Title	Review of the empirical literature on factors affecting the supply of off-farm labour
Author(s)	Brick, Aoife
Publication Date	2005
Publication Information	Brick, A., (2005) "Review of the empirical literature on factors affecting the supply of off-farm labour" (Working Paper No. 0105) Department of Ecnomics, National University of Ireland, Galway.
Publisher	National University of Ireland, Galway
Item record	http://hdl.handle.net/10379/985

REVIEW OF THE EMPIRICAL LITERATURE ON FACTORS AFFECTING THE SUPPLY OF OFF-FARM LABOUR

Aoife Brick

Working Paper No. 105 **October 2005**

Department of Economics,
National University of Ireland, Galway.

http://www.nuigalway.ie/ecn

Environmental Change Institute
National University of Ireland, Galway, Ireland

HEA
Higher Education Authority
An tÚdarás um Ard-Oideachas

Abstract

The objective of this paper is to assess the currently available literature relating to the labour allocation of farm households. An overview of the theoretical model relating to joint participation and hours of labour supply decisions of farm households is presented; followed by the resulting empirical specification. A discussion of the factors affecting both the participation in an off-farm job and the level of off-farm labour supplied is then undertaken and empirical findings from a range of studies are presented. There is found to be a degree of consensus among authors in relation to the variables chosen to explain the decisions and the nature of the relationships established. Broadly speaking, household characteristics have a stronger influence on spouses decisions than on operators, and farm characteristics have a stronger impact on operators decisions than spouses.

JEL Classification: J22, J43

Keywords: Labour supply, off-farm work, agricultural households

Introduction

The objective of this paper is to assess the currently available literature relating to the labour allocation of farm households. Firstly, an overview of the theoretical model relating to joint participation and hours of labour supply decisions of farm households is presented; followed by the resulting empirical specification. Secondly, a discussion of the factors affecting both the participation in an off-farm job and the level of off-farm labour supplied is undertaken. Empirical results from a range of studies conducted between 1971 and 2004[1] are discussed.

Theoretical model

A neoclassical household model based on utility maximisation is the one most frequently employed in the literature. This basic model as adapted from those presented in Huffman (1980, 1991), Lass*, et al.* (1991), and Weersink (1992) is presented here.

In the agricultural household model, farm households are assumed to maximise utility subject to constraints on time, income and farm production. Utility, U, is assumed to be derived from purchased goods (Y_h) and the home-time of the operator and spouse (indexed separately) (T_h), and is affected by human capital (H_h) and other household and area characteristics (Z_h), which are assumed to be exogenous to current consumption decisions:

$$U = U(Y_h, T_h; H_h, Z_h) \qquad [1]$$

Utility is maximised subject to constraints on time, income and farm productivity.

Time constraint:

The operator and spouse have a fixed amount of time (T), which can be allocated to home time (T_h), farm work (T_f) or off-farm work (T_{of}).

$$T = T_h + T_f + T_{of} \qquad [2]$$

[1] This review can, in some sense, be seen to overlap and significantly update that conducted by Lass*, et al.* (1991). The literature in that study extended from 1971 to 1989.

Budget constraint:

The consumption of market goods at the price P_h is limited by the amount of available income earned from farm profits, off-farm wages and other exogenous household income (V).

Farm profit is equal to the price of farm output (P_f), multiplied by output (Y_f), less the variable cost (RX). Where R is the input price vector and X is the quantity of inputs used. Off-farm income is the product of the hours worked off-farm (T_{of}) and the wage rate (W_{of}).

$$P_h Y_h = P_f Y_f - RX + W_{of} T_{of} + V \qquad [3]$$

Farm production constraint:

The final constraint to the household represents the technology available to produce farm output

$$Y_f = f(T_f, X; Z_f, H_f) \qquad [4]$$

f (.) = concave production function

Z_f = exogenous farm specific characteristics

H_f = vector of human capital stock variables influencing the productivity of the farm

Human capital variables will also influence the off-farm earning potential of the operator/spouse along with other market conditions Z_{of}, which implies that the wage rate should be expressed as

$$W_{of} = W_{of}(H_{of}, Z_{of}) \qquad [5]$$

Substituting equations 2, 3, 4 and 5 into equation 1 results in the equation [6], which is maximised through the choice of variable inputs X, and allocation of labour by the operator and spouse to farm (T_f) and off-farm (T_{of}) activities.

$$\begin{aligned} L = {} & U(T_h, Y_h; H_h, Z_h) + \lambda[P_f f(T_f, X; Z_f, H_f) - RX + W_{of} T_{of} + V - P_h Y_h] \\ & + \gamma(T - T_f - T_{of} - T_h) \end{aligned} \qquad [6]$$

The Kuhn-Tucker conditions for a maximum are:

$$\frac{\partial L}{\partial X} = \lambda[P_f f_X - R] = 0 \qquad [7]$$

$$\frac{\partial L}{\partial T_f} = \lambda P_f f_{T_f} - \gamma = 0 \qquad [8]$$

$$\frac{\partial L}{\partial T_{of}} = \lambda W_{of} - \gamma \leq 0, T_{of} \geq 0, T_{of}(\lambda W_{of} - \lambda) = 0 \qquad [9]$$

$$\frac{\partial L}{\partial T_h} = U_{T_h} - \gamma = 0 \qquad [10]$$

$$\frac{\partial L}{\partial Y_h} = U_{Y_h} - \lambda P_h = 0 \qquad [11]$$

$$\frac{\partial L}{\partial \lambda} = P_f f(T_f, X; Z_f, H_f) - RX + W_{of} T_{of} + V - P_h Y_h = 0 \qquad [12]$$

$$\frac{\partial L}{\partial \gamma} = T - T_f - T_{of} + T_h = 0 \qquad [13]$$

where λ and γ are Lagrange multipliers for marginal utility of income and human time and U_j and f_j are partial derivatives of the functions U and f.

The operator/spouse will allocate hours to farm work up to the point that the marginal rate of substitution between home time and consumption (γ/λ) is equal to the marginal value of farm labour. Using equation [9], off-farm work will be zero ($T_{of} = 0$) if the marginal return to off-farm labour or wage rate is less than the marginal rate of substitution between home-time and consumption goods ($W_{of}(H_{of}, Z_{of}) < \gamma/\lambda$). Assuming an interior solution ($T_{of} > 0$), the off-farm wage will equal the marginal value of farm labour (reservation wage[2]):

$$\gamma/\lambda = W_{of}(H_{of}, Z_{of}) \qquad [14]$$

The decision to work off-farm can be summarised through the following participation rule:

$$D = \begin{cases} 1 \text{ if } W_{of}(H_{of}, Z_{of}) > \gamma/\lambda\big|_{T_{of}=0} \\ 0 \text{ if } W_{of}(H_{of}, Z_{of}) \leq \gamma/\lambda\big|_{T_{of}=0} \end{cases} \qquad [15]$$

Equation [15] states that the operator/spouse will work off-farm (D = 1) if the wage rate is greater than the marginal value of farm labour (reservation wage), assuming no off-farm work and evaluated at the point of optimal allocation of time between farm work and leisure. The binary decision rule is thus a function of all the exogenous variables in the model since the optimal off-farm work hours T_{of}^* is jointly determined with farm labour allocation T_f^*.

[2] Reservation wage may be defined as that wage below which an individual is unwilling to accept a particular job offer, preferring instead to opt for non-participation.

Solving the Kuhn-Tucker conditions in terms of the exogenous factors leads to the empirical specification for the participation decision as a probability model. The binary decision to participate is generally modelled using one of the probability models (probit or logit).

Given the decision to participate, the market wage rate will be observed. Market wages are usually missing for non-participants. To correct for the censored nature of the sample, wage equations are generally estimated by the procedure outlined in Heckman (1974). The resulting model is then used to predict wages for those who do not participate in the off-farm labour market and the Tobit procedure is applied to the entire sample of data for the time spent working off-farm. Alternatively, the Heckman procedure can be used to estimate the labour supply function using the sub-sample of working individuals.

Off-farm labour force participation

Probit models are generally used to estimate the off-farm labour force participation of the farm household. The dependent variable is a dummy variable, which is equal to one if the subject participates in off-farm work and is equal to zero otherwise. Univariate probits are used when the decision of the farm operator or spouse alone is under consideration (Sumner, 1982; Pfaffermayr*, et al.*, 1991). They are also used when the participation decisions of the operator and spouse are assumed, or are proved, not to be jointly determined (Furtan*, et al.*, 1985; Lass*, et al.*, 1989; Findeis*, et al.*, 1991; Lass and Gempesaw, 1992; Weersink*, et al.*, 1998). When the decisions of the operator and spouse are assumed to be jointly determined, a bivariate probit model is estimated. The cross-equation correlation coefficient is used to investigate the validity of the assertion that decisions made within a single-family operator and spouse household might not be independent. If the cross-equation correlation coefficient is significant then the results of the bivariate model are used for the analysis and decisions are assumed dependent (Gould and Saupe, 1989; Tokle and Huffman, 1991; Benjamin and Guyomard, 1994; Findeis and Lass, 1994; Lee, 1998, Lim-Applegate*, et al.*, 2002; Bharadwaj and Findeis, 2003; Kwon*, et al.*, 2003). If, however, the correlation coefficient is not significant, often two univariate probits are estimated instead. In many cases, the coefficients of the bivariate and univariate models are consistent in sign and magnitude (Lass*, et al.*, 1989; Huffman and Lange, 1989; Lass and Gempesaw, 1992; Keeney and Matthews, 2000).

The following literature review focuses on literature from more economically developed countries and spans more than thirty years of material between 1971 and 2004. Each main variable/variable group are compared across studies, allowing for an in-depth comparison of

the results obtained by various researchers in their examinations of the factors that affect off-farm participation.

Table 1 summarises the econometric specifications, dependent variables, sample sizes, country of origin, and, where relevant, the cross equation correlation coefficients. As can be seen from the summary all authors with the exception of Simpson and Kapitany (1983) use a utility maximising model based on neoclassical labour theory. Simpson and Kapitany (1983) test an alternative to the neoclassical utility maximising model, the income-targeting model. The income target model assumes that farmers aim to obtain a target income not to maximise utility. Their results supported to some extent the utility maximising hypothesis but as Kjeldahl (1995) points out

> "There is no particular contradiction between the utility maximising objective and the target income objective. The latter may be perceived as nested in the former" p 117

In these types of models discussed here, variables in four broad categories are examined; farm, operator/spouse, household and location characteristics.

In this table, and all subsequent tables in this paper, the direction and significance of the cross-equation correlation coefficient and the relationship between various variables and off-farm participation and off-farm labour supply of farm operators and spouses are indicated by (+ sig) for a significant positive relationship and (- sig) for a significant negative relationship. Significant implies that the result is found to be statistically significant at the 10 percent level.

Table 1: Off-farm labour force participation literature summary

Author (Publication Year)	Econometric Specification	Dependent Variable		Data			rho[3]	TM[4]	Wages[5]
				Geographic Region	Year	Sample Size			
Huffman (1980)	Weighted least squares	$\log_e$ (odds off farm work)	Operator	USA (Iowa, Nth. C. & Okl.)	1964	n = 276[6]	n/a[7]	✻	✓
Sumner (1982)	Univariate Probit	Probit (1, 0)	Operator – Est. 1[8]	USA (Illinois)	1971	n = 832	n/a	✻	✖
			Operator – Est. 2						
Simpson and Kapitany (1983)	Multivariate Logit	$\log_e$ (odds off farm work)	Entrants	Canada (Saskatchewan)	1978	n = 495	n/a	✻ ✚	✖
			Established			n = 3,430[9]	n/a		
			Older				n/a		
Furtan, *et al.* (1985)	Univariate Probit	Probit (1, 0)	Husband	Canada (Saskatchewan)	1981	n = 144	n/a	✻	✖
			Wife						
Gould and Saupe (1989)	Bivariate Probit	Probit (1, 0)	Operator	USA (Wisconsin)	1983	n = 293	+ sig	✻	✖
			Spouse						
			Operator		1987		+ sig		
			Spouse						
Huffman and Lange (1989)	Bivariate Probit	Probit (1, 0)	Husband	USA (Iowa)	1977	n = 771	+	✻	✖
			Wife						
Lass, *et al.* (1989)	Univariate Probit†	Probit (1, 0)	Operator	USA (Massachusetts)	1986	n = 114	n/a	✻	✖
			Spouse						
Findeis, *et al.* (1991)	Univariate Probit	Probit (1, 0)	Operator	USA (Pennsylvania)	1986	n = 989	n/a	✻	✖
			Spouse						
Pfaffermayr, *et al.* (1991)	Ordered Probit[10]	Probit (1, 0)	Operator	Austria	1989	n = 1,842	n/a	✻	✶
Tokle and Huffman (1991)	Bivariate Probit	Probit (1, 0)	Husband	USA (23 States)	1978/82	n = 5,866	+ sig	✻	✖
			Wife						
Lass and Gempesaw (1992)	Univariate Probit†	Probit (1, 0)	Operator Spouse	USA (Pennsylvania)	1986	n = 610	n/a	✻	✖
Weersink (1992)	Univariate Logit	$\log_e$ (odds of farm work)	Operator	Canada (Ontario)	1990	n = 614	n/a	✻	✖
Benjamin (1994)	Univariate Probit	Probit (1, 0)	Husband	France	1988	n = 1518	n/a	✻	✖
			Wife						

[3] Cross-equation correlation coefficient
[4] TM = Theoretical Model, ✻ = Utility maximising model and ✚ = income targeting model
[5] ✓ = include actual wages, ✖ = reduced form model, ✶ = include estimated wages
[6] Counties
[7] n/a = Not applicable
[8] Estimation 1 does not include farm type variables, estimation 2 does include farm type variables
[9] Does not indicate the number in each category
† The author/s indicate that a bivariate probit was initially tested but given that the hypothesis of zero cross-equation correlation was not rejected results from univariate probit estimates are presented instead.
[10] Ordered Probit: dummy for full-time farmers, dummy for casual off-farm workers and dummy for permanent off-farm workers

Author (Publication Year)	Econometric Specification	Dependent Variable		Data			rho	TM	Wages
				Geographic Region	Year	Sample Size			
Benjamin and Guyomard (1994)	Bivariate Probit	Probit (1, 0)	Operator Wife	France	1988	n = 7,032	+ sig	✻	✖
Findeis and Lass (1994)	Univariate probit†	Probit (1, 0)	Rural dominant	USA (Pennsylvania)	1986	n = 343	n/a	✻	✖
	Bivariate probit		Urban dominant			n = 513	- sig	✻	✖
Kimhi (1994)	Quasi-maximum likelihood method	Participate in off-farm work (1, 0)	Operator Spouse	Israel	1981	n = 9,872	+	✻	✖
Benjamin, *et al.* (1996)[11]	Multinomial logit	8-work regimes	Farm Men Farm Women	France	1988	n = 7,032	n/a	✻	✖
Kimhi (1996)	Bivariate Probit	Probit (1, 0)	Operator Spouse	Israel	1981	n = 4,626	+ sig	✻	✖
Lee (1998)	Bivariate Probit Multinomial Logit	Probit (1, 0) Mlogit (1 ,2, 3, 4)	Husband Wife	Landkreis Emsland (Hessen, Germany)	1991	n = 323	-	✻	✖
			Husband Wife	Werra-Meissner-Kries (Hessen, Germany)		n = 208	+ sig		
Huffman and El Osta (1998)	Reduced form logit	Participate in off-farm work (1, 0)	Operator – Est. 1[12] Operator – Est. 2[13]	USA	1991	n = 2,076	n/a	✻	✖
Weersink, *et al.* (1998)	Univariate Probit†	Probit (1, 0)	Operator Spouse	USA (New York) – n=147 and Canada (Ontario) – n=239	1991	n = 386	n/a	✻	✖
Howard and Swidinsky (1999)	Univariate Probit	Probit (1,0)	Operator	Canada	1986	n = 53,143	n/a	✻	✖
Keeney and Matthews (2000)	Bivariate Probit	Probit (1, 0)	Operator Spouse	Ireland	1994	n = 781	+	✻	✖
Woldehanna, *et al.* (2000)	Independent double-hurdle model	Probability of off-farm work (1, 0)	Household	Netherlands	1971/72-1992/93	n = 912	n/a	✻	✓
Lim-Applegate, *et al.* (2002)	Bivariate Probit	Probit (1, 0)	Operator Spouse	Australia	1994/95	n = 2,430	+ sig	✻	✖
Benjamin and Kimhi (2003)[11]	Multinomial logit	16-work regimes	Farm Men Farm Women	France	2000	n = 35,641	n/a	✻	✖
Bharadwaj and Findeis (2003)	Bivariate Probit	Probit (1, 0)	Farm Men Farm Women	USA	2001	n = 2,661	sig[14]	✻	✖
Findeis and Swaminathan (2003)	Quasi-maximum likelihood[15]	Participate in off-farm work (1, 0)	Operator Spouse	USA	2001	n = 2,661	n/a	✻	✖

