The Australian Journal of Agricultural and Resource Economics, 46:1, pp. 85–98

Determinants of non-farm labour participation rates among farmers in Australia

Hazel Lim-Applegate, Gil Rodriguez and Rose Olfert*

In recent decades, non-farm employment has become prevalent and an important source of income for Australian farm families. However, models identifying the relative significance of the socioeconomic variables influencing non-farm employment participation rates have never been estimated in Australia. In this paper, a bivariate probit model of non-farm employment participation rates was estimated, using information from the Australian Bureau of Agricultural Resource Economics (ABARE) 1994–1995 surveys. It was found that the participation decision of the farm operator and spouse is likely to be jointly determined, that non-farm employment participation increased at a declining rate with age among farmers and that university education enhances the participation rates particularly among spouses. Participation rates were also higher among spouses with lower other income and with no dependent children.

1. Introduction

Non-farm employment is off-farm employment in the non-farm sector and, for this paper, excludes self-employment. The proportion of farm couples with at least one member employed in the non-farm sector increased from 21 per cent in 1982–1983, to 29 per cent in 1994–1995. For these families, non-farm wages and salaries accounted on average for around 42 per cent of the total family income in 1994–1995.

Previous studies of off-farm employment found several reasons for farm family members seeking non-farm employment. As an additional source of income, families rely on non-farm employment to meet farm or family needs. In North America, Simpson and Kapitany (1983) found that non-farm earnings assisted young couples in financing their farm investment requirements. Other studies noted that risk-averse farmers resort to non-farm employment as a risk management strategy (Mishra and Goodwin 1997; Martin and McLeay 1998).

*Hazel Lim-Applegate is a Senior Officer at the Australian Treasury Department and Gil Rodriguez is a Senior Economist at the Australian Bureau of Agricultural and Resource Economics, Canberra, Australia; Rose Olfert is a Professor at the Department of Agricultural Economics, University of Saskatchewan, Canada.

Despite the importance of non-farm employment, quantitative analysis of the factors influencing off-farm employment is scarce in Australia. There are no empirical models of off-farm employment participation rates of Australian farmers (Rural Industries Research 1998). The latest research in off-farm labour supply estimation was that of Robinson, McMahon and Quiggin (1982). Using the Bureau of Agricultural Economics 1977–1978 farm survey data and estimating a tobit model, they found that age, education, farm assets, cash receipts and off-farm employment opportunities influenced significantly the labour hours spent off-farm by broadacre farmers.

The aim in this study is to analyse the socioeconomic factors influencing farmers' participation in non-farm employment by using a reduced-form bivariate probit model.

2. Theoretical model

The starting point in analysing off-farm employment decisions of a single-family, operator–spouse household is the trade-off between leisure (all non-work activities) and the consumption of goods (Huffman and Lange 1989). The household foregoes some leisure activities to consume goods and vice versa. In figure 1, this trade-off is represented by the indifference curve, U.

However, the different combinations of good and leisure units that a household could access at a given indifference curve such as U is limited by the available income. The slope of U is the marginal rate of substitution between leisure (L) and consumption goods (C). It may be written as:

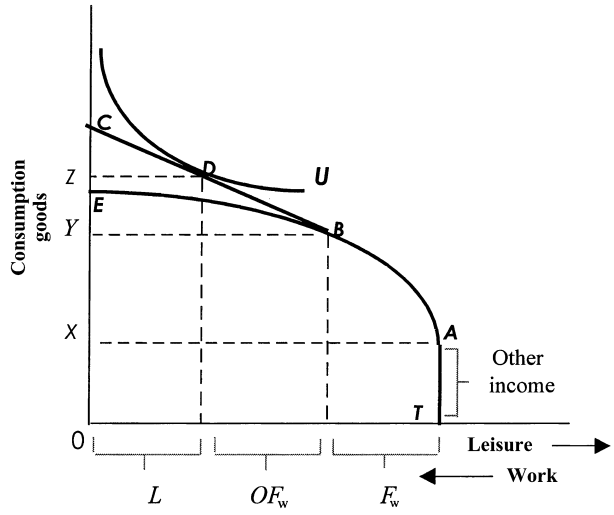

Figure 1 Graphical representation of the leisure good model.

$$\text{MRS} = F(C, L : B)$$

where B is a set of exogenous household characteristics, such as age of the spouse and operator and the number of dependent children.

