向他人購苗戶數	26	100.00	170	100.00	98	100.00	15	100.00	309

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1-(4)您本期購買秧苗來自於？(單選)(A104)

	北部		中部		南部		東部		
	戶數	百分比	戶數	百分比	戶數	百分比	戶數	百分比	戶數
附近農家	6	23.08	24	7.77	10	3.24	4	1.29	44
本鄉農家	4	15.38	7	2.27	12	3.88	2	0.65	25
外鄉農家	0	0.00	6	1.94	5	1.62	0	0	11
本鄉育苗中心	10	38.46	102	33.01	54	17.48	8	2.59	174
外鄉育苗中心	4	15.38	26	8.41	14	4.53	1	0.32	45
農會	0	0.00	0	0	0	0	0	0	0
其他	1	3.85	3	0.97	3	0.97	0	0	7
向他人購苗戶數	26	100.00	170	100.00	98	100.00	15	100.00	309

1-(5)您選擇此家(上題答案)秧苗的原因為何？(複選)(A105)

	北部		中部		南部		東部		
	戶數	百分比	戶數	百分比	戶數	百分比	戶數	百分比	戶數
過去種植此家種苗經驗佳	11	42.31	28	16.47	28	28.57	2	13.33	69
看他人種植此家種苗成果良好	1	3.85	8	4.71	7	7.14	0	0.00	16
此家種苗品種符合需求	10	38.46	39	22.94	19	19.39	7	46.67	75
此家有代耕插秧	2	7.69	28	16.47	24	24.49	0	0.00	54
距離自家農場很近	6	23.08	83	48.82	27	27.55	8	53.33	124
對方有送貨到家的服務	8	30.77	41	24.12	13	13.27	0	0.00	62
長期往來	9	34.62	110	64.71	59	60.20	5	33.33	183
價格便宜	6	23.08	5	2.94	1	1.02	1	6.67	13
其他	0	0.00	1	0.59	0	0.00	0	0.00	1
向他人購苗戶數	26	100.00	170	100.00	98	100.00	15	100.00	309

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2.秧苗自行生產(問卷第4頁;A2)

2-(3)您知不知道哪裡可以購買或取得種子？(複選)(A203)

	北部		中部		南部		東部		
	戶數	百分比	戶數	百分比	戶數	百分比	戶數	百分比	戶數
自給(前期留下)	12	52.17	17	68.00	3	50.00	4	80.00	36
附近農家	7	30.43	5	20.00	2	33.33	0	0.00	14
本鄉農家	3	13.04	1	4.00	2	33.33	1	20.00	7
外鄉農家	2	8.70	2	8.00	3	50.00	0	0.00	7
本鄉育苗中心	13	56.52	2	8.00	4	66.67	0	0.00	19
外鄉育苗中心	3	13.04	0	0.00	1	16.67	0	0.00	4
農會	17	73.91	8	32.00	0	0.00	3	60.00	28
其他	2	8.70	4	16.00	1	16.67	0	0.00	7
自行育苗戶數	23	100.00	25	100.00	6	100.00	5	100.00	59

2-(4)您本期使用種子來自於哪裡？(單選)(A204)

	北部		中部		南部		東部		
	戶數	百分比	戶數	百分比	戶數	百分比	戶數	百分比	戶數
自給(前期留下)	7	30.43	14	56.00	3	50.00	3	60.00	27
附近農家	0	0.00	2	8.00	0	0.00	1	20.00	3
本鄉農家	4	17.39	1	4.00	0	0.00	0	0.00	5
外鄉農家	0	0.00	3	12.00	1	16.67	0	0.00	4
本鄉育苗中心	1	4.35	0	0.00	1	16.67	0	0.00	2
外鄉育苗中心	0	0.00	0	0.00	0	0.00	0	0.00	0
農會	11	47.83	2	8.00	0	0.00	1	20.00	14
其他	0	0.00	3	12.00	1	16.67	0	0.00	4
自行育苗戶數	23	100.00	25	100.00	6	100.00	5	100.00	59

2-(5)您選擇此家(上題答案)種子的原因為何？(複選)(A205)

	北部		中部		南部		東部		
	戶數	百分比	戶數	百分比	戶數	百分比	戶數	百分比	戶數
過去種植此家種子經驗佳	10	43.48	3	12.00	0	0.00	2	40.00	15
看他人種植此家種子成果良好	8	34.78	3	12.00	1	16.67	0	0.00	12
此家種子品種符合需求	10	43.48	8	32.00	3	50.00	0	0.00	21
價格便宜	3	13.04	2	8.00	0	0.00	0	0.00	5
對方有送貨到家的服務	23	100.00	21	84.00	6	100.00	3	60.00	53
距離自家農場很近	5	21.74	1	4.00	0	0.00	0	0.00	6
長期往來	7	30.43	3	12.00	0	0.00	0	0.00	10
其他	2	8.70	5	20.00	3	50.00	1	20.00	11
自行育苗戶數	23	100.00	25	100.00	6	100.00	5	100.00	59

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2-(6)育苗時所需機器設備(A206)

2-(6)-a.耕耘機

耕耘機(育苗用)租用來源？(單選)(A206A21Z)