[11] Because of the number of regimes, it is not easy to interpret the coefficients; hence, the authors derive the marginal effects of the explanatory variables and consider the overall effects on participation in their analysis. For this reason, in the tables that follow, only the overall direction of the effect and not the significance is reported.
[12] Estimation 1: the value of farmland owned (LAND) and the value of farm capital in machinery and equipment, breeding stock, and farm buildings (FCAPITAL) are included as regressors. Hence off-farm work decisions are conditional upon LAND and FCAPITAL
[13] Estimation 2: LAND and FCAPITAL are attributes that are jointly determined with farm operator's off-farm participation and on and off-farm hours and are not included as regressors.
[14] The paper does not indicate if the correlation is positive or negative, only that it is significant
[15] Assumes a household bargaining model

Author (Publication Year)	Econometric Specification	Dependent Variable		Data			rho	TM	Wages
				Geographic Region	Year	Sample Size			
Kwon, *et al.* (2003)	Bivariate Probit	Probit (1, 0)	Husband Wife	USA (Iowa)	1999	n = 266	+ sig	*	✖
McNally (2003)	Linear probability model	Probability of off-farm work (1, 0)	Operator	England & Wales	1988-1997	n = 5,190[16]	n/a	*	✖
Serra, *et al.* (2003)	Univariate Probit	Probit (1, 0)	Household Household	USA (Kansas)	1993/95 1996/00	n = 3,592 n = 6,475	n/a	*	✖

[16] 5,190 farms – 22,665 observations over the ten years

Household characteristics

This section outlines the results of previous studies in relation to household characteristics.

Age and gender

The age of the operator and spouse is generally found to be an important determinant of off-farm participation. Age and age-squared are, where possible, typically both included in participation equations. Including the age-squared variable allows possible life-cycle effects to be captured. That is, it is generally observed that the probability of off-farm participation increases with age up to a maximum and then begins to decline. It is thought that individuals increase their work effort in earlier years as they accumulate assets to draw on later in life (Lass*, et al.*, 1991).

For farm operators, in the studies reviewed here, the probability of participating in off-farm work is significantly greater at a younger age (Table 2). On average, the probability of operator participation in off-farm work reaches a maximum when they are in their forties, at which point it begins to decrease with age. Weersink (1992) who had only categorical age data available for farm operators, he still found that participation increased with age and then to decline, as suggested by the life-cycle hypothesis.

For spouses the results are less clear. The quadratic life-cycle effect is observed by some authors (Lass*, et al.*, 1989; Lass and Gempesaw, 1992; Benjamin and Guyomard, 1994; Corsi and Findeis, 2000; Kimhi and Seiler, 2001; Lim-Applegate*, et al.*, 2002; Bharadwaj and Findeis, 2003; Kwon*, et al.*, 2003), while others find conflicting results. In some studies, for farm women, advancing age has been shown to be negatively then positively related to the probability of off-farm work (Gould and Saupe, 1989; Kimhi, 1994, 1996; Weersink*, et al.*, 1998). This might be explained by the general increase in the female labour force participation rate in recent years in many countries. Where the life-cycle effect is observed, spouse participation tends to peak when they are in their early to mid-forties.

Cross-age effects, that is the effect of operator age on the off-farm participation of the spouse and vice versa, are not generally found to be consistent across studies. In some cases, cross-age effects are not examined due to multicollinearity problems, which can arise from including both operator and spouse age in both equations.

Table 2: Impact of age and gender on off-farm participation

		Operator				Spouse			
		Age Years	Age^2	Peak	Gender Dummy	Age Years	Age^2	Peak	Gender Dummy
Huffman (1980)	Operator	+	-	NA[17]					
Sumner (1982)	Operator Est. 1	+ sig	- sig	43					
	Operator Est. 2	+ sig	- sig	41					
Gould and Saupe (1989)	Operator (1982)	+	-	NA					
	Spouse (1982)					-	+	NA	
	Operator (1986)	+ sig	- sig	NA					
	Spouse (1986)					-	+	NA	
Huffman and Lange (1989)	Husband	-	-	NA		+ sig			
	Wife	+	-	NA		-		NA	
Lass, *et al.* (1989)	Operator	+ sig	- sig	48	+ sig				
	Spouse					+ sig	- sig	44	+
Findeis, *et al.* (1991)	Operator	+ sig	- sig	41.4					
	Spouse					+ sig	- sig	43.9	
Tokle and Huffman (1991)	Husband	+ sig	- sig	26.2					
	Wife	+	- sig	NA					
Lass and Gempesaw (1992)	Operator	+ sig	- sig	43		- sig	+ sig	53	
	Spouse	-	+	NA		+	-	36	
Benjamin (1994)	Husband	+ sig	- sig	45.7					
	Wife					+ sig	- sig	33.8	
Benjamin and Guyomard (1994)	Operator	+ sig	- sig	45		+ sig	- sig	56.8	
	Spouse	- sig	+ sig	63		+ sig	- sig	42.5	
Findeis and Lass (1994)	Rural dominant	+ sig	- sig	35	-				
	Urban dominant	+ sig	- sig	37	-				
Kimhi (1994)	Operator	+ sig	- sig	41		+		NA	
	Spouse	+ sig	- sig	NA		- sig		40	
Benjamin, *et al.* (1996[11])	Farm Men	+	-	NA		+	-	NA	
	Farm Women	-	+	NA		+	-	NA	
Kimhi (1996)	Operator	+ sig	- sig	NA		- sig	+ sig	NA	
	Spouse	+ sig	- sig	NA		- sig	+ sig	NA	
Lee (1998)	Husband (region 1)	+ sig	- sig	47.5[18]		-	+	NA	
	Wife (region 1)	-	+	NA		+	-	40	
	Husband (region 2)	+ sig	- sig	47.5		-	-	NA	
	Wife (region 2)	-	+	NA		+	-	40	
Huffman and El Osta (1998)	Operator – Est. 1	+ sig	- sig	45.6					
	Operator – Est. 2	+ sig	- sig	44.8					
Weersink, *et al.* (1998)	Operator	+ sig	- sig	39					
	Spouse					- sig	+	NA	
Howard and Swidinsky (1999)	Operator	- sig	+ sig	50					
Corsi and Findeis (2000)	Operator[19]	+ sig	- sig	49					
	Spouse[20]					+ sig	- sig	48.6	
	Spouse[21]					+	-	NA	
Keeney and Matthews (2000)	Operator	+	- sig	34					
	Spouse	+	- sig	NA					
Woldehanna *et al.* (2000)	Household (operator age)	+ sig	- sig	41					
Kimhi and Seiler (2001)[22]	Male operator/spouse	+ sig	- sig	37					
	Female operator/spouse					+ sig	- sig	43	
Lim-Applegate, *et al.* (2002)	Operator	+	-	51					
	Spouse					+ sig	- sig	34	
Benjamin and Kimhi (2003)[11]	Farm Men	-							
	Farm Women					-			
Bharadwaj and Findeis (2003)	Farm Men	+ sig	- sig	41					
	Farm Women					+ sig	- sig	39	
Findeis and Swaminathan (2003)	Operator	- sig	-	NA					
	Spouse	- sig	- sig	NA					

[17] NA = not available
[18] Lee (1998) says that own age for husbands "reach their peak at the age of late 40's for husband's and around the age of 40 for wives" 47.5 has been inserted to give a value mid-way between 45 and 50 for husband's
[19] Dummy model
[20] Split model – working off-farm in 1985
[21] Split model – not working off-farm in 1985
[22] Quasi-maximum likelihood estimation –the model includes 3 different equations: for the male operator or spouse, for the female operator or spouse and for the oldest adult child – results for the first two equations are included here.

		Operator				Spouse			
		Age Years	Age^2	Peak	Gender Dummy	Age Years	Age^2	Peak	Gender Dummy
Kwon, *et al.* (2003)	Husband	+ sig	- sig	47					
	Wife					+ sig	- sig	45	
McNally (2003)	Operator	- sig							
Serra, *et al.* (2003)	Operator (1993-95)	+ sig	- sig	NA					
	Operator (1996-00)	+ sig	- sig	NA					

Gender is not commonly included in off-farm participation estimations, because in many cases farm couples, where the operator is male and the spouse is female, are pre-selected for inclusion. Lass, *et al.* (1989) do include a gender dummy variable, as they have not pre-selected male operators. They find that male operators are significantly more likely to work off-farm than female operators are; the result for spouses was not found to be significantly different from zero. Findeis and Lass (1994) also include a gender dummy variable, but it was not found to be significant for farm operators in either rural or urban dominant labour market areas.

Farm raised and health

Huffman and Lange (1989) and Huffman and El Osta (1998) find that farm operators who are raised on a farm are significantly less likely to work off-farm than those raised elsewhere (Table 3). It appears that early farm experience raises the reservation wage of the farm operator.

Huffman and El Osta (1998) include operator health as an explanatory variable. They find, predictably, that having chronic health problems lowers the probability of off-farm participation of the farm operator.

Table 3: Impact of farm raised and health on off-farm participation

		Farm raised Operator	Health[23] Dummy
Huffman and Lange (1989)	Husband	- sig	
	Wife	-	
Huffman and El Osta (1998)	Operator – Est. 1	-	- sig
	Operator – Est. 2	- sig	-sig

[23] 1 = chronic health problems

Education and training

Education and training are two commonly used indicators of an individual's stock of human capital. In some cases, both education and training are separated into general and agriculture related categories.

A higher number of years of general education tends to have a significant positive impact on the probability of off-farm labour force participation of both farm operators and spouses (Table 4). This result is likely to be associated with the increase in off-farm earning potential associated with higher levels of education; additional education raises the off-farm wage rate by more than the reservation wage at farm or home activities. In Lee (1998), in the multinomial logit model he finds that additional general education of the operator has a significant positive impact on off-farm participation but only in the regime in which only the operator is working off-farm. Kimhi, (1994, 1996) and Kimhi and Seiler (2001) find negative own-education effects for spouses but they do suggest that these results are counter-intuitive.

The impact of operator years of general education on the probability of spouse participation tends to be consistent in sign across studies. In general, for spouses, additional operator schooling causes an increase in his/her probability of working off-farm (Gould and Saupe, 1989; Kimhi, 1994, 1996; Keeney and Matthews, 2000). On the other hand, results for operators are more ambiguous; a majority of authors find that additional spouse years of general education lead to a decrease in the probability of the operator working off-farm (Furtan*, et al.*, 1985; Tokle and Huffman, 1991; Kimhi, 1994, 1996; Lee, 1998[24]).

University level education is not included in many studies of off-farm labour participation. Where it is included, results for operators are mixed and for the most part not significantly different from zero (Table 4). Lim-Applegate*, et al.* (2002) and Bharadwaj and Findeis (2003) find that for spouses, university level education has a significant positive impact on the probability of spouse off-farm participation.

For some authors, the number of years of education is not available so they elect to include dummy variables to represent the highest level of education achieved by an operator or spouse. In such instances, the results are generally similar to those above. Weersink (1992) finds that those operators with some high school education or university level education are significantly more likely to work off-farm than those with only elementary school education.

[24] Only in the regime where only the operator is working off-farm (Emsland)

Weersink, *et al.* (1998) find that those operators and spouses who have not completed high school are significantly less likely to work off-farm than those who have completed. In addition, spouses who have completed a university level education are significantly more likely to work off-farm than those who have only completed high school. Finally, Findeis and Swaminathan (2003) find, that those operators and spouses who have not completed a university level education are significantly less likely to work off-farm than those who have.

> "Being a high-school graduate but not graduating from college is associated with a lower likelihood of working off the farm and a greater likelihood of using human capital in farm work, for both men and women. This means that having a college education enhances the likelihood of off-farm work." Findeis and Swaminathan, 2003, p 9

Having completed non-farm vocational training has a significant positive effect on the probability of off-farm work participation of spouses. The results for operators are similar, Sumner (1982), Gould and Saupe (1989), Lee (1998)[25] and Bharadwaj and Findeis (2003) all find that having completed non-farm vocational training increases the operator's probability of working off-farm.

Few authors differentiate between general and agricultural education. Intuitively, it is expected that a higher level of agricultural education of the operator or spouse will increase the marginal productivity of his/her farm work and therefore reduce the probability of he/she working off-farm, i.e. agricultural education raises reservation wages by more than it raises market wages. This is found to be the case in Pfaffermayr, *et al.* (1991), Benjamin and Guyomard (1994) and Bharadwaj and Findeis (2003) (Table 4). Agricultural education of the spouse is not generally found to have a significant impact on the probability of participation, with the exception of Benjamin and Guyomard (1994) who find it has the predicted negative effect on the probability of spouse participation in off-farm work.

Thus in summary, Both general education and non-farm training have a larger effect on market wages than on the marginal productivity of farm labour leading to an increase in the probability of off-farm work, i.e. they increase the market wage by more than they increase the reservation wage.

---

[25] In the multinomial logit model, the result is negative significant in the wife only regime in Emsland and positive significant for the husband only and both regimes in Werra-Meissner-Kreis.