In figure 1, this income constraint is $TABC$. The vertical segment TA of the income constraint represents other income. The curved segment ABE characterises income from farm production. The slope of ABE is the value of the marginal product of farm labour. ABE has a concave shape because diminishing returns to labour occur at the margin due to some fixed factors of production. At an optimal level of farm profit, marginal returns to labour would be equal to the farm wage (W_f).

The linear segment BC represents the earnings from off-farm work. The slope of BC is the off-farm wage rate (W_{of}). While off-farm offer wages might be influenced by the skills and experience of the spouse or operator, it was assumed in this paper that it is independent of time worked, an assumption similarly adopted by Huffman and Lange (1989, p. 472) and Sumner (1982, p. 501). Pencavel (1986, p. 59) indicated that such a horizontal labour demand may not be true in the presence of quasi-fixed hiring and training costs.

The optimum allocation between the goods and leisure units occurs at the equilibrium point D where the highest attainable indifference curve is tangent to the income constraint. At D, the marginal rate of substitution between the consumption of goods and leisure activities is equal to the farm and off-farm wage rates. Consequently, the household allocates time such that F_w, OF_w and L units are spent on farm and off-farm work and leisure, respectively. Furthermore, at point D, the household earns YZ units of off-farm income, XY units of farm income and $0X$ units of other income.

Based on the relevant reservation wage (W_h) of this leisure–good model, the participation rule adopted by the spouse (s) or operator (o) is:
Accept off-farm work when,

$$\text{MRS}_h \leqslant W_f(t_f^*) \leqslant W_h, h = s \text{ or } o$$

Reject off-farm work when,

$$\text{MRS}_h > W_f(t_f^*) > W_h, h = s \text{ or } o$$

It should be noted that the farm wage $W_f(\text{t}_f^*)$ is the rate that corresponds to the optimal hours of farm work (t_f^*).

Because the personal characteristics of the operator and spouse, apart from the other household characteristics, might affect MRS_h, this raises the possibility that the participation decision by the operator and spouse would be jointly determined.

3. Model estimation

To analyse the off-farm participation decision made jointly by the operator (o) and spouse (s), the bivariate probit model is specified as:

$$Y_o^* = x_o\beta_o + u_o$$

$$Y_s^* = x_s\beta_s + u_s$$

$$\mathrm{E}(u_o) = \mathrm{E}(u_s) = 0$$

$$\mathrm{Var}(u_o) = \mathrm{Var}(u_s) = 1$$

$Cov(u_o, u_s) = \rho$ where Y_i^*, $i = o, s$, is the latent or unobservable variable. The observable variable is a dummy variable representing the non-farm labour participation decision of the operator or spouse:

$Y_i = 1$ if $Y_i^* > 0$ or when the reservation wage (W_h) of the spouse or operator is less than or equal to the non-farm offer wage ($W_{n\,f}$),

$$Y_i = 0 \text{ otherwise.}$$

x_i and β_i are the $K \times 1$ independent variable and parameter vectors for each observation. The variables (x_i) hypothesised to influence the labour force participation decision are age, education, presence of preschool children, other income such as income from investments, type of industry and off-farm labour market characteristic variables (table 1). u_o and u_s are the model error variables.

The bivariate probit parameters were estimated through a maximum likelihood technique available in LIMDEP (version 7.0).

Data used in estimating the probit models were based on the 1994–1995 AAGIS (Australian Agricultural and Grazing Industries survey) and ADIS (Australian Dairy Industry survey), which had sample sizes of 1435 and 332, respectively. Approximately 30 per cent of the original sample were excluded in the estimation process because they were sole-operator households on professionally managed farms; farmers not residing on the surveyed farms and farmers with incomplete data on financial variables were omitted.