	北部		中部		南部		東部		
	戶數	百分比	戶數	百分比	戶數	百分比	戶數	百分比	戶數
附近農家	0	0.00	1	4.00	0	0.00	0	0.00	1
本鄉農家	0	0.00	0	0.00	0	0.00	0	0.00	0
外鄉農家	0	0.00	0	0.00	0	0.00	0	0.00	0
本鄉育苗中心	0	0.00	0	0.00	0	0.00	0	0.00	0
外鄉育苗中心	0	0.00	0	0.00	0	0.00	0	0.00	0
農會	0	0.00	0	0.00	0	0.00	0	0.00	0
其他	0	0.00	0	0.00	0	0.00	0	0.00	0
自行育苗戶數	23	100.00	25	100.00	6	100.00	5	100.00	59

2-(6)-b.播種機

播種機(育苗用)租用來源？(單選)(A206B21Z)

	北部		中部		南部		東部		
	戶數	百分比	戶數	百分比	戶數	百分比	戶數	百分比	戶數
附近農家	1	4.35	2	8.00	0	0.00	0	0.00	3
本鄉農家	0	0.00	0	0.00	0	0.00	0	0.00	0
外鄉農家	0	0.00	0	0.00	0	0.00	0	0.00	0
本鄉育苗中心	0	0.00	0	0.00	0	0.00	0	0.00	0
外鄉育苗中心	0	0.00	0	0.00	0	0.00	0	0.00	0
農會	0	0.00	0	0.00	0	0.00	0	0.00	0
其他	1	4.35	0	0.00	0	0.00	0	0.00	1
自行育苗戶數	23	100.00	25	100.00	6	100.00	5	100.00	59

國科會計劃「作業耕種約定、交易成本及台灣農場經營效率」
之統計整理初表

2-(7)育苗所使用人力(育苗時期所需，含自有、僱用及機工部分)(A207)

自行育苗雇工來源(單選)(A207B)

	北部		中部		南部		東部		
	戶數	百分比	戶數	百分比	戶數	百分比	戶數	百分比	戶數
附近農家	2	8.70	3	12.00	0	0.00	0	0.00	5
本鄉農家	1	4.35	0	0.00	0	0.00	1	20.00	2
外鄉農家	0	0.00	0	0.00	0	0.00	0	0.00	0
其他	0	0.00	0	0.00	0	0.00	0	0.00	0
自行育苗戶數	23	100.00	25	100.00	6	100.00	5	100.00	59

國科會計劃「作業耕種約定、交易成本及台灣農場經營效率」之統計整理初表

2-(11)本期是否有賣苗給其他農家？(A211Z)

	北部		中部		南部		東部		
	戶數	百分比	戶數	百分比	戶數	百分比	戶數	百分比	戶數
有賣苗給其他農家	5	21.74	6	24.00	1	16.67	1	20.00	13
沒有賣苗給其他農家	17	73.91	19	76.00	5	83.33	4	80.00	45
自行育苗戶數	23	100.00	25	100.00	6	100.00	5	100.00	59

2-(12)本期您及您的家人是否有至其他農家幫忙育苗工作？(A212Z)

	北部		中部		南部		東部		
	戶數	百分比	戶數	百分比	戶數	百分比	戶數	百分比	戶數
有至其他農家幫忙育苗	2	8.70	2	8.00	0	0.00	0	0.00	4
沒至其他農家幫忙育苗	21	91.30	23	92.00	6	100.00	5	100.00	55
自行育苗戶數	23	100.00	25	100.00	6	100.00	5	100.00	59

2-(13)是否有將耕耘機或播種機提供他人育苗作業使用？(A213Z)

	北部		中部		南部		東部		
	戶數	百分比	戶數	百分比	戶數	百分比	戶數	百分比	戶數
將機械提供他人育苗使用	1	4.35	0	0.00	0	0.00	0	0.00	1
沒將機械提供他人育苗使用	22	95.65	25	100.00	6	100.00	5	100.00	58
自行育苗戶數	23	100.00	25	100.00	6	100.00	5	100.00	59

Total
百分比
83.97
16.03
100.00

Total
百分比
46.28
17.15
22.98
8.74
8.41
75.40
7.77
100.00

Total
百分比
41.42
30.74
14.24
69.58
32.04
0.97
0.32
100.00

國科會計劃「作業耕種約定、交易成本及台灣農場經營效率」之統計整理初表

Total
百分比
14.24
8.09
3.56
56.31
14.56
0
2.27
100.00

Total
百分比
22.33
5.18
24.27
17.48
40.13
20.06
59.22
4.21
0.32
100.00

Total
百分比
61.02
23.73
11.86
11.86
32.20
6.78
47.46
11.86
100.00

Total
百分比
45.76
5.08
8.47
6.78
3.39
0.00
23.73
6.78
100.00

Total
百分比
25.42
20.34
35.59
8.47
89.83
10.17
16.95
18.64
100.00

國科會計劃「作業耕種約定、交易成本及台灣農場經營效率」之統計整理初表

Total
百分比
1.69
0.00
0.00
0.00
0.00
0.00
0.00
100.00

Total
百分比
5.08
0.00
0.00
0.00
0.00
0.00
1.69
100.00

國科會計劃「作業耕種約定、交易成本及台灣農場經營效率」之統計整理初表

Total
百分比
8.47
3.39
0.00
0.00
100.00

國科會計劃「作業耕種約定、交易成本及台灣農場經營效率」之統計整理初表

Total
百分比
22.03
76.27
100.00

Total
百分比
6.78
93.22
100.00

Total
百分比
1.69
98.31
100.00