Table 4: Impact of education and training on off-farm participation

		General Education		Non-farm training[26]		Farm Ed./ Training	
		Operator Years	Spouse Years	Operator Dummy	Spouse Dummy	Operator Dummy	Spouse Dummy
Huffman (1980)	Operator	+ sig	+ sig				
Sumner (1982)	Operator Est. 1	+	-	+ sig		+	
	Operator Est. 2	+	-	+ sig		+ sig	
Simpson and Kapitany (1983)	Entrants	+ sig	-				
	Established	+ sig	-				
	Older	-	-				
Furtan, *et al.* (1985)	Husband	+	- sig				
	Wife	-	+ sig				
Gould and Saupe (1989)	Operator (1982)	+ sig	+	+ sig			
	Spouse (1982)	+	+		+ sig		
	Operator (1986)	+	+	+			
	Spouse (1986)	+ sig	+ sig		+ sig		
Huffman and Lange (1989)	Husband	+ sig	- sig				
	Wife	+	+ sig				
Lass, *et al.* (1989)	Operator	+ sig					
	Spouse		+				
Findeis, *et al.* (1991)	Operator	+ sig					
	Spouse		+ sig				
Pfaffermayr, *et al.* (1991)	Operator					- sig	+
Tokle and Huffman (1991)	Husband	+	- sig				
	Wife	-	+ sig				
Lass and Gempesaw (1992)	Operator	+	+ sig				
	Spouse	+	+ sig				
Benjamin and Guyomard (1994)	Operator	+ sig	+			- sig	- sig
	Wife	-	+ sig			+	- sig
Findeis and Lass (1994)	Rural dominant	-	+				
	Urban dominant	+	+ sig				
Kimhi (1994)	Operator	+ sig	- sig				
	Spouse	+ sig	-				
Kimhi (1996)	Operator	+ sig	- sig				
	Spouse	+ sig	- sig				
Huffman and El Osta (1998)	Operator – Est. 1	+ sig	-				
	Operator – Est. 2	+ sig	-				
Lee (1998)	Husband (region 1)	+ sig	- sig	+	-	+	
	Wife (region 1)	+	+ sig	-	+ sig	-	
	Husband (region 2)	+	-	+ sig	+	-	
	Wife (region 2)	+	+	+	+	+ sig	
Howard and Swidinsky (1999)	Operator	- sig					
Corsi and Findeis (2000)	Operator[19]	+ sig					
	Spouse[20]		+				
	Spouse[21]		+ sig				
Keeney and Matthews (2000)	Operator	+ sig					
	Spouse		+ sig				
Woldehanna, *et al.* (2000)	Household	+ sig					

Continued overleaf…

[26] Vocational training

Table 4 cont…		General Education		Non-farm training[27]		Farm Education / Training		University Education	
		Operator Years	Spouse Years	Operator Dummy	Spouse Dummy	Operator Dummy	Spouse Dummy	Operator Dummy	Spouse Dummy
Kimhi and Seiler (2001)	Male operator/spouse	+				-		+ sig	
	Female operator/spouse		- sig				+		-
Lim-Applegate, *et al.* (2002)	Operator	+						+	-
	Spouse	-	+		+ sig			-	+ sig
Bharadwaj and Findeis (2003)	Farm Men			+ sig		- sig		+ sig	
	Farm Women				+ sig		-		+ sig
Kwon, *et al.* (2003)	Husband	+	-						
	Wife	- sig	+ sig						

Table 4 cont…		Secondary school education				Farm Education		Farm Training		University Education	
		Less than		Greater than/ some college							
		Operator Dummy	Spouse Dummy	Operator Dummy	Spouse Dummy	Operator Dummy	Spouse Dummy	Operator Dummy	Spouse Dummy	Operator Dummy	Spouse Dummy
Weersink (1992)[28]	Operator	+ sig		+ sig						+ sig	
Benjamin (1994)	Husband			+ sig	+	-	-	- sig	+		
	Wife			+	+ sig	-	-	+	- sig		
Benjamin, *et al.* (1996)[11]	Farm Men			+	+	-	-				
	Farm Women			+	+	+	-				
Weersink, *et al.* (1998)[29]	Operator	- sig								-	
	Spouse		- sig								+ sig
Benjamin and Kimhi (2003)[11]	Farm Men			+	+	-	+				
	Farm Women			-	+	+	-				
Findeis and Swaminathan (2003)[30]	Operator	- sig		- sig							
	Spouse		- sig		- sig						

[27] Vocational training
[28] Reference category – Elementary school
[29] Reference category – High school
[30] Reference category – College and beyond

On-farm experience

The number of years of on-farm experience is a human capital variable affecting only the marginal productivity of farm labour and not the market wage rate (Weersink, 1992). Years of on-farm experience are, as expected, found to have an inverse relationship with the probability of off-farm employment, that is, the higher the number of years of on-farm work experience the lower the probability of working off-farm (Table 5). On-farm experience has a similar effect to agricultural education, that is, on-farm labour productivity is improved, thereby increasing the operators/spouses reservation wage.

The empirical evidence is limited for both farm and, in particular, off-farm experience. The main reason for this is that including both experience and age variables in participation models can lead to multicollinearity problems. One of the only studies to include off-farm experience as an independent variable were Simpson and Kapitany (1983). They find that off-farm work experience has a positive effect on the likelihood of off-farm participation of 'entrant' (new to farming) farmers and a negative effect on 'established' and 'older' farmers. They claim that this result for 'older' farmers

> “reflects the declining market value of off-farm work skills and the rising value of on-farm work skills” Simpson and Kapitany, 1983, p 804

Howard and Swidinsky (1999) find similar results for a Canadian data set (1986). They find that operators who entered farming post-1976 are significantly more likely to participate in off-farm work than those who entered between 1971 and 1976.

Huffman (2001) highlights that

> "In some agricultural environments, experience rather than schooling may be a more important form of human capital, while in other environments, schooling has a major advantage over experience. In a static (political, economic, technical) environment, accumulated experience seems to be a better investment than schooling." Huffman, 2001, p 346

However, he states that when the political and economic environments are changing, and technology is continually updated, the skills obtained from formal schooling have an advantage over work experience.

Table 5: Impact of farm experience on off-farm participation

		Farm experience		
		Operator Dummy	**Operator Years**	**Spouse Years**
Sumner (1982)	Operator Est. 1	- sig[31]		
	Operator Est. 2	- sig		
Furtan, *et al.* (1985)	Husband		- sig	
	Wife		- sig	
Lass, *et al.* (1989)	Operator		-	
	Spouse			-
Findeis, *et al.* (1991)	Operator		-	
	Spouse			-
Pfaffermayr, *et al.* (1991)	Operator		- sig	
Weersink (1992)	Operator		- sig	
Benjamin (1994)	Husband		- sig	
	Wife		- sig	
Benjamin and Guyomard (1994)	Operator		- sig	
	Wife		- sig	
Benjamin, *et al.* (1996)[11]	Farm Men		-	
	Farm Women		-	
Kimhi and Seiler (2001)	Male operator/spouse		- sig[32]	
	Female operator/spouse		-	
Benjamin and Kimhi (2003)[11]	Farm Men		-	
	Farm Women		+	

Other income

Transfer[33], asset and other income are found to have a significant negative impact on the probability of off-farm participation of both the operator and spouse, which is consistent with leisure being a normal good (Huffman and El Osta, 1998). The only exception is the unexpected significant positive result found by Huffman (1980) (Table 6). He includes measures of both unrealised and realised income. Realised income, (defined as, income received from non-farm businesses and professions; social security, pensions, veterans and welfare payments; and rent from farm and non-farm property, interest and dividends) have an unexpected positive impact on the probability of operator off-farm participation. Other income increases net farm income, inflating the marginal value of farm labour, which determines the reservation wage that must be exceeded before an off-farm job is considered, thereby reducing the probability of off-farm participation.

Howard and Swidinsky (1999) include several other sources of income in their model, including spouse's income, investment income and government support income; all of which have a significant negative impact on the probability the farm operator works off-farm. In general, other income tends to produce the probability the operator works off-farm.

[31] 1 = farmer in 1965; survey conducted 1971
[32] Kimhi and Seiler, 2001 – Tenure = the amount of time the current owner has operated the farm
[33] Refer to non-agriculture transfer payments

Table 6: Impact of other income and transfer payments on off-farm participation

		Other Income	Other Income[2]	Other Income	Transfer or Asset Income
		$		% of total	$/DM
Huffman (1980)	Operator	+ sig			
Sumner (1982)	Operator Est. 1	- sig			
	Operator Est. 2	- sig			
Gould and Saupe (1989)	Operator				- sig
	Spouse				- sig
	Operator				-
	Spouse				- sig
Lass, *et al.* (1989)	Operator			- sig	
	Spouse			-	
Lass and Gempesaw (1992)	Operator			- sig	
	Spouse			-	
Weersink (1992)	Operator	+[34]			
Benjamin and Guyomard (1994)	Operator	-			
	Wife	-			
Findeis and Lass (1994)	Rural	- sig			
	Urban	- sig			
Huffman and El Osta (1998)	Operator – Est. 1	- sig	+ sig		
	Operator – Est. 2	- sig	+ sig		
Lee (1998)	Husband (region 1)				+ sig
	Wife (region 1)				- sig
	Husband (region 2)				-
	Wife (region 2)				+
Howard and Swidinsky (1999)	Operator	- sig[35]			- sig
Lim-Applegate, *et al.* (2002)	Operator	-			
	Spouse	- sig			

Children and other household members

The demographic composition of the farm household has been found to have a strong impact on the probability of off-farm participation of both the farm operator and spouse in many studies (Table 7). Generally, the impact of children on the probability of off-farm participation of the farm spouse is stronger than that on the probability of off-farm participation of the operator. The number or presence of children is found to have a significant negative impact on the probability of off-farm participation of spouses; with the presence of preschool children having the strongest impacts. With younger children requiring a high level of care, this result is expected a priori. Contrary to expectations, older children[36] are also found to have a negative impact on the probability of off-farm participation of spouses in most cases. The effect of older children is usually not determined a priori, as although caring for children should induce a negative effect; additional household expenses should induce a positive one. It would be expected that older children would reduce the reservation wage of the spouse as, in most cases, the amount of care required reduces with age, but this does not appear to be the case in most studies considered here. Weersink (1992),

[34] Dummy variable – other off-farm income (yes=1)
[35] Three separate sources of other income were included in the model all three had significant negative signs, they were – spouse's income, investment income and government support income
[36] With the exception of Weersink, *et al.* (1998)

Keeney and Matthews (2000) and Lim-Applegate, *et al.* (2002) were the only studies considered here to find that older children significantly increase the probability of off-farm participation of the spouse. It would appear that the time costs of all children are more important than are their monetary costs for the spouse.

In Lee (1998), he finds that the number of children under 14 years old in the households has a significant negative impact on the off-farm participation of the farm spouse in the bivariate probit estimation. Using the multinomial logit model he goes further and says that this effect only comes through in the regime in which only the spouse works off-farm in the case of region one (Emsland) and for both the 'spouse only' and 'both working' off-farm in the case of region two (Werra-Meissner-Kreis).

In contrast to the results for spouses, the impact of the number and presence of children on the farm operator are more ambiguous. The number and presence of younger children are found to have conflicting results across studies. A number of studies (Lass, *et al.*, 1989; Findeis, *et al.*, 1991; Kimhi, 1996; Weersink, *et al.*, 1998; Keeney and Matthews, 2000) find that young children have a significant positive effect on the probability of off-farm participation of the farm operator. This could indicate that operators react to the financial burden of young children. However, other studies (Huffman and Lange, 1989; Tokle and Huffman, 1991; Findeis and Swaminathan, 2003) find that young children have a significant negative impact on the probability of farm operator off-farm participation. This indicates that in these studies caring for young children is perhaps more compatible with farm than off-farm work (Huffman and Lange, 1989). In the case of older children, there are found to be more significant positive than negative results. The number of older children able to assume domestic and/or on-farm tasks decreases the operator's reservation wage and subsequently increases the likelihood of off-farm participation.

Table 7: Impact of children on off-farm participation

			Number of children present by age (years)							
		0-5[37]	**0-6**	**4-6**	**6-12**	**6-18**	**12-19**	**<14**	**>14**	**Total**
Huffman (1980)	Operator		-							
Sumner (1982)	Operator Est. 1									+
	Operator Est. 2									+
Furtan, *et al.* (1985)	Husband									
	Wife		- sig		-					
Gould and Saupe (1989)	Operator (1982)		+							
	Spouse (1982)		- sig							
	Operator (1986)		-							
	Spouse (1986)		- sig							
Huffman and Lange (1989)	Husband			- sig	+	+				
	Wife			- sig	- sig	-				

[37] Dummy variable equal to one if children 0-5 years present in the household

			Number of children present by age (years)							
		0-5[37]	0-6	4-6	6-12	6-18	12-19	<14	>14	Total
Lass, *et al.* (1989)	Operator		+ sig			-				
	Spouse		-			-				
Findeis, *et al.* (1991)	Operator	+ sig							+ sig	
	Spouse	- sig							+	
Tokle and Huffman (1991)	Husband			-	- sig					
	Wife			- sig	- sig					
Lass and Gempesaw (1992)	Operator		-			-				
	Spouse		- sig			- sig				
Benjamin (1994)	Husband		-		-		+			
	Wife		- sig		- sig		-			
Benjamin and Guyomard (1994)	Operator		-		-		+			
	Wife		- sig		- sig		- sig			
Findeis and Lass (1994)	Rural	-				-				
	Urban	-				-				
Kimhi (1994)	Operator							-	+ sig	
	Spouse							- sig	- sig	
Benjamin, *et al.* (1996)[11]	Farm Men		-		-		+			
	Farm Women		-		-		-			
Kimhi (1996)	Operator		+ sig	- sig			- sig			
	Spouse		- sig	- sig			- sig			
Lee (1998)	Husband (region 1)									-
	Wife (region 1)									-
	Husband (region 2)									-
	Wife (region 2)									- sig
Weersink, *et al.* (1998)	Operator				+ sig		+			
	Spouse				- sig		+ sig			
Corsi and Findeis (2000)	Operator[19]		-			+				
	Spouse[20]		+			+				
	Spouse[21]		- sig			+				
Keeney and Matthews (2000)	Operator		-		+ sig		+ sig			
	Spouse		+		+ sig		-			
Kimhi and Seiler (2001)	Male operator/ spouse							-	+	
	Female operator/ spouse							-	-	
Lim-Applegate, *et al.* (2002)	Operator		-		-		- sig			
	Spouse		- sig		- sig		+ sig			
Benjamin and Kimhi (2003)[11]	Farm Men		-							
	Farm Women		-		-		-			
Bharadwaj and Findeis (2003)	Farm Men		-		-		-			
	Farm Women		- sig							
Findeis and Swaminathan (2003)	Operator	- sig								
	Spouse	- sig								
Kwon, *et al.* (2003)	Husband									+
	Wife									-

Where included, the presence of other adults in a household has been found to have a positive impact on the probability of operator and spouse participation; though only Kimhi (1996) and Bharadwaj and Findeis (2003) find these results to be significant (Table 8).

> "It seems that additional adults are substitutes for the couple in farm work, given current farm characteristics, and therefore the operator's and spouse's tendency to work off-farm is increasing with the number of prime-age household members" Kimhi, 1996, p 437

Howard and Swidinsky (1999) take a different approach to the inclusion of family characteristics in their model. They include a series of dummy variables including the participation of a son and spouse in agriculture. They find that having a son working on the farm increases the probability of off-farm work as does having a spouse in a non-agricultural

job. Not having a spouse or having a spouse involved with agriculture has a significant negative impact on the off farm participation of the farm operator.

Family size generally has a significant positive impact on the off-farm participation of operators and spouses. According to Woldehanna, *et al.* (2000), households with a larger family size have relatively higher marginal utility of income and a stronger desire to participate in off-farm work.

Table 8: Impact of adults and other family/household members on off-farm participation

		Adult >19	**Adult 19-21 / < 30[38]/ 22-31/ 42-51 / 62-71**	**Adult 32-41**	**Adult 52-61**	**Adult 72-81**	**Family size**	**Other household members**
		Heads	**Heads**	**Heads**	**Heads**	**Heads**	**Heads**	**Dummy**
Pfaffermayr, *et al.* (1991)	Operator							+ sig
Benjamin (1994)	Husband						-	
	Wife						-	
Benjamin and Guyomard (1994)	Operator						+	
	Wife						+ sig	
Kimhi (1996)	Operator		+ sig	-	- sig	-		
	Spouse		+ sig	+ sig	- sig	+ sig		
Huffman and El Osta (1998)	Operator – Est. 1						+	
	Operator – Est. 2						+	
Lee (1998)	Husband (region 1)						+	
	Wife (region 1)						+	
	Husband (region 2)						+	
	Wife (region 2)						+	
Corsi and Findeis (2000)	Operator[19]		+					
	Spouse[20]		+					
	Spouse[21]		-					
Keeney and Matthews (2000)	Operator	+ sig						
	Spouse	+						
Woldehanna, *et al.* (2000)	Household						+ sig	
Bharadwaj and Findeis (2003)	Farm Men	+ sig						
	Farm Women	+						
Findeis and Swaminathan (2003)	Operator						-	
	Spouse						- sig	

Farm characteristics

Farm size, sales, output and capital

Larger farm scale, as measured by sales, output, net farm income, farm assets or capital stock generally has a significant negative impact on the probability of off-farm participation of the operator and spouse (Table 9).