Based on the descriptive statistics of the sample (table 2), it appears that the distinct traits of farmers doing non-farm work are that they are younger,

Table 1 Data definitions

Variable	Expected sign	Description
Personal characteristics		
Age	+	
Square of age	−	
Education		
4 years of high school	?	1 attended/completed 1–4 years high school, 0 otherwise
6 years of high school	?	1 attended/completed additional 1–2 years high school, 0 otherwise
Vocational	?	1 completed trade apprenticeship/technical/vocational, 0 otherwise
University	?	1 completed university/other tertiary, 0 otherwise
Farm household characteristics		
Presence of preschool children	?	1 if individual has at least one child aged less than 6, 0 otherwise
Other income	−	Government payments, income from investments and other business activities, including wages and salaries from working on other farms
Farm characteristic		
Industry	+	1 if farm is classified under broadacre industry, 0 if dairy industry
Off-farm labour market characteristics		
Zone		ABARE zones
Wheat–sheep zone	?	1 located in wheat–sheep zone, 0 otherwise
High rainfall zone	?	1 located in high rainfall zone, 0 otherwise
Remoteness		The statistical local area is classified to a metropolitan area, rural zone or remote zone and then according to the population size of the associated urban centre.
Rural	?	1 Rural area 10,000 < population = 25,000, 0 otherwise
Remote	?	1 Remote area 5,000 < population = 10,000, 0 otherwise
Other remote	?	1 Other remote population = 5,000, 0 otherwise
Six State dummies	?	The six variables represent the six States New South Wales, Victoria, Queensland, South Australia, Western Australia and Tasmania. The dummy variable gets a value of 1 if located in the State that the variable corresponds to. To represent a farm in the Northern Territory, all the six dummy variables take 0 values

ABARE, Australian Bureau of Agricultural and Resource Economics.

Table 2 Descriptive statistics for Australian farm operators and spouses, 1994–1995

		Spouse				Operator			
		Working in the non-farm sector ($n = 304$)		Not working in the non-farm sector ($n = 911$)		Working in the non-farm sector ($n = 52$)		Not working in the non-farm sector ($n = 1163$)	
Variable	Unit	Estimate	RSE	Estimate	RSE	Estimate	RSE	Estimate	RSE
Personal characteristics									
Age	Years	45	(2)	52	(1)	49	(5)	53	(1)
Educational attainment									
Attended/completed primary school	%	3	(52)	10	(17)	#		13	
Completed 1–4 years high school	%	26	(14)	47	(5)	36	(26)	54	(4)
Completed 5–6 years high school	%	21	(18)	24	(9)	20	(34)	21	(7)
Completed trade apprenticeship/ technical/vocational	%	13	(22)	6	(20)	18	(51)	6	(16)
Completed university/other tertiary	%	37	(11)	12	(13)	26	(44)	7	(14)
Female	%	99	(1)	99	(1)	0	(0)	1	(43)
Farm household characteristics									
No. children aged less than 6									
0	%	87	(4)	89	(2)	77	(14)	89	(1)
1	%	10	(31)	6	(17)	17	(53)	6	(17)
$\geqslant 2$	%	4	(41)	5	(22)	6	(95)	5	(16)
Income from investments, business dividends and Government payments*	$	5167	(12)	8168	(11)	7417	(42)	7309	(9)
Farm characteristics									
Engaged in broadacre farming	%	88	(0)	79	(0)	95	(0)	80	(0)
Geographic non-farm labour market characteristics									
New South Wales	%	30		31		28		31	
Victoria	%	32		29		47		28	
Queensland	%	13		16		5		16	
South Australia	%	11		10		13		10	
Western Australia	%	12		11		9		12	