The only inconsistent results in the studies reviewed is the significant positive impact of farm size (hectares) on the probability of participation in Woldehanna, *et al.* (2000) and Kimhi and Seiler (2001). Woldehanna, *et al.* (2000) emphasize that

[38] Corsi and Findeis (2000)

> "The net positive effect of land on the off-farm participation decision is a strange result which cannot be explained within the framework of a neo-classical economic theory" Woldehanna*, et al.*, 2000, p 170

Kimhi and Seiler (2001) are also surprised by the significant positive impact of land on the probability of off-farm participation of the operator and spouse

> "If land was important as a factor of production, we would have expected the opposite. It is clear, then, that landholdings are not important for farm production, and its significant effect is probably due to its correlation with unobserved factors." Kimhi and Seiler, 2001, p 12

In terms of farm household financial well being, increases in the financial pressures on farm households, that is, a decrease in farm household income or increases in the debt to asset ratio increases the probability of off-farm participation of the farm operator in particular (Weersink, 1992; Weersink*, et al.*, 1998; McNally, 2003).

Table 9: Impact of farm size, sales, output and capital on off-farm participation

		Farm size	**ln Farm size**	**Sales**	**Output**	**Income**	**Asset Value**	**Capital Stock**	**Debt/ asset ratio**
		Hect/Acre			**$**	**$**			
Huffman (1980)	Operator				- sig				
Simpson and Kapitany (1983)	Entrants							- sig	
	Established							- sig	
	Older							- sig	
Huffman and Lange (1989)	Husband						- sig		
	Wife						- sig		
Lass*, et al.* (1989)	Operator			- sig					
	Spouse			- sig					
Findeis*, et al.* (1991)	Operator			- sig					
	Spouse			- sig					
Pfaffermayr*, et al.* (1991)	Operator		- sig						
Lass and Gempesaw (1992)	Operator			- sig					
	Spouse			- sig					
Weersink (1992)	Operator	- sig						-	+ sig
Benjamin (1994)	Husband	- sig							
	Wife	-sig							
Benjamin and Guyomard (1994)	Operator	- sig							
	Wife	- sig							
Kimhi (1994)	Operator		- sig						
	Spouse		-						
Benjamin*, et al.* (1996)[11]	Farm Men	+[39]					-[40]		
	Farm Women	+					-		
Huffman and El Osta (1998)	Operator – Est. 1						- sig		
	Operator – Est. 2								
Weersink*, et al.* (1998)	Operator					- sig			+ sig
	Spouse					-			+
Howard and Swidinsky (1999)	Operator			- sig		- sig			
Corsi and Findeis (2000)	Operator[19]	-							
	Spouse[20]	+							
	Spouse[21]	+							

[39] Result significant in two regimes only (1) man and woman work off-farm and use hired labour (- sig) and (2) man works off-farm and woman does not work off-farm, use hired labour (+ sig)
[40] SGM – Standard Gross Margin

		Farm size Hect/Acre	ln Farm size	Sales	Output $	Income $	Asset Value	Capital Stock	Debt/ asset ratio
Keeney and Matthews (2000)	Operator	+						- sig	
	Spouse	-						+	
Woldehanna, *et al.* (2000)	Household	+ sig						-	
Kimhi and Seiler (2001)	Male operator/spouse	+ sig						- sig	
	Female operator/spouse	+ sig						- sig	
Bharadwaj and Findeis (2003)	Farm men						-		
	Farm women						-		
Findeis and Swaminathan (2003)	Operator						- sig		
	Spouse						- sig		
McNally (2003)	Operator	+ sig/- sig[41]							+ sig
Kwon, *et al.* (2003)	Husband		+						
	Wife		+						

Farm type

It seems realistic to expect that the type of farming undertaken and the labour hours required will affect the probability of off-farm participation. Dairy farming has an overwhelmingly negative impact on the probability of off-farm participation of both farm operators and spouses (Table 10). It is the most labour intensive farm type and is associated with a low level of risk and seasonality which together discourage off-farm work (Sumner, 1982). Dairy farming increases the reservation wage of both the operator and spouse. Operators and spouses on predominately livestock farms are more likely to work off-farm than those on dairy farms.

Operators and spouses involved in mixed farming, crops, and vegetables are significantly more likely to participate in off-farm work than operators and spouses involved with other farm types, particularly dairying and livestock. Furtan, *et al.* (1985) and Pfaffermayr, *et al.* (1991) do not distinguish between dairy and livestock farms, both are included under livestock, this explains their significant negative result for operators with livestock.

Table 10: Impact of farm type on off-farm participation

		Dairy Dummy	Livestock Dummy	Pigs %	Mixed Dummy	Crops Dummy	Vegetables Dummy	Fruit Dummy
Sumner (1982)[42]	Operator Est. 2	- sig		- sig		- sig		
Furtan, *et al.* (1985)	Husband		- sig					
	Wife		- sig					
Gould and Saupe (1989)	Operator ('82)	- sig				-		
	Spouse ('82)	- sig				-		
	Operator ('86)	- sig						
	Spouse ('86)	- sig				+ sig		
Lass, *et al.* (1989)	Operator	-				+	+	-
	Spouse	-				-	+	+
Findeis, *et al.* (1991)	Operator	- sig	+ sig					
	Spouse	- sig	-					
Pfaffermayr, *et al.* (1991)	Operator		- sig					
	Operator	- sig				-	-	-

[41] + sig = small farm (< 40 Economic Size Units (ESU)), - sig = medium farm (40 - < 100 ESU) dummies compared to large farms (>= 100 ESU)
[42] Implies % of total livestock/ % of total acres

		Dairy Dummy	Livestock Dummy	Pigs %	Mixed Dummy	Crops Dummy	Vegetables Dummy	Fruit Dummy
Lass and Gempesaw (1992)	Operator	- sig				-	-	-
Lass and Gempesaw (1992)	Spouse	-	+	- sig	+ sig	+ sig	+ sig	+
Benjamin and Guyomard (1994)	Wife		-	-	+	+ sig	+ sig	+
Findeis and Lass (1994)	Rural	- sig	+ sig				-	
	Urban	- sig	+ sig				-	
Kimhi (1994)	Operator	- sig						
	Spouse	- sig						
Benjamin, *et al.* (1996)[11]	Farm Men	-	-	-		+	+	
	Farm Women	-	-	-		+	+	
Kimhi (1996)[43]	Operator	+ sig						
	Spouse	+ sig						
Weersink, *et al.* (1998)	Operator	-[44]						
	Spouse	-						
Howard and Swidinsky (1999)	Operator	- sig	- sig	- sig				
Corsi and Findeis (2000)	Operator[19]	- sig						
	Spouse[20]	+						
	Spouse[21]	-						
Keeney and Matthews (2000)	Operator	- sig						
	Spouse	-						
Kimhi and Seiler (2001)	Male		-			- sig		
	Female		-			- sig		
Benjamin and Kimhi (2003)[11]	Farm Men	-		-	-			-
	Farm Women	-		-	-			-
McNally (2003)	Operator	- sig		-		+		
Kwon, *et al.* (2003)	Husband		- sig					
	Wife		+					

Sole proprietorships, corporations and partnerships

A binary variable is included in some models to indicate if the farm business is incorporated (Simpson and Kapitany, 1983; Lass, *et al.*, 1989; Weersink, 1992, Benjamin and Guyomard, 1994; Findeis and Lass, 1994). A partnership or corporation may increase farm productivity through labour specialisation or it might indicate that the farm is a secondary career alternative. In general, the results indicate that operators and spouses have a higher probability of working off-farm when the farm is incorporated (Table 11).

Howard and Swidinsky (1999) find that operators of farms organised as sole proprietorships or corporation are less likely to participate in off-farm work than operators of farms organised as partnerships.

Table 11: Impact of farm business legal organisation on off-farm participation

		Sole Proprietorship Dummy	Partnership Dummy	Corporation Dummy
Simpson and Kapitany (1983)	Entrants			-
	Established			+
	Older			+
Lass, *et al.* (1989)	Operator			+ sig
	Spouse			+ sig
Weersink (1992)	Operator			+
Benjamin (1994)	Husband		+	
	Wife		+ sig	

[43] The focus in this paper is on the impact of demographic composition of farm households on off-farm labour force participation, the author provides no explanation as to why the dairy coefficients are inconsistent in sign with those of other authors

[44] Number of milk cows

		Sole Proprietorship Dummy	Partnership Dummy	Corporation Dummy
Benjamin and Guyomard (1994)	Operator			+
	Wife			+ sig
Findeis and Lass (1994)	Rural			- sig
	Urban			-
Benjamin, *et al.* (1996)[11]	Farm Men		+	
	Farm Women		+	
Howard and Swidinsky (1999)	Operator	-		- sig
Benjamin and Kimhi (2003)[11]	Farm Men		-	
	Farm Women		-	

Subsidies and farm related transfer payments

Benjamin (1994) examines the impact of farm subsidies on the probability of off-farm participation of the farm husband and wife. She finds that an increase of 10 percent in subsidies significantly decreases the husbands' probability of off-farm participation by 0.5 percent; the impact on the spouse is negative but not significantly different from zero (Table 12). Keeney and Matthews (2000) find that the probability of participation is dependent on the type of direct payment received. In general, direct payments are found to be a significant deterrent for farm family members to work off-farm, and behave in the same way as the 'other income' sources discussed earlier. The higher the 'Premia' payments received the less likely the operator and spouse are to work off-farm, indicating that direct payments increase farm income, which in turn inflates the marginal value of farm labour which reduces the reservation wage for both the operator and spouse. McNally (2003) finds that the probability of an operator working off-farm significantly declines as headage (livestock payments) increase; Keeney and Matthews (2000) find a similar result for operators, though it is not significantly different from zero.

Table 12: Impact of farm income support on off-farm participation

		Subsidies	Receipts of:			Dependence on:		
		$/Fr	Premia	Headage	Arable	Premia	Headage	Arable
Benjamin (1994)	Husband	- sig						
	Wife	-						
Benjamin, *et al.* (1996)[11]	Farm Men	+[45]						
	Farm Women	+						
Keeney and Matthews (2000)	Operator		- sig	-	+	+	+	-
	Spouse		- sig	+	+ sig	+ sig	- sig	-
McNally (2003)	Operator			- sig	+			

[45] Result only significant for one of the labour regimes – where the man and woman do not work off-farm and the farm uses hired labour

On-farm diversification, tourism and forestry

Benjamin, *et al.* (1996) and Benjamin and Kimhi (2003) both include a dummy variable to account for diversified activity on the farm (Table 13). Both studies conclude that on-farm diversification activities reduce the probability of off-farm participation of both the farm operator and spouse. On-farm diversification can, in many cases, be seen as an alternative to off-farm work as a means of increasing/stabilising income.

Agri-tourism is a specific type of diversified farm activity. Although it has been found that being involved in a diversified activity reduces the probability of off-farm participation, agri-tourism is found to increase the probability of off-farm participation for operators and spouses (Benjamin and Guyomard, 1994). This result can be explained by the fact that agri-tourism enterprises are, in most instances, seasonal and part-time endeavours and their existence reveals the need for an alternative source of income in the household (Benjamin, *et al.*, 1996).

Lass, *et al.* (1989) find that farm operators involved in forestry activities had a higher probability of working off-farm than farmers engaged in livestock production. This can be explained by the lower labour demands associated with forestry compared to livestock production.

Table 13: Impact of on-farm diversification on off-farm participation

		Diversification Dummy	**Agri - Tourism Dummy**	**Forestry Dummy**
Lass, *et al.* (1989)	Operator			+ sig
	Spouse			-
Lass and Gempesaw (1992)	Operator			-
	Spouse			-
Benjamin (1994)	Husband	-	+ sig	
	Wife	- sig	+ sig	
Benjamin and Guyomard (1994)	Operator		+ sig	
	Spouse		+ sig	
Benjamin, *et al.* (1996)[11]	Farm Men	-[46]	-	
	Farm Women	-	+	
Benjamin and Kimhi (2003)[11]	Farm Men	-		
	Farm Women	-		

Satisfaction with farming

Weersink, *et al.* (1998) find that a higher level of dissatisfaction with farm life of the spouse significantly increases the probability of spousal participation in off-farm work. Though displeasure with farm living is an impetus for off-farm employment by the spouse, it has the opposite, but insignificant, impact on the probability of off-farm work by the operator.

[46] Result is positive in all regimes and significant in three of the seven cases

Location characteristics

The effects of location have been examined using a wide variety of measures including local labour market conditions, population density, the proportion of employment in various economic sectors, local job opportunities and the distance to town and city.

Local labour market conditions

The impact of the unemployment rate on the probability of off-farm participation is varied across studies (Table 14). A high unemployment rate is found to have a negative impact on the probability of participation of the operator and spouse by Benjamin and Guyomard (1994) and Howard and Swidinsky (1999). Though generally, the unemployment rate is not found to have a significant impact on the probability of off-farm participation of the operator or spouse (Gould and Saupe, 1989; Lass*, et al.*, 1989; Keeney and Matthews, 2000; Bharadwaj and Findeis, 2003; Findeis and Swaminathan, 2003). Two studies find a significant positive relationship between the unemployment rate and the probability of off-farm participation of farm operators, Findeis and Lass (1994) and Huffman and El Osta, (1998),

> "In rural areas a higher unemployment rate is (weakly) associated with a greater likelihood of off-farm work. This result observed in other studies (Lass*, et al.*, 1989), likely reflects a relationship between local economic conditions and the success of local farms" Findeis and Lass, 1994, p 11

Predictably, employment density has a significant positive impact on off-farm participation (Findeis and Lass, 1994), as do job opportunities locally (Keeney and Matthews, 2000) and the non-farm job growth rate (Findeis and Swaminathan, 2003). However, Keeney and Matthews (2000) find that the more 'job competition' there is locally the less likely it is that the spouse will participate in the off-farm labour market.

Findeis*, et al.* (1991) include the percentage change in employment in manufacturing and services amongst the explanatory variables. They find that changes in the manufacturing and services sectors are positively correlated with the probability of off-farm work participation of farm operators and spouses. It was found that growth in manufacturing was associated with greater off-farm participation among farmers in the off-farm labour market; where manufacturing employment declined over the 1980-86 period, the probability of off-farm work amongst operators decreased. They find that changes in service sector employment had a greater influence on the probability of operator off-farm participation than changes in manufacturing.

In Findeis and Lass (1994), local labour market structure has no impact on urban off-farm work participation. In rural areas, the proportion of manufacturing employment is inversely related to off-farm work participation, which they suggest indicates that the nature of rural manufacturing is not consistent with farm work. The only other authors to include labour market structure variables, Corsi and Findeis (2000), find that for spouses, job availability rather than the type of job influences the probability of participation. For operators, choices with respect to alternative job opportunities are not found, in most cases, to significantly influence the operator's decision.

Population density is found to have conflicting results in the studies examined. Generally the hypothesis is that population density has a positive impact on the probability of off-farm employment (Weersink, 1992). However conflicting results are found by Benjamin (1994) (farm wives only) and Howard and Swidinsky (1999). In fact, Benjamin (1994) states that

> "The effect of population density is somewhat puzzling. An increase in population density has a negative impact on the wife's participation in off-farm labour. In fact, we expected a positive effect since a high population could induce better off-farm employment opportunities." Benjamin, 1994, p 336

Table 14: Impact of local labour market conditions on off-farm participation

		Unemployment	Employment density in county of residence	Proportion of employment in:				
				Manu-facturing	Wholesale and retail	Trade	Low wage services	High wage services
		%	%	%	%	%	%	%
Gould and Saupe (1989)	Operator (1982)	-						
	Spouse (1982)	+						
	Operator (1986)	+						
	Spouse (1986)	+						
Lass, *et al.* (1989)	Operator	+						
	Spouse	-						
Findeis, *et al.* (1991)	Operator		+ sig	+ sig[47]			+ sig	
	Spouse		+ sig	+			+ sig	
Findeis and Lass (1994)	Rural	+ sig		- sig	- sig		+	+
	Urban	+		+	+		+	-
Benjamin, *et al.* (1996)[11]	Farm Men	+						
	Farm Women	+						
Huffman and El Osta (1998)	Operator – Est. 1	+						
	Operator – Est. 2	+ sig						
Corsi and Findeis (2000)	Operator[19]			+		- sig	-	+ sig
	Spouse[20]			+ sig		+	-	+
	Spouse[21]			+ sig		+ sig	+ sig	-

		Unemploy ment	Unemployment growth rate	Population density	Non-farm job growth rate 95-00	Non-agricultural jobs per mile^2	Job oppor tunities
		%	%	Per (area)^2	%		
Weersink (1992)	Operator	+		+ sig			
Benjamin (1994)	Husband			-			
	Wife			- sig			
Benjamin and Guyomard (1994)	Operator	- sig		+			
	Wife	- sig		+			

[47] Percentage change in manufacturing/service industries in county of residence 1980-1986

		Unemployment	Unemployment growth rate	Population density	Non-farm job growth rate 95-00	Non-agricultural jobs per mile^2	Job opportunities
		%	%	Per (area)^2	%		
Howard and Swidinsky (1999)	Operator	- sig[48]		- sig			
Keeney and Matthews (2000)	Operator	-				-	-
	Spouse	-				- sig	+ sig
Bharadwaj and Findeis (2003)	Farm Men		+				
	Farm Women		-				
Findeis and Swaminathan (2003)	Operator	+			+ sig		
	Spouse	-			+ sig		

Distance to town and city

In general, the distance variable coefficients are of the expected sign (Table 15). Huffman and Lange (1989), Lass, *et al.* (1989), Findeis, *et al.* (1991) and Lass and Gempesaw (1992) all find that the greater the distance from the town or city the less likely is participation in off-farm work. Gould and Saupe (1989) use a dummy variable to indicate if the farm household is in an urban area. They hypothesise that because of lower transportation costs and greater urban employment opportunities the outcome will be a positive coefficient; in all estimations, the results are positive but not significantly different from zero.

Instead of using distance variables, some authors choose to include regional dummy variables as indicators of location characteristics (Huffman, 1980; Furtan, *et al.*, 1985; Tokle and Huffman, 1991; Huffman and El Osta, 1998; Weersink, *et al.*, 1998, Lim-Applegate, *et al.*, 2002; Bharadwaj and Findeis, 2003; Findeis and Swaminathan, 2003). Authors have included anything from one to seven dummy variables in their estimations. For the most part, results for these dummies are not found to be significantly different from zero. Notable exceptions were in Weersink, *et al.* (1998) and Findeis and Swaminathan (2003). In Weersink, *et al.* (1998), farm operators in New York are found to be significantly less likely to work off-farm than their counterparts in Ontario[49]. Conversely, spouses in New York have a significantly higher probability of working off-farm than spouses in Ontario. The authors emphasise that differences in social policy in the two countries have not been captured by the other explanatory variables in the model and as a result, the dummy variables for the country in which the farm is located may be accounting for such differences. Howard and Swidinsky (1999) include four dummy variables representing regions of Canada in their estimations, they find that compared with Ontario (the omitted region), operators in all other regions with the exception of Quebec have a significantly higher probability of working off-farm. Findeis and Swaminathan (2003) find that relative to women in the South and the Fruitful Rim of the

[48] Male unemployment rate

[49] In Weersink, *et al.* (1998) the coefficient for location for the operator is reported as negative and significant in the table of results but in the text is reported as insignificant; the results from the table of results are considered here.

United States, which are heavily dependent on fruit and vegetable farming, farmwomen in the Prairie Gateway, the Heartland, the Northern Great Plains and the Basin and Range regions are more likely to be working off-farm. They point out that this is a surprising result as these farms are located away from off-farm job opportunities along the coast. For men, they find that those in the Midwest and West are more likely to work on-farm and less likely to work off-farm than those in the Fruitful Rim and the South.

Lass*, et al.* (1991) highlight

> "Location variables have generally performed poorly. It is likely that binary location variables measure regional differences in farming as well as location relative to employment opportunities" Lass*, et al.*, 1991, p 246

Table 15: Impact of distance to town/city on off-farm participation

		Distance		Urban
		Town (m/km)	**City (m/km)**	**Dummy**
Sumner (1982)	Operator Est. 1	- sig	+ sig	
	Operator Est. 2	- sig	+	
Gould and Saupe (1989)	Operator (1982)			+
	Spouse (1982)			+
	Operator (1986)			+
	Spouse (1986)			+
Huffman and Lange (1989)	Husband		- sig	
	Wife		- sig	
Lass*, et al.* (1989)	Operator	-		
	Spouse	-		
Findeis*, et al.* (1991)	Operator	+		
	Spouse	-		
Lass and Gempesaw (1992)	Operator	-		
	Spouse	-		
Huffman and El Osta (1998)	Operator – Est. 1		+	
	Operator – Est. 2		-	

In conclusion, the results of the participation models discussed above which examine the factors that affect the probability of off-farm participation are as expected.

Off-farm labour supply

What follows is a review of the literature relating to the quantity of off-farm labour supplied by farm operators and their spouses. Instead of the dichotomous participation decision under consideration in the previous section, that is, the operator/spouse works off-farm or not, this section deals with the number of hours or days of off-farm labour supplied. The dependent variable in these models is some measure of the time worked off-farm by the operator and/or spouse (Table 16). This is usually the number of hours worked off-farm annually.

Changes in the farm production function, off-farm wage rate or the utility function affect the number of off-farm labour hours supplied by the operator or spouse (Lass*, et al.*, 1991). In general, the number of off-farm labour hours supplied depends on the wage, home characteristics, farm characteristics and location characteristics. The problem of sample selection or incidental truncation arises as the number of hours of labour supplied is only observed if the individual is actually working off-farm; for these people it may therefore be inferred that the market wage exceeds the reservation wage. Thus, the hours variable is incidentally truncated (Greene, 2003). This causes the sample to be non-random. To avoid sample selection bias, the estimation must take the sample selection phenomenon into account.

Sample selection bias

If those included in the estimation process differ from those who are excluded then the results will reflect the characteristics and behaviour of the former group but not of the latter. Obviously, there will be no sample selection bias if the included (that is, workers) are not systematically different from the excluded (that is, non-off-farm workers).

Because the problem arises from the 'truncation' of the distribution of a particular characteristic, economists have habitually referred to this situation as a 'truncated' regression instead of the more accurate term 'censored'. In the present context, truncation would occur if there are observations only for individuals working off-farm. However, what we are presented with is censorship, that is, there is information about the characteristics of non-off-farm working individuals (such as age, education, location, family size etc.) – though not, of course with respect to their market wages. Techniques have been developed to correct for this problem. The correction consists, in effect, of predicting the missing information on the censored variable (wages) from whatever information is available in the rest of the data set.

Several approaches can be employed in situations where there are limited observations on the dependent variable. In the cases below, Tobit models or models based on Heckman's two-stage approach are most commonly employed; sample selection bias is generally not found to be a problem in these estimations.

As with Table 1, Table 16 summarises the econometric specifications, dependent variables, sample size and country of origin of the studies under consideration.

Table 16: Off-farm labour supply literature summary

Author (Publication Year)	Econometric Specification	Dependent Variable		Data			TM[4]	Wages[50]
				Country	Year	Sample Size		
Polzin and MacDonald (1971)	OLS	Annual off-farm days	Households	USA (Montana / Nth. Carolina/ Mississippi / Kansas)	1964	n = 56/100/82/105[51]	*	✓
Huffman (1980)	Weighted least squares	ln annual off-farm days	Operator	USA (Iowa / Nth. Carolina / Oklahoma)	1964	n = 276	*	✓
Sumner (1982)	Two-stage least squares	ln annual off-farm hours	Operator – Est. 1[8]	USA (Illinois)	1971	n = 329	*	✶
			Operator – Est. 2					
Furtan, *et al.* (1985)	Tobit model	Annual off-farm hours	Husband	Canada (Saskatchewan)	1980	n = 250	*	✶
			Wife					
Jensen and Salant (1985)	OLS	Annual off-farm hours	Operator	USA (Mississippi and Tennessee)	1981	n = 301	*	✶
Streeter and Saupe (1986)	OLS	Annual off-farm hours	Operator – Est. 1[52]	USA (Mississippi)	1981	n = 247	*	✶
			Operator – Est. 2					
Huffman and Lange (1989)	Two-stage ridge regression estimates	Annual off-farm hours	Husband	USA (Iowa)	1977	n = 771	*	✶
			Wife					
Lass, *et al.* (1989)	Two-stage least squares	Annual off-farm hours	Husband	USA (Massachusetts)	1986	n = 41	*	✓
			Wife			n = 31		
Pfaffermayr, *et al.* (1991)	Tobit model	Weekly off-farm hours	Operator	Austria	1989	n = 1,842	*	✶
Lass and Gempesaw (1992)	Random Coefficients Model	Annual off-farm hours	Operator – Both worked off-farm	USA (Pennsylvania)	1986	n = ---[53]	*	✓
			Operator – Operator only			n = ---		
			Spouse – Both worked off-farm			n = ---		
			Spouse – Spouse only			n = ---		
Findeis and Lass (1994)	Two-stage least squares	Annual off-farm days	Operator – Urban (hired labour)	USA (Pennsylvania)	1986	n = 38	*	✶
			Operator – Urban (no hired labour)			n = 92		
			Operator – Rural (hired labour)			n = 26		
			Operator – Rural (no hired labour)			n = 73		
Mishra and Goodwin (1997)	Tobit model	Annual off-farm hours	Operator	USA (Kansas)	1992	n = 599	*	✖
			Spouse					
Huffman and El Osta (1998)	OLS	Annual off-farm hours	Operator – Est. 1[12]	USA	1991	n = 551	*	✓
			Operator – Est. 2[13]					
Weersink, *et al.* (1998)	Two-stage least squares	Annual off-farm hours	Spouse	New York/Ontario	1991	n = 112	*	✶
Howard and Swidinsky (1999)	Truncated regression	Annual off-farm hours	Operator	Canada	1986	n = 23,251	*	✶
Keeney and Matthews (2000)	Two-stage least squares	ln annual off-farm hours	Operator	Ireland	1994	n = 122	*	✶
			Spouse					

[50] ✓ = include actual wages, ✖ = reduced form hours model, ✶ = include estimated wages
[51] A total of 343 counties in four states with four separate regressions, because the significance and direction of the results are the same for the four states the results are presented together.
[52] Estimation 1 includes the 'predicted total farm revenue and excludes the 'market value of assets' and the 'percent of revenue from beef production'. Estimation 2 excludes the 'predicted total farm revenue and includes the 'market value of assets' and the 'percent of revenue from beef production'
[53] Total sample size = 610, sample size for each of the four scenarios not available

Author (Publication Year)	Econometric Specification	Dependent Variable		Data			TM[4]	Wages[50]
				Country	Year	Sample Size		
McNally (2003)	OLS	ln annual off-farm hours	Operator	England & Wales	1988-1997	n = 446[54]	*	✖
El Osta, *et al.* (2004)	Tobit model	Off-farm hours	Operator – Est. 1[55]	USA	2001	n = 731	*	✓
			Operator – Est. 2[56]					
Goodwin and Mishra (2004)	Tobit model[57]	Annual off-farm hours	Operator	USA	2001	n = 2,000	*	✖
Kimhi and Rapaport (2004)	Ordered Probit	Level off-farm labour supply (1-5)[58]	Adult members	Israel	1995	n = 3,000	*	✖

[54] 446 farms – 1,387 observations over ten years
[55] Where govt. payments are entered as total predicted govt. payments
[56] Where govt. payments are entered as three separate programs
[57] This model simultaneously estimates efficiency and hours
[58] < 1/4 of a full-time job, 1/4 to 1/2 of a full-time job, 1/2 to 3/4 of a full-time job, full-time or not at all

Household characteristics

The following outlines the household characteristics that have been found to affect the quantity of off-farm labour supplied.

Age and gender

Operator age is generally included in labour supply models as age and age-squared, in an attempt to capture any quadratic life-cycle effect associated with both off-farm labour force participation and off-farm labour supply hours. The quadratic life-cycle effect, as noted earlier, demonstrates that, in this case, the amount of off-farm labour supplied by farm operators increases with age up to a point, after which it begins to decrease. This result has been found by Huffman (1980), Sumner (1982), Streeter and Saupe (1986), Huffman and Lange (1989), Howard and Swidinsky (1999) and El Osta*, et al.* (2004); with the exception of Streeter and Saupe (1986) – estimation one – and Huffman and Lange (1989) all results are significant (Table 17). For those models that include operator age only, that is they exclude age-squared, it is found that the amount of off-farm labour supplied decreases significantly as age increases (Lass*, et al.*, 1989; Lass and Gempesaw, 1992). Operator hours are typically found to be maximised when they are in their forties and early fifties, both Huffman (1980) and Kimhi and Rapaport (2004)[59] find work effort to be maximised at 53 years. In Sumner (1982), operator work effort was at a maximum at 47 and 50 years, and in Streeter and Saupe (1986) they find it to be maximised at 43 and 41 years; with the maximum value in each study dependent on the particular estimation under consideration. Finally, El Osta*, et al.* (2004) find a maximum at 43 years in each estimation.

When spouse age[60] is included in the models, it is found to have a negative and significant impact on spouse hours of labour supplied (Furtan*, et al.*, 1985; Lass*, et al.*, 1989; Lass and Gempesaw, 1992 – when both work) and a significant positive impact on operator hours of labour supplied (Huffman and Lange, 1989; Lass and Gempesaw, 1992). This implies that, as with operator, the quantity of off-farm labour supplied by the spouse decreases with age. However, cross-age effects are not generally found to be statistically different from zero, that is, operator age does not have a significant impact on the amount of off-farm labour supplied

[59] In Kimhi and Rapaport (2004), the dependent variable is off-farm hours supplied by adult household members
[60] Spouse age-squared is not included as a dependent variable in any of the models under consideration here

by the spouse and vice versa. The results for age are consistent with those found in the off-farm labour force participation models discussed above.

Gender is not a characteristic that is usually included in labour supply models; in the majority of cases, due to the nature of the data, all operators are male. In some cases, however, it is appropriate to include a gender dummy. Lass, *et al.* (1989) find that male operators worked nearly 800 more hours annually off-farm than female operators. Male spouses are found to work fewer off-farm hours but this result was not significant. In addition, in Kimhi and Rapaport (2004), where the dependent variable is the quantity of off-farm work provided by all adult household members, they find that females supply significantly less off-farm labour than males.

Table 17: Impact of age and gender on off-farm hours supplied

		Operator			Spouse		
		Age Years	**Age^2**	**Peak**	**Gender Dummy**	**Age Years**	**Gender Dummy**
Huffman (1980)	Operator	+ sig	- sig	53			
Sumner (1982)	Operator – Est. 1	+	-	50			
	Operator – Est. 2	+ sig	- sig	47			
Furtan, *et al.* (1985)	Spouse					- sig	
Jensen and Salant (1985)	Operator		-	NA[61]			
Streeter and Saupe (1986)	Operator – Est. 1	+ sig	- sig	43			
	Operator – Est. 2	+ sig	- sig	41			
Huffman and Lange (1989)	Husband (both)	+	+	NA		+	
	Husband only	+	- sig	NA		+	
	Spouse (both)	+	+	NA		-	
	Spouse only	+	-	NA		-	
Lass, *et al.* (1989)	Operator	- sig		NA	+ sig [62]		
	Spouse					- sig	-
Lass and Gempesaw (1992)	Husband (both)	+		NA		- sig	
	Husband only	- sig		NA			
	Spouse (both)	+		NA		- sig	
	Spouse only					+ sig	
Findeis and Lass (1994)	Urban (hired)	+		NA			
	Urban (no hired)	+ sig		NA			
	Rural (hired)	+		NA			
	Rural (no hired)	+		NA			
Howard and Swidinsky (1999)	Operator	+ sig	- sig	46			
McNally (2003)	Operator	-		NA			
El Osta, *et al.* (2004)	Operator – Est. 1	+ sig	- sig	43			
	Operator – Est. 2	+ sig	- sig	43			
Goodwin and Mishra (2004)	Operator	- sig		NA			
Kimhi and Rapaport (2004)[63]	Adult members	+ sig	- sig	53	- sig[64]		

Farm raised, health and marital status

In Huffman and Lange (1989), where both spouses work off-farm, husbands who were raised on a farm work 178 hours less off-farm annually than those raised elsewhere (Table 18).