Tasmania	%	2	3	0	3
Northern Territory	%	#	#	#	#
Zone					
Pastoral	%	3	5	1	4
Wheat–sheep	%	51	44	48	46
High rainfall	%	47	51	51	50
Location†					
Metropolitan to small rural centres	%	8	6	9	6
Other rural centres	%	77	78	85	78
Remote centres	%	2	1	0	1
Other remote centres	%	13	15	6	15

*This also includes income from self-employment and wages and salaries from work in other farms.
†As defined in the Department of Primary Industries and Energy and Department of Human Services and Health 1994 (see table 1).
Few or no individuals were in this category.
n is the sample size.
Figures in parentheses are relative standard errors, expressed as percentages of the estimates.

underwent tertiary education, engaged in broadacre farming and, in the case of spouses, have lower other income.

The empirical definitions of the independent variables of the bivariate probit model and expected signs of the coefficients of each independent variable are given in table 1.

The coefficients of age and the square of age were expected to be positive and negative, respectively, yielding a non-linear relationship between non-farm employment participation rates and age. This specification is driven by the life earnings cycle hypothesis (see Robinson *et al.* 1982, p. 26; Huffman and Lange 1989, p. 475), which suggests that young farmers tend to be more willing to do non-farm work to finance additional assets or to gain non-farm job experience. In contrast, established older farmers are likely to be less willing to do non-farm work because they may have sufficient income from other sources such as investment income or may not possess the necessary skills.

Education, being a component of human capital investment, could be valuable on and off the farm. While formal education may raise a person's marginal productivity on farm and, hence, raise the opportunity cost of working off-farm, formal education among Australian farmers is likely to have greater marginal returns in the off-farm sector. Rasheed, Rodriguez and Garnaut (1998) found that education levels tended to be higher for Australian farmers with off-farm employment in 1996–1997, with almost half of the females being in professional occupations. This positive correlation between education and off-farm employment is also supported in the literature (Gunter and McNamara 1990; Lass and Gempesaw 1992).

The presence of preschool children may influence the decision of farmers to undertake non-farm work in two ways. The child care demands of preschool children could restrict the time available to farmers for non-farm work. However, having children increases the consumption requirements of the family, thereby contributing to the need for non-farm work.

The influence of farm characteristics on non-farm employment participation is mainly represented by dummy variables approximating the timing and intensity of farm labour use.

The difference in the timing of the farm tasks in the broadacre and dairy industries has implications on the time allocation patterns of farmers. Dairy farming requires farmers to undertake daily tasks at specific hours and thereby limits their availability for non-farm work. Hence, it is hypothesised that dairy farmers would have lower non-farm work participation rates than broadacre farmers.

Geographic characteristics of the non-farm labour market can potentially restrict the access of farmers to non-farm work through high commuting costs and time. The proximity of farms to metropolitan and rural areas with high

population densities is likely to present more non-farm job opportunities than would sparsely populated communities (Huffman 1980; Weersink 1992).

To account for these factors, the remoteness index formulated by the Department of Primary Industries and Energy and the Department of Human Services and Health (1994) using both the farm's distance from the nearest population centres and the size of these centres was used in this study.

Ideally, information that could precisely represent other local market conditions, such as percentage of jobs in the construction, retail sales, manufacturing and mining, and other service industries in different states and zones should be used (Gunter and McNamara 1990). Due to the absence of this information, dummy state and zone variables were used to represent the interstate differences in labour market conditions and state-specific effects not captured by the other explanatory variables. Huffman (1980) adopted the same approach. Furthermore, as noted by Sumner (1982, p. 504), these variables have unpredictable signs because of the interplay of offsetting factors on the farm and off-farm marginal value of time.

4. Model results

The results of the bivariate probit analysis are presented in table 3.

The estimated correlation of the error terms (Rho) was positive, 0.27. It is significantly different from zero based on the calculated *t*-statistic and likelihood ratio test. This result tends to confirm that operator and spouse decisions are jointly determined. Hence, a bivariate probit model was the appropriate estimation approach rather than estimating two separate univariate probit models in analysing the participation decisions of the operator and spouse.

The pseudo R^2, an indication of the goodness of the bivariate probit model (Judge *et al.* 1986, p. 774), was 0.16, comparable to that obtained by Lass and Gempesaw (1992, p. 405).

Ideally, all the relevant personal characteristics of the operators would be included in the spouse equation and vice versa. However, attempting to include all the personal characteristics in both equations led to severe multicollinearity problems. Gould and Saupe (1989, p. 962) and Tokle and Huffman (1991, p. 662) had similar problems in estimating their bivariate off-farm participation models. The former decided to eliminate the age variables across equations and included instead education variables, while the latter used the operator's age across equations. We adopted the Gould–Saupe approach and included only the spouse or operator university education variable across equations as including all educational variables resulted in severe multicollinearity problems. Furthermore, to a certain extent, univer-

Table 3 Estimated bivariate probit equations for farm operator's and spouse's off-farm work 1994–1995

	Units	Spouse Coefficients	T-value	Operator Coefficients	T-value
Constant		−2.0437	−1.592	−5.1005	−1.717
Farm spouse characteristics					
Age	Years	0.0964	1.903		
Age^2		−0.0014	−2.635		
Education					
4 years high school	0,1	0.0683	0.234		
6 years high school	0,1	0.1151	0.977		
Vocational	0,1	0.3368	2.041		
University	0,1	0.8884	7.093	−0.1410	−0.936
Farm operator characteristics					
Age	Years			0.1125	1.285
Age^2				−0.0011	−1.287
Education					
4 years high school	0,1			0.4095	0.240
6 years high school	0,1			0.2880	0.068
Vocational	0,1			0.2297	0.606
University	0,1	−0.0724	−0.307	0.4287	1.412
Farm household characteristics					
Other income	$	−0.0123	−5.173	−0.0058	−1.034
Children < 6	0,1	−0.5223	−3.493	0.3617	1.216
Farm characteristics					
Broadacre	0,1	0.1812	1.346	0.2880	1.065
Area characteristics					
New South Wales	0,1	−0.2302	−0.539	−0.3779	−0.596
Victoria	0,1	−0.0669	−0.156	0.0828	0.132
Queensland	0,1	−0.3552	−0.852	−0.7024	−1.121
South Australia	0,1	−0.0618	−0.145	0.0543	0.087
Western Australia	0,1	−0.1533	−0.361	−0.4523	−0.727
Tasmania	0,1	−0.1306	−0.273	−0.5495	−0.307
Wheat–sheep zone	0,1	0.0628	0.330	−0.1294	−0.344
High rainfall zone	0,1	0.0636	0.300	−0.2209	−0.495
Rural area	0,1	−0.0995	−0.430	0.4070	0.702
Remote area	0,1	0.0965	0.238	0.7176	0.739
Other remote	0,1	−0.2669	−1.030	0.0006	0.001

Log-likelihood function −755.4650; Pesudo R^2 0.1600; Rho 0.2695; *t*-value for Rho 2.5650.

sity education might approximate a substantial portion of the human capital that could enhance labour productivity on- and off-farm.

Age had a non-linear effect on participation in the non-farm sector. While the age coefficients had the expected signs in both equations, they were only significant in the spouse equation.

While education variables had a positive effect on participation rates, implying that education raises the spouse or operator's off-farm wage by more than its corresponding rise in their reservation wages, not all educational variables, particularly lower educational levels, are statistically significant (table 3). However, tertiary education increases the participation rates of operators and spouses. In the case of spouses, vocational schooling also increases their participation rates.

Also, though not statistically significant, the cross-effects of the operator or spouse tertiary education on participation rates are negative, suggesting that it could raise their reservation wages relative to the non-farm offer wage.

The presence of preschool children had a negative effect on the spouse's participation rate. As women constituted 99 per cent of the spouse observations, the negative effect of dependent children on the women's participation rate is likely to reflect the child-care demands on them. This finding is consistent with the findings by Gronau (1977); Heckman (1974); Huffman and Lange (1989) and, more recently, Pradhan and van Soest (1997) and Costa (2000).