[61] NA = not available
[62] Lass, *et al.* (1989) – Male = 1
[63] Variables in Kimhi and Rapaport (2004) refer to adult household members not to the farm operator specifically
[64] Kimhi and Rapaport (2004) – Female = 1

Huffman and El Osta (1998) also find that operators raised on a farm worked fewer off-farm hours but their results are not found to be significantly different from zero.

Similar to gender, marital status is seldom included as a dependent variable in labour supply models, as in many cases only married couples are selected from the dataset for analysis. Where included, it was found to have a positive impact on the off-farm hours supplied by farm operators. That is, married operators contribute a higher number of off-farm hours than non-married operators (Jensen and Salant, 1985; Pfaffermayr, *et al.*, 1991).

Two studies, Sumner (1982) and Huffman and El Osta (1998), include operator health as an explanatory variable. A similar result is found by both, namely that being in good health leads to a higher number of hours contributed to off-farm work and having chronic health problems leads to fewer hours contributed off-farm; although the results are of the expected sign, neither are found to be significant.

Table 18: Impact of being farm raised, health and marital status on off-farm hours supplied

		Farm raised Operator Dummy	**Marital Status Operator Dummy**	**Health[65] Operator Dummy**
Sumner (1982)	Operator – Est. 1			+
	Operator – Est. 2			+
Jensen and Salant (1985)	Operator		+	
Huffman and Lange (1989)	Husband (both)	- sig		
	Husband only	+		
	Spouse (both)	+		
	Spouse only	+		
Pfaffermayr, *et al.* (1991)	Operator		+ sig	
Huffman and El Osta (1998)	Operator – Est. 1	-		-
	Operator – Est. 2	-		-

Education and training

An individuals education is an important determinant of their off-farm labour supply, particularly in more economically developed countries. As Lass, *et al.* (1991) and Laszlo (2004) outline, education has two separate effects on the number of off-farm hours worked; a direct effect and an indirect effect. Firstly, education effects hours worked through its effect on the wage rate, that is, a higher level of education leads to a higher wage rate and thus changes in hours. Secondly, it is also possible that education has an effect on operator and spouse supply of off-farm hours, independently of its effect on the wage, that is, an indirect effect. There are several reasons why this indirect effect of education might be present. It may be the case that more educated operators and spouses work more hours because of the

[65] In Sumner (1982) the health variable is a dummy variable where 1 ⇒ good health. In Huffman and El Osta, (1998) health is a dummy variable where 1 ⇒ chronic health problems

occupations in which they are engaged, that is, as they have access to more high-paying jobs. In addition, to keep these jobs, operators and spouses may provide extra time and effort to ensure tenure or permanence in the occupation. Moreover, these jobs might instead be less physically intensive or spread out over more hours. Thus, increased education may provide operators and spouses with job opportunities characterised by different hours requirements. Alternatively, education can improve operator or spouse allocation of labour to various activities. Finally, education may affect attitudes towards work and thus desired hours. As Laszlo (2004) highlights, the earnings return to education may be decomposed into three effects, the wage elasticity of labour supply, the wage return to education and the direct effect of education on hours of labour supplied. The following section will only examine the direct effect of education and training on off-farm labour supply of operators and spouses, as in many cases the information to calculate the total effects is not available.

The majority of the results indicated a positive and inelastic to slightly elastic effect of education on the supply of off-farm labour of the operator and spouse (Lass*, et al.*, 1991) – Table 19. Own-education effects for the operator are generally positive, indicating that an operator with a higher level of general education supplies a greater number of hours or days of off-farm labour (Huffman, 1980; Huffman and Lange, 1989; Lass*, et al.*, 1989; Lass and Gempesaw, 1992; Findeis and Lass, 1994 – urban, Mishra and Goodwin, 1997; Howard and Swidinsky, 1999; Goodwin and Mishra, 2004; Kimhi and Rapaport, 2004). Goodwin and Mishra (2004) report that each additional year of general education raises the operator's annual supply of off-farm labour by 15 hours.

Own-education effects of spouse education, that is the impact of spouse education on spouse off-farm labour supply, only feature in four of the studies under consideration here. Huffman and Lange (1989) and Lass and Gempesaw (1992) find spouse own-education effects to have a significant negative impact on off-farm hours worked when the spouse only works off-farm, and a positive impact when both work off-farm. In Lass and Gempesaw (1992), one year of additional spouse education resulted in a reduction of over 400 hours in spouse off-farm labour supply when the operator did not work; the authors offer no explanation as to why this result is so strong. The results of spouse education effects found in the remaining two studies in which they were included, Lass*, et al.* (1989) and Mishra and Goodwin (1997), were not significantly different from zero.

Cross-education effects of spouse education on operator labour supply are generally positive and significant (Table 19), that is, an increase in spouse education implies an increase in the

off-farm hours provided by the operator. There are a number of exceptions namely Sumner (1982), Jensen and Salant (1985) and Huffman and Lange (1989) – when only the husband works; although only Sumner (1982) finds a significant negative result; with each additional year of spouse education reducing the operators hours worked off-farm by 10 percent.

> "The coefficient on the farm wife's education is large and negative. This coefficient reflects an income effect (wives with more education contribute more to family income). The wife's education is complementary with the farmer's time at either farming or non-work activities" Sumner, 1982, p 508

Agriculture specific education is included in only a few studies simply due to lack of data. Where included, operator agricultural education has a negative impact on the level of off-farm labour supplied (Sumner, 1982; Pfaffermayr*, et al.*, 1991; Mishra and Goodwin, 1997; Kimhi and Rapaport, 2004). Mishra and Goodwin (1997) also include the impact of operator agricultural education on the spouse, and they find it has a significant positive impact on off-farm labour supplied by the spouse. Farm specific education raises the marginal productivity of farm work. Mishra and Goodwin (1997) find that when an operator has participated in farm-specific educational activities they work 88 hours less off-farm annually. The authors highlight that this effect is quite large and is perhaps due to correlation with omitted variables relevant to off-farm employment

> "Seminar attendance may reflect the intensity of a farmer's involvement and interest in agricultural issues, a characteristic likely to be correlated with less work off the farm." Mishra and Goodwin, 1997, p 886

They also find that farmer seminar participation has a significant positive impact on spouse's off-farm hours. If the farmer has completed farm-related seminars, the spouse works 144 more hours off-farm annually.

Lass*, et al.* (1989) consider the impact of on-the-job training, they find that operators work 450 fewer hours annually when they have received training. This may be due training enhancing productivity. Spouses also worked fewer hours, though this result is not significantly different from zero.

Table 19: Impact of general education, agricultural education and vocational training on off-farm hours supplied

		General Education		Agri. Ed./ Training		Non-farm training (vocational)	
		Operator Years	Spouse Years	Operator Dummy	Spouse Dummy	Operator Dummy	Spouse Dummy
Huffman (1980)	Operator	+ sig	+				
Sumner (1982)	Operator – Est. 1	+	- sig	-			
	Operator – Est. 2	+	- sig	-			
Jensen and Salant (1985)	Operator	- sig	-				
Huffman and Lange (1989)	Husband (both)	+ sig	+ sig				
	Husband only	+	-				
	Spouse (both)	+ sig	+ sig				
	Spouse only	+	- sig				
Lass, *et al.* (1989)	Operator	+				- sig	
	Spouse		-				-
Pfaffermayr, *et al.* (1991)	Operator			- sig			
Lass and Gempesaw (1992)	Operator (both)	- sig	+ sig				
	Operator only	+ sig					
	Spouse (both)	-	+				
	Spouse only		- sig				
Findeis and Lass (1994)	Urban (hired)	+	+ sig				
	Urban (no hired)	+	+ sig				
	Rural (hired)	-	+ sig				
	Rural (no hired)	-	+				
Mishra and Goodwin (1997)	Operator	+		- sig	+ sig		
	Spouse		+				
Huffman and El Osta (1998)	Operator – Est. 1		+				
	Operator – Est. 2		+				
Howard and Swidinsky (1999)	Operator	+ sig					
El Osta, *et al.* (2004)	Operator – Est. 1	-					
	Operator – Est. 2	-					
Goodwin and Mishra (2004)	Operator	+ sig					
Kimhi and Rapaport (2004)	Adult members	+ sig[66]		- sig			

Farm and off-farm experience

As expected, farm experience has a significant negative impact on the quantity of off-farm labour supplied by the operator[67] (Sumner, 1982; Furtan, *et al.*, 1985; Pfaffermayr, *et al.*, 1991; Mishra and Goodwin, 1997) (Table 20). Farm experience, like farm training, increases the value of farm time and therefore reduces the amount of time devoted to off-farm work. An additional year of farm experience was found by Mishra and Goodwin (1997) to reduce the off-farm supply of operators by five hours and by 16 hours for the spouse annually. Farm experience affects hours of labour supplied indirectly through the farm production function and directly through the labour-supply function. Howard and Swidinsky (1999) find that the more experience an operator has, as indicated by when they first entered farming, the less the quantity of off-farm labour supplied.

Off-farm work experience provided, in many cases, stronger results than general education. Off-farm work experience has a significantly positive impact on own off-farm labour supply of both the operator and the spouse (Lass, *et al.*, 1989; Lass and Gempesaw, 1992; Mishra

[66] Dummies for high school and higher education i.e. those operators with high school or higher education are more likely to work off-farm than those with less than high school education

[67] Results for the spouse are not significant

and Goodwin, 1997). Lass, *et al.* (1989) find that each additional year of off-farm experience resulted in an additional 20 hours of off-farm work annually for the farm operator and an additional 60 hours for the spouse. Mishra and Goodwin (1997) find a similar result with an additional year of off-farm experience increasing off-farm labour supplied by the operator by 17 hours and by 43 hours for the spouse. Off-farm experience impacts on hours of labour supplied indirectly through the wage rate and directly through the labour-supply function. A high level of off-farm experience implies a greater accumulation of human capital specific to off-farm work and thus suggests larger relative returns to off-farm work.

Table 20: Impact of farm experience on off-farm hours supplied

		Farm experience			Off-farm experience	
		Operator Dummy[68]	**Operator Years**	**Spouse Years**	**Operator Years**	**Spouse Years**
Sumner (1982)	Operator – Est. 1	- sig				
	Operator – Est. 2	- sig				
Furtan, *et al.* (1985)	Husband		- sig			
	Wife					
Lass, *et al.* (1989)	Operator		+		+ sig	
	Spouse			-		+ sig
Pfaffermayr, *et al.* (1991)	Operator		- sig			
Lass and Gempesaw (1992)	Operator (both)				+ sig	+ sig
	Operator only				+ sig	
	Spouse (both)				-	+ sig
	Spouse only					+ sig
Mishra and Goodwin (1997)	Operator		- sig		+ sig	
	Spouse			+		+ sig

Wages – off-farm wage and hired farm labour wage

Off-farm wages can be said to represent the value of an individual's stock of human capital in the market place, and in the short-run can be considered fixed (Lass, *et al.*, 1991). In many cases, the operator or spouse does not work off-farm and so wage equations can be estimated as part of the model to provide predicted wages for those individuals who do not participate. Assuming leisure is a normal good, the response of off-farm labour supply to an increase in the wage is ambiguous. As off-farm wages increase, substitutions of off-farm labour for farm labour and home-time occur. There are also income effects for consumption and an income effect due to the reduction of farm income as labour is substituted from farm to off-farm work. Thus, the signs and magnitudes for elasticities of supply are uncertain for both men and women. Empirical evidence suggests that substitution effects outweigh income effects (Lass, *et al.*, 1991).

[68] Equal to one if respondent was a farmer in 1965 – survey was conducted in 1971

Own-wage effects for the operator are generally found to have a significant positive impact on the quantity of off-farm labour supplied – Table 21 (Huffman, 1980, Sumner, 1982; Jensen and Salant, 1985; Streeter and Saupe, 1986; Huffman and Lange, 1989; Lass*, et al.*, 1989; Pfaffermayr*, et al.*, 1991; Findeis and Lass, 1994). Spouse own-wage effects also tend to be positive, a result found by Furtan*, et al.* (1985), Huffman and Lange (1989) and Lass and Gempesaw (1992) (where both the operator and spouse work off-farm).

Own-wage elasticities for the operator and spouse are reported in Table 21. In the majority of cases, own-wage elasticities for both operators and spouses tended to be less than one. Own wage elasticities for operators range from 0.038 in Huffman and Lange (1989) where only the operator works, to 1.434 in Findeis and Lass (1994) in rural dominant labour markets where operators avail of hired labour. For spouses, own wage elasticities range from 0.054 in Huffman and Lange (1989) where both the operator and spouse work off-farm to 4.210[69] in Furtan*, et al.* (1985). Where appropriate, cross wage elasticities are also calculated. Furtan*, et al.* (1985), Lass*, et al.* (1989) and Keeney and Matthews (2000) find that operator labour appears to be a substitute for the spouse working off-farm. In the studies conducted by Huffman and Lange (1989) and Lass and Gempesaw (1992) they find that operator and spouse labour were complements for each other. Therefore, the results do not provide consistent evidence regarding the adjustment of operator or spouse hours worked off-farm given the off-farm hours worked by their spouse.

As Lass*, et al.* (1991) highlight, the Tobit approach, in this case employed by Furtan*, et al.* (1985), would be expected to yield a higher elasticity estimate than the two-stage Heckman approach as it utilises the entire sample including zero values for hours worked off-farm.

The hired labour wage rate has a negative but insignificant impact on off-farm hours (Findeis and Lass, 1994; Huffman and El Osta, 1998)

Table 21: Impact of wages on off-farm hours supplied

		Wage rate				Wage elasticity		
		Operator	Spouse	Hired	State avg.	Operator	Spouse	
		$						
Huffman (1980)	Operator	+ sig	-			0.340	-0.064	
Sumner (1982)*	Operator – Est. 1	+ sig				1.130		§
	Operator – Est. 2	+ sig				1.010		
Furtan*, et al.* (1985)	Husband	+	-			0.720	3.280	
	Wife	-	+ sig			-0.400	4.210	
Lopez (1984)	Operator					0.180		

[69] "What is surprising is the magnitude of the wage elasticity of supply for women. A possible explanation is that rural women are just beginning to enter the labour market and are, therefore, more active in searching for employment." Furtan*, et al.*, 1985, p 218

		Wage rate				Wage elasticity		
		Operator	Spouse	Hired	State avg.	Operator	Spouse	
		$						
Jensen and Salant (1985)	Operator	+ sig				0.210[70]		
Streeter and Saupe (1986)	Operator – Est. 1	+ sig				0.32[71]		
	Operator – Est. 2	+						
Huffman and Lange (1989)*	Operator (both)	+ sig	+ sig			0.091	0.079	§
	Operator only	+				0.038		
	Spouse (both)	+ sig	+ sig			0.045	0.054	
	Spouse only		- sig				-0.119	
Lass, *et al.* (1989)	Operator	- sig				-0.150		§
	Spouse		-			-0.060		
Pfaffermayr, *et al.* (1991)*	Operator	+ sig						
Lass and Gempesaw (1992)	Operator (both)	-	-			-0.060	-0.110	
	Operator only	-				-0.050		
	Spouse (both)	+	+			0.300	0.120	
	Spouse only		- sig				-0.720	
Findeis and Lass (1994)*	Urban (hired)	+		-		0.967		§
	Urban (no hired)	+				0.624		
	Rural (hired)	+		-		1.434		
	Rural (no hired)	+				0.079		
Huffman and El Osta (1998)	Operator – Est. 1	+ sig		-		0.188		§
	Operator – Est. 2	+ sig		-		0.182		
Weersink, *et al.* (1998)	Spouse (only)		+				2.390	§
Howard and Swidinsky (1999)	Operator	- sig				-0.299		
Keeney and Matthews (2000)	Operator	- sig	- sig			-0.480	-0.480	§
	Spouse	+	-			-0.010	-0.124	
El Osta, *et al.* (2004)	Operator – Est. 1				+			
	Operator – Est. 2				+			
* implies ln wage	§ implies not calculated in the paper itself – calculated by author see Brick (2005)							

Other income and fringe benefits

Larger receipts of unearned income are correlated with less off-farm work; this would suggest that decreases in unearned income of farm households may result in increased off-farm employment of farm operators and spouses (Table 22). Streeter and Saupe (1986) include the square of unearned income in their estimations, they find that increasing unearned income had a significant negative impact on off-farm labour supplied up to a maximum (Est. 1 = $975 and Est. 2 = $881) at which point it was found to increase the number of off-farm hours supplied. They suggest that high levels of unearned income are correlated with higher levels of off-farm labour supplied because the resulting larger income would increase investment opportunities.

Jensen and Salant (1985) and Streeter and Saupe (1986) include the fringe benefits associated with off-farm work in their estimations. Jensen and Salant (1985) include a monetary estimate of the benefits accruing to an off-farm job, these include paid vacation and/or sick leave, health insurance, pension and life insurance. Streeter and Saupe (1986) include a dummy variable indicating the receipt of health benefits. Both studies conclude that there is a positive link between the receipt of benefits and the number of hours worked off-farm. In Streeter and Saupe (1986), this relationship was found to be significant in both estimations;

[70] From Huffman (1991), p 103
[71] Lass, *et al.*, 1991, p 247

with those in receipt of health benefits working on average 18 percent more than those without benefits.

Table 22: Impact of other income and fringe benefits on off-farm hours supplied

		Unearned income		Other income		Benefits
		$	Squared	$	% of total	Operator
Sumner (1982)	Operator - Est. 1	-				
	Operator - Est. 2	-				
Jensen and Salant (1985)	Operator	-				+
Streeter and Saupe (1986)	Operator - Est. 1	- sig	+ sig			+ sig[72]
	Operator - Est. 2	- sig	+ sig			+ sig
Lass, *et al.* (1989)	Operator	+				
	Spouse	+				
Lass and Gempesaw (1992)	Operator (both)				- sig	
	Operator only				-	
	Spouse (both)				+	
	Spouse only				+	
Huffman and El Osta (1998)	Operator – Est. 1	- sig				
	Operator – Est. 2	- sig				
Howard and Swidinsky (1999)	Operator	-[73]		+ sig		- sig

Children and other household members

The presence of children and other household members has been shown to significantly effect both the off-farm participation decision and off-farm hours supplied by the farm operator and spouse (Table 23). A priori it is expected that the presence of children, particularly young children, have a negative impact on the off-farm hours worked by farm spouses, as in the most countries responsibility for childcare is usually undertaken by women. For operators, however, the a priori expectations are more ambiguous. On the one hand, childcare responsibilities may be undertaken by the operator leading to a negative impact on the off-farm hours worked. On the other hand, there may be increased financial pressure on the family due to a larger family size leading to a positive impact on off-farm hours worked.

It is found that higher numbers of young children (< six years old) or the presence of young children, has the effect of increasing the operator's off-farm labour supply. In other words, in the majority of cases the empirical evidence supports the hypothesis that a greater number of children represent greater financial responsibility for farm operators leading to increased hours worked off-farm (Huffman, 1980; Jensen and Salant, 1985; Huffman and Lange, 1989 – operator only and Lass and Gempesaw, 1992 – both). Huffman (1980) find that each child under the age of five years increased days worked off-farm by 66 percent annually.

[72] Health benefits = 1 if any

[73] In this case unearned income is investment income, other income implies spouses income and benefits are government income support ($)

For spouses, young children tend to have a negative impact on the amount of off-farm labour supplied (Furtan, *et al.*, 1985; Lass, *et al.*, 1989; Huffman and Lange, 1989; Lass and Gempesaw, 1992; Weersink, *et al.*, 1998). For Weersink, *et al.* (1998) each additional child under six years old reduces the hours worked off-farm by the spouse by 278 hours annually. Exceptions to this have emerged in a number of studies, but only when the spouse alone works off-farm, in these cases a positive impact on off-farm hours is observed (Huffman and Lange, 1989; Lass and Gempesaw, 1992). A possible explanation being that the financial pressure of children appears to be greater on the spouse than in cases where the operator is also working off-farm.

Older children are found to have a positive impact on the quantity of off-farm labour supplied by operators[74] (Jensen and Salant, 1985; Huffman and Lange, 1989; Lass, *et al.*, 1989; Findeis, *et al.*, 1991), the results for spouses are generally insignificant. The results for operators may illustrate the fact that as children get older they require less care and in some cases assist with farm chores, which enable operators in particular to increase off-farm labour supply.

The numbers of adults within the household and family size have no significant impact on the labour supply allocation of operators or spouses. Howard and Swidinsky (1999) find that having a son working on the farm decreases the number of hours of off-farm labour supply by the farm operator. Not having a spouse, having a spouse who works in agriculture or a spouse who works in a non-agricultural job all have a significant negative impact on the number of hours supplied.

[74] With the exception of Lass and Gempesaw (1992) and Keeney and Matthews (2000); the results for Keeney and Matthews are insignificant.

Table 23: Impact of children and other household members on off-farm hours supplied

		Children		KIDS (0-6)		KIDS (6-12)	KIDS (6-17)	KIDS (6-18)	KIDS (12-19)	KIDS (18+)	Adult (>19)	Family size	Other Household Members
		Dummy	**Heads**	**Dummy**	**Heads**	**Heads**	**Dummy**	**Heads**	**Heads**	**Dummy**	**Heads**	**Heads**	**Dummy**
Huffman (1980)	Operator				+ sig								
Sumner (1982)	Operator - Est. 1		+										
	Operator - Est. 2		+										
Furtan, *et al.* (1985)	Husband		+										
	Wife				- sig								
Jensen and Salant (1985)	Operator			+			+			- sig			
Huffman and Lange (1989)	Operator (both)				-	+			+ sig				
	Operator only				+ sig	-			+				
	Spouse (both)				-	-			-				
	Spouse only				+	-			-				
Lass, *et al.* (1989)	Operator				- sig			+ sig					
	Spouse				-			- sig					
Pfaffermayr, *et al.* (1991)	Operator												- sig
Lass and Gempesaw (1992)	Operator (both)				+ sig			- sig					
	Operator only				- sig			- sig					
	Spouse (both)				- sig			- sig					
	Spouse only				+ sig			+ sig					
Findeis and Lass (1994)	Urban (hired)							+ sig					
	Urban (no hired)							+					
	Rural (hired)							+					
	Rural (no hired)							-					
Mishra and Goodwin (1997)	Operator	+ sig										+	
	Spouse	- sig										+	
Huffman and El Osta (1998)	Operator – Est. 1											-	
	Operator – Est. 2											-	
Weersink, *et al.* (1998)	Spouse				- sig	-			+				
Keeney and Matthews (2000)	Operator			-		-			-		-		
	Spouse			-		- sig			-		+		
El Osta, *et al.* (2004)	Operator – Est. 1											+	
	Operator – Est. 2											+	
Goodwin and Mishra (2004)	Operator		- sig[75]									+ sig	
Kimhi and Rapaport (2004)	Adult members		-							+ sig[76]			

[75] Number of children aged 0-13 years old

[76] >= 22 years old, the existence of siblings of the operator has a significant positive impact on the level of off-farm participation, the existence of parents has a significant negative impact on participation levels

Farm characteristics

As discussed in Lass*, et al.* (1991), there are two approaches to modelling the impact of farm production factors on the quantity of off-farm labour supplied by farm operators and spouses. In an ideal situation, the quasi-rent function would be estimated and the predicted values used as independent variables in the labour supply function. As the data necessary to estimate these functions is often unavailable, the value of total sales or production is used as an alternative. Instead of estimating the quasi-rent function, production functions are estimated and the predicted values included in the labour supply function. The second option available is to estimate the labour supply function as a reduced form model by including the exogenous factors that affect production. The exogenous factors influencing labour supply are outlined in the following sections.

Farm size, sales, revenue and output

The size of the farm has a predictable significant negative impact on the off-farm labour supply of the operator, that is, the larger the farm the less time the operator will devote to off-farm work (Pfaffermayr*, et al.*, 1991; Mishra and Goodwin, 1997; Keeney and Matthews, 2000) – Table 24. Sales, predicted farm revenue and output are generally significantly negatively correlated with off-farm labour supply of farm operators (Polzin and MacDonald, 1971; Huffman, 1980; Streeter and Saupe, 1986; Lass*, et al.*, 1989; Lass and Gempesaw, 1992; Howard and Swidinsky, 1999). This makes intuitive sense, since when farm revenue grows it seems logical to reduce off-farm hours. Polzin and MacDonald (1971) used data from counties across four US states (Montana, Kansas, Mississippi and North Carolina), to investigate the relationship between off-farm days worked and farm and off-farm characteristics. They find that the average value of products sold per farm was inversely related to the off-farm days supplied in all four states. Lass*, et al.* (1989) find that an increase in farm sales[77] leads to a significant decrease of 470 hours worked off-farm annually by farm operators; there is no significant impact on the hours supplied by the spouse.

[77] The sales variable was categorical 1=<$10,000, 2=$10,000-$39,000, 3=$40,000-$99,000, 4=$100,000-$499,000 and 5=>$500,000

Farm income, asset value and debt to asset ratio

Variation in farm income leads to the operator investing more time in off-farm labour supply (Mishra and Goodwin, 1997).

> "This result confirms expectations in that increases in the variability of farm earnings evoke significant increases in the off-farm labour supply of farmers"
> Mishra and Goodwin, 1997, p 884

They find that a 10 percent increase in the coefficient of variation for farm earnings increases off-farm labour supply of operators by 21 hours annually (Table 24).

Predictably the higher the net worth of the farm, net farm income and market value of assets the less time the operator will devote to off-farm work (Furtan*, et al.*, 1985; Streeter and Saupe, 1986; Weersink*, et al.*, 1998). The impact of net worth of the farm on the off-farm labour supplied is three times stronger on the operator than the spouse in Furtan*, et al.* (1985); both results are significantly negative.

Mishra and Goodwin (1997) and McNally (2003) include debt to asset ratio, and both find that operators and spouses[78] who operate farms with higher debt to asset ratios supply a higher quantity of off-farm labour.

[78] Mishra and Goodwin (1997) estimate for spouses as well as operators

Table 24: Impact of farm size, sales, output and income on the hours of off-farm labour supplied

		Farm size	Sales	Predicted total farm revenue	ln output	Coefficient of variation of gross farm income	Net worth of the farm household	Net farm income	Market value of assets	Debt to asset ratio
		Hectares/ acres	$	$			$	$	$	
Polzin and MacDonald (1971)	Household		- sig							
Huffman (1980)	Operator				- sig					
Furtan, *et al.* (1985)	Husband						- sig			
	Wife						- sig			
Streeter and Saupe (1986)	Operator - Est. 1			- sig						
	Operator - Est. 2								- sig	
Lass, *et al.* (1989)	Operator		- sig							
	Spouse		-							
Pfaffermayr, *et al.* (1991)	Operator	- sig								
Lass and Gempesaw (1992)	Operator (both)		+							
	Operator only		+ sig							
	Spouse (both)		+							
	Spouse only		+ sig							
Mishra and Goodwin (1997)	Operator	- sig				+ sig				+ sig
	Spouse	+				+ sig				+ sig
Huffman and El Osta (1998)	Operator – Est. 1								+[79]	- sig[80]
Weersink, *et al.* (1998)	Spouse							-		+
Howard and Swidinsky (1999)	Operator		- sig					-		
Keeney and Matthews (2000)	Operator	- sig								
	Spouse	+								
McNally (2003)	Operator	+ / -[81]								+ sig
Goodwin and Mishra (2004)	Operator	-	+ sig[82]				- sig			
Kimhi and Rapaport (2004)	Adult members	-								

[79] Value of farmland owned
[80] Value of farm machinery and equipment, breeding stock, and farm buildings
[81] + = small farm (< 40 Economic Size Units (ESU)), - = medium farm (40 - < 100 ESU) dummies compared to large farms (>= 100 ESU)
[82] Ratio of livestock sales to total sales plus government payments

Farm type

A number of studies include the impact of various farm types on the level of off-farm participation. It is likely that the type of farming undertaken on-farm will have a greater impact on the participation decision than the decision relating to the number of hours or days to participate. Due to the labour intensive nature of the dairy industry, dairy farmers work significantly fewer hours off-farm (Sumner, 1982; Lass*, et al.*, 1989; Findeis*, et al.*, 1991; Lass and Gempesaw, 1992; Findeis and Lass, 1994; Weersink*, et al.*, 1998; Keeney and Matthews, 2000; El Osta*, et al.*, 2004) – Table 25. Howard and Swidinsky (1999) find that dairy farm operators work significantly fewer hours off-farm than tillage farmers (exc. wheat). Findeis and Lass (1994) include dummy variables to account for livestock farming and dairy farming, they find that livestock farmers work more hours off-farm than other farm types and dairy farmers work significantly fewer hours than other farm types; this is as expected since livestock farming is less labour intensive than dairy farming. El Osta*, et al.* (2004) find that operators on farms who specialise in dairy farming work significantly fewer hours off-farm than those involved in other farm enterprises; specifically, being a dairy farmer reduces operator off-farm hours by 544 hours per annum in estimation one and by 527 hours per annum in estimation two.

Table 25: Impact of farm type on off-farm hours supplied

		Dairy Dummy	**Livestock Dummy**	**Pigs Dummy**	**Crops Dummy**
Sumner (1982)	Operator - Est. 2	-			
Furtan*, et al.* (1985)	Husband		- sig[83]		
Lass*, et al.* (1989)	Operator	-			
	Spouse	- sig			
Lass and Gempesaw (1992)	Operator (both)	+			
	Operator only	- sig			
	Spouse (both)	-			
	Spouse only	+			
Findeis and Lass (1994)	Urban (hired)	- sig	+ sig		
	Urban (no hired)	- sig	+ sig		
	Rural (hired)	- sig	+ sig		
	Rural (no hired)	- sig	+ sig		
Weersink*, et al.* (1998)	Spouse	-			
Howard and Swidinsky (1999)	Operator	- sig	+	-	
Keeney and Matthews (2000)	Operator	-			
	Spouse	-			
McNally (2003)	Operator	-		+	-
El Osta*, et al.* (2004)	Operator – Est. 1	- sig			
	Operator – Est. 2	- sig			

[83] This represents the coefficient on a dummy variable for the presence of livestock, they do not appear to discriminate between dairy cows and other livestock and therefore the result is not included in the discussion

Direct payments

Larger receipts of direct payments are generally correlated with less farm work; this suggests that a decrease in the amount of direct payments received by farm households, may result in an increase in the number of off-farm hours worked by farm operators and spouses. In general, this effect is found to be significant – Table 26 – (Mishra and Goodwin, 1997; Keeney and Matthews, 2000 (dependence on premia); El Osta*, et al.*, 2004; Goodwin and Mishra, 2004). Keeney and Matthews (2000) find that the impact of direct payments is dependent on the type of direct payment involved. Premia and arable receipts tend not to affect off-farm labour supply, however, headage payments, most of which are conditional on substantial forage area being available to reduce stocking density, are found to be associated with more off-farm work by the operator.

> "This shows that an operator with substantial headage payment receipts will substitute labour towards non-farm sources… Livestock enterprises are less labour intensive and have less opportunity cost, thus releasing labour resources for off-farm work." Keeney and Matthews, 2000, p 19

El Osta*, et al.* (2004) took a different approach by estimating two separate models. In the first estimation, expected government payments[84] are merged into one independent variable; they find that an increase in all payments by $1,000 reduces the off-farm hours worked by the operator significantly by seven hours annually. In the second estimation, each of the three government payments are entered into the model separately. They find that Agricultural Transition payments had the largest effect on the hours worked off-farm by the operator; for each $1,000 increase in such payments, off-farm supply was significantly reduced by 12 hours annually. Loan deficiency payments significantly reduced supply by eight hours per year and agricultural disaster payments had no significant impact on supply. In short, payments are found to have only a minimal impact on the off-farm labour supplied by farm operators.