Figure 2 plots this negative impact of having preschool children on the participation rate of a spouse who finished university education. With other factors being equal, the probability of a 35-year-old spouse accepting non-farm employment was 90 per cent if she had no young children compared with 78 per cent if she did.

The other income variable had a negative effect on participation rates, suggesting that time spent on leisure is a normal good but it is only significant

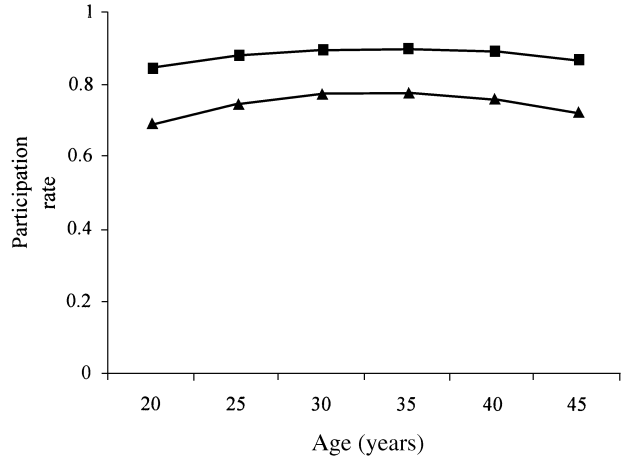

Figure 2 Effects of having preschool children and age on participation rate of spouses with university education. (■) Without preschool children; (▲) with preschool children.

in the spouse equation. Farmers residing in metropolitan and rural areas with high population densities are likely to have higher participation rates than those living in remote areas. Broadacre farmers were more likely to be active participants in non-farm work than dairy farmers. Dairy farming requires the presence of farmers at critical times each day. The industry variable had the expected sign but it was insignificant in both the spouse and operator equations.

5. Conclusions

In this study, participation in non-farm work was analysed as a jointly determined decision between Australian farm couples. Participation decisions of wives and husbands toward non-farm work were shown to be jointly determined. Impacts of personal, household, farm and locational characteristics on this joint decision to work in the non-farm sector were investigated using data from the 1994–1995 surveys of broadacre and dairy farms, conducted by the Australian Bureau of Agricultural and Resource Economics. In particular, the key hypothesis was that the important socioeconomic factors influencing the participation rates of farmers in non-farm work were their education, age, work experience, presence of preschool children, other income earnings and the characteristics of the non-farm labour market, such as the location of employment centres.

Results showed that the spouses' participation in the non-farm sector was relatively more sensitive to some personal (age and own educational levels) and household characteristics (other household income and presence of preschool children) than was the case for the operators. Participation in non-farm employment was more likely to increase at a declining rate with age among spouses than for operators.

The results also revealed that human capital, as captured in education, was essential in improving participation rates of farm spouses. Having tertiary/university education tended to raise the non-farm offer wages for spouses beyond their reservation wages more than it did for the operators. Moreover, finishing vocational schooling enhanced spouses' participation rates.

Spouses' participation in non-farm work was found to be related negatively to, and was relatively more sensitive to, changes in the levels of other income than it was for operators. This suggests that spouses may be significantly motivated by the desire to cope with shortfalls in the household's ability to procure necessities when other income was low and vice versa.

However, the presence of preschool children seemed to deter participation in non-farm work among spouses. Among spouses, there was a large dominant substitution effect away from non-farm work toward household

work. The child care demands of preschool children could have restricted the time available to spouses for non-farm work, thereby increasing their reservation wage.

References

Costa, D.L. 2000, 'From mill town to board room: the rise of women's paid labor', *Journal of Economic Perspectives*, vol. 14, pp. 101–22.

Department of Primary Industries and Energy and Department of Human Services and Health 1994, *Rural, Remote and Metropolitan