[84] The three payments under consideration are 1) Agriculture disaster payments, 2) Loan deficiency payments and 3) Agricultural Transition payments

Table 26: Impact of farm income support on off-farm hours supplied

		Direct Payments	Receipts			Dependence		
			Premia	Arable	Headage	Premia	Arable	Headage
		$	£	£	£	%	%	%
Mishra and Goodwin (1997)	Operator	- sig						
	Spouse	- sig						
Keeney and Matthews (2000)	Operator		+	+	+ sig	- sig	-	-
	Spouse	-						
El Osta, *et al.* (2004)	Operator – Est. 1	- sig						
	Operator – Est. 2	- sig[85]						
McNally (2003)	Operator			+	- sig			
Goodwin and Mishra (2004)	Operator	- sig						

Farming attitudes – non-pecuniary benefits to farming

Streeter and Saupe (1986) and Weersink, *et al.* (1998) include attitudinal variables in their analysis of the off-farm labour supply of farm operators (Table 27). They find that a positive attitude towards farming, particularly the farming lifestyle, has a negative impact on the off-farm labour supply of the operator.

Table 27: Impact of farming attitudes on off-farm hours supplied

		Satisfaction with farm life	Farm lifestyle is number one goal	Increased production is number one goal
Streeter and Saupe (1986)	Operator - Est. 1		- sig	- sig
	Operator - Est. 2		-	- sig
Weersink, *et al.* (1998)	Spouse	-		

Location characteristics

Local labour market conditions

Local labour market conditions and structure are found to have a significant impact on the off-farm labour supply of farm operators in many of the studies under consideration (Table 28). Findeis and Lass (1994) find that the higher the proportion of employment in manufacturing and the wholesale and retail trade in an area, the more off-farm labour is supplied by the farm operator. The results found by El Osta, *et al.* (2004) also have the expected positive sign but are not significantly different from zero. The rate of unemployment in the local area is generally not found to have a significant impact on the off-farm hours supplied by the operator and spouse in the studies in which it is included; only Lass, *et al.* (1989) find a significant result. When the local labour market exhibited relatively excess supply, that is a higher rate of unemployment, they found that operators worked

[85] In Estimation 2 the direct payments are divided into three categories, in this case two of the three categories are – sig and the third. (Agricultural disaster payments) is negative but insignificant

significantly fewer hours off-farm; in fact, they work 101 hours less for each percentage increase in the unemployment rate.

Table 28: Impact of local labour market conditions on off-farm hours supplied

		Proportion of employment in			Unemployment rate	Non-agri jobs per mile^2	Population Density
		Services	Manufacturing	Wholesale & retail			
		%			%		Persons/km^2
Polzin and MacDonald (1971)	Household		+ sig[86]				
Lass, *et al.* (1989)	Operator				- sig		
	Spouse				-		
Findeis and Lass (1994)	Urban (hired)		-	-			
	Urban (no hired)		+ sig	+ sig			
	Rural (hired)		+	+			
	Rural (no hired)		+ sig	-			
Howard and Swidinsky (1999)	Operator				-		+ sig
Keeney and Matthews (2000)	Operator				-	- sig	
	Spouse				-	+	
El Osta, *et al.* (2004)	Operator – Est. 1	+	-	+			
	Operator – Est. 2	+	-	+			

Commuting distance and distance to city/job

In most cases, distance is not found to be a significant factor in the allocation of off-farm time for either the operator or spouse (Table 29). Streeter and Saupe (1986) and Lass and Gempesaw (1992) show a significant positive impact of distance to off-farm job and commuting distance on operator off-farm labour supply. This could indicate that operators are aware of the time-costs associated with participation and by working more hours, these fixed time costs are partially offset. In Lass and Gempesaw (1992), the operator's commuting distance has little impact on supply, although when both worked, the operator did respond negatively to the spouse's commute. Huffman and El Osta (1998) were the only authors to find a significant negative relationship between operator off-farm hours and distance to a city; other authors did not find any results significantly different from zero. Their results suggest that distance from a major labour market has a negative impact on the off-farm hours worked by operators.

[86] Percentage of non-agricultural employment in manufacturing

Table 29: Impact of commuting distance and distance to city/job on off-farm hours supplied

		Commuting distance		Distance to			
		Operator	Spouse	Town	City	City^2	Job
		m/km		m/km			m/km
Streeter and Saupe (1986)	Operator - Est. 1						+
	Operator - Est. 2						+ sig
Huffman and Lange (1989)	Operator (both)				-	-	
	Operator only				-	+	
	Spouse (both)				+	-	
	Spouse only				+	-	
Lass, *et al.* (1989)	Operator	+ sig					
	Spouse	-					
Lass and Gempesaw (1992)	Operator (both)	-	- sig				
	Operator only	-					
	Spouse (both)	-	+				
	Spouse only		+				
Mishra and Goodwin (1997)	Operator			+			
	Spouse			+			
Huffman and El Osta (1998)	Operator – Est. 1				- sig		
	Operator – Est. 2				- sig		
Weersink, *et al.* (1998)	Spouse						+
El Osta, *et al.* (2004)	Operator – Est. 1			-			
	Operator – Est. 2			-			
Goodwin and Mishra (2004)	Operator			-			

As in the participation estimations, some authors have included specific regional variables into their labour supply models. For example, recently Weersink, *et al.* (1998) found that farm spouses in New York are working a higher number of hours off-farm than those in Ontario; although this result is not found to be significantly different from zero. In addition, McNally (2003) looked at the impact of direct payments on off-farm labour supply in three regions in England and in Wales. She finds that operators in Wales worked a significantly higher number of off-farm hours than operators in the North of England. Those operators in the West of England worked significantly fewer hours than those in the North of England. Howard and Swidinsky (1999) find conflicting location results for participation and labour supply. In their supply model they find that compared with Ontario (the omitted region), all other regions except for Quebec have lower labour supply.

Overall, the results of the labour supply models, as with the results of the participation models, are generally as expected and the majority of the relationships can be explained within a neoclassical household utility maximising model. In all cases where the same independent variables were included in both participation and supply models, the signs of the coefficients are the same, that is, the variables influenced off-farm participation and quantity of supplied in the same direction.

The above sections have outlined the empirical results relating to off-farm labour force participation and off-farm labour supply respectively. It is found that results were generally as expected a priori. Broadly speaking, household characteristics have a stronger influence on spouses decisions than on operators and farm characteristics have a stronger impact on operators decisions than spouses.

There is a degree of consensus among authors in relation to the variables chosen to explain the decisions and the nature of the relationships established. Further, the results tend to support the theoretical proposition that pluriactivity in the form of off-farm participation in the case of the operator is influenced by the size and type of farm and resultant income and labour intensity.

Bibliography

Benjamin, C. (1994). "The Growing Importance of Diversification Activities for French Farm Households." *Journal of Rural Studies,* 10(4): 331-342.

Benjamin, C., A. Corsi and H. Guyomard (1996). "Modelling labour decisions of French agricultural households." *Applied Economics,* 28(12): 1577-1589.

Benjamin, C. and H. Guyomard (1994). "Off-farm work decisions of French agricultural households". In *Agricultural household modelling and family economics*. F. Caillavet, H. Guyomard and R. Lifran (eds.). Amsterdam**:** 65-85.

Benjamin, C. and A. Kimhi (2003). Farm work, off-farm work, and hired farm labour: Estimating a discrete-choice model of French farm couples' labour decisions, Center for Agricultural Economic Research, Hebrew University of Jerusalem.

Bharadwaj, L. and J. Findeis (2003). *Off-farm work among farm women: motivations, earnings, and benefit receipts*. Annual Meeting of the American Agricultural Association, Montreal, Canada.

Brick, A. (2005). The Off-Farm Labour Force Participation of Farm Households in Co. Mayo. Department of Economics, National University of Ireland, Galway. Unpublished PhD Thesis.

Corsi, A. and J. L. Findeis (2000). "True state dependence and heterogeneity in off-farm labour participation." *European Review of Agricultural Economics,* 27(2): 127-151.

El Osta, H., M. Ahearn and A. K. Mishra (2004). "Labour supply by farm operators under "decoupled" farm program payments." *Review of Economics of the Household,* 2(4): 367-385.

Findeis, J. and D. Lass (1994). Labour decisions by agricultural households: interrelationships between off-farm labour supply and hired labour demand, Population Research Institute, Pennsylvania State University.

Findeis, J., D. Lass and M. C. Hallberg (1991). "Effects of location on off-farm employment decisions". In *Multiple Job-Holding Among Farm Families*. M. C. Hallberg, J. Findeis and D. Lass (eds.), Iowa State University Press**:** 263-276.

Findeis, J. and H. Swaminathan (2003). *Off-farm employment, intrahousehold work decisions, and why it matters: revisiting the subjective equilibrium of the farm household-firm*. Agricultural Economics Society Annual Meeting, Plymouth, UK.

Furtan, W. H., G. C. Van Kooten and S. J. Thompson (1985). "The Estimation of Off-Farm Labour Supply Functions in Saskatchewan." *Journal of Agricultural Economics,* 36: 211-220.

Goodwin, B. K. and A. K. Mishra (2004). "Farming efficiency and the determinants of multiple job holding by farm operators." *American Journal of Agricultural Economics,* 86(3): 722-729.

Gould, B. and W. Saupe (1989). "Off-Farm Labour Market Entry and Exit." *American Journal of Agricultural Economics,* 71(4): 960-969.

Greene, W. H. (2003). *Econometric Analysis*. Upper Saddle River, N.J., Prentice Hall.

Heckman, J. (1974). "Shadow Prices, Market Wages, and Labour Supply." *Econometrica,* 42(4): 679-694.

Huffman, W. (1980). "Farm and Off-Farm Work Decisions: The Role of Human Capital." *Review of Economics and Statistics,* 62(1): 14-23.

Huffman, W. (1991). "Agricultural household models: Survey and critique". In *Multiple Job-Holding Among Farm Families*. M. C. Hallberg, J. Findeis and D. Lass (eds.), Iowa State University Press**:** 79-111.

Huffman, W. (2001). "Human Capital: Education and Agriculture". In *Handbook of Agricultural Economics - Agricultural Production*. B. Gardner and G. C. Rausser (eds.). Amsterdam, Elsevier Science B.V.**:** 333 - 381.

Huffman, W. and H. El Osta (1998). *Off-farm work participation, off-farm labour supply and on-farm labour demand of U.S. farm operators*. 1998 Summer AAEA meetings, Salt Lake City, Utah.

Huffman, W. and M. Lange (1989). "Off-farm work decisions of husbands and wives: joint decision making." *Review of Economics and Statistics,* 71(3): 471-480.

Jensen, H. H. and P. Salant (1985). "The Role of Fringe Benefits in Operator Off-Farm Labour Supply." *American Journal of Agricultural Economics,* 67(4): 1095-1099.

Keeney, M. and A. Matthews (2000). *Multiple job holding - explaining participation in off-farm employment, labour demand and labour supply of Irish farm households*. International Association of Agricultural Economists Conference (IAAE) XXIV, Berlin.

Kimhi, A. (1994). "Quasi-Maximum Likelihood Estimation of Multivariate Probit Models - Farm Couples Labour Participation." *American Journal of Agricultural Economics,* 76(4): 828-835.

Kimhi, A. (1996). "Demographic composition of farm households and its effect on time allocation." *Journal of Population Economics,* 9(4): 429-439.

Kimhi, A. and E. Rapaport (2004). "Time allocation between farm and off-farm activities in Israeli farm households." *American Journal of Agricultural Economics,* 86(3): 716-721.

Kimhi, A. and E. Seiler (2001). *The effect of family composition on the off-farm participation decisions in Israeli farm households*. 2001 ESPE Conference.

Kjeldahl, R. (1995). Direct Income payments to farmers uses, implications and an empirical investigation of labour supply response in a sample of Danish farm households. Copenhagen, Danish Institute of Agricultural and Fisheries Economics**:** 171.

Kwon, C., P. Orazem and D. Otto (2003). Off-farm labour supply responses to permanent and transitory farm income, Department of Economics, Working Papers Series, Iowa State University**:** 31.

Lass, D., J. Findeis and M. C. Hallberg (1989). "Off-farm employment decisions by Massachusetts farm households." *Northeastern Journal of Agricultural and Resource Economics,* 18(2): 149-159.

Lass, D., J. Findeis and M. C. Hallberg (1991). "Factors affecting the supply of off-farm labour: A review of empirical evidence". In *Multiple Job-Holding Among Farm Families*. M. C. Hallberg, J. Findeis and D. Lass (eds.), Iowa State University Press**:** 239-262.

Lass, D. A. and C. M. Gempesaw (1992). "The Supply of Off-Farm Labour - a Random-Coefficients Approach." *American Journal of Agricultural Economics,* 74(2): 400-411.

Laszlo, S. (2004). Education, Labour Supply and Market Development in Rural Peru, Department of Economics, McGill University.

Lee, M. (1998). Off-Farm Labour Supply and Various Aspects Related of Resource Allocation by Agricultural Households. *Faculty of Agriculture*, Universitat Gottingen**.**

Lim-Applegate, H., G. Rodriguez and R. Olfert (2002). "Determinants of non-farm labour participation rates among farmers in Australia." *The Australian Journal of Agricultural and Resource Economics,* 46(1): 85-98.

Lopez, R. (1984). "Estimating Labour Supply and Production Decisions of Self-Employed Farm Producers." *European Economic Review,* 24: 64-82.

McNally, S. (2003). Aspects of Structural Change on European Farms: an empirical analysis. *Unpublished PhD Thesis, Department of Economics*, University College London.

Mishra, A. K. and B. K. Goodwin (1997). "Farm income variability and the supply of off-farm labor." *American Journal of Agricultural Economics,* 79(3): 880-887.

Pfaffermayr, M., C. Weiss and J. Zweimuller (1991). "Farm income, market wages, and off-farm labour supply." *Austrian Economic Papers,* 18(2): 221-235.

Polzin, P. and P. MacDonald (1971). "Off-farm Work: A Marginal Analysis." *The Quarterly Journal of Economics,* 85(3): 540 - 545.

Serra, T., B. K. Goodwin and A. M. Featherstone (2003). *Farm households' wealth and off-farm supply of labour*. 78th Annual Agricultural Economics Society Conference, Imperial College, South Kensington, London.

Simpson, W. and M. Kapitany (1983). "The off-farm work behaviour of farm operators." *American Journal of Agricultural Economics,* 65(4): 801-805.

Streeter, D. and W. Saupe (1986). Non-Monetary Considerations in Farm Operator Labour Allocations. Ithaca, New York, Department of Agricultural Economics, Cornell University**:** 20.

Sumner, D. (1982). "The off-farm labour supply of farmers." *American Journal of Agricultural Economics,* 64(3): 499-509.

Tokle, J. and W. Huffman (1991). "Local economic conditions and wage labour decisions of farm and rural non-farm couples." *American Journal of Agricultural Economics,* 73(3): 652-670.

Weersink, A. (1992). "Off-farm Labour Decisions by Ontario Swine Producers." *Canadian Journal of Agricultural Economics,* 40: 235-251.

Weersink, A., C. Nicholson and J. Weerhewa (1998). "Multiple Job Holdings Among Dairy Farm Families in New York and Ontario." *Agricultural Economics,* 18(2): 127-143.

Woldehanna, T., A. O. Lansink and J. Peerlings (2000). "Off-farm work decisions on Dutch cash crop farms and the 1992 and Agenda 2000 CAP reforms." *Agricultural Economics,* **22**(2): 163-171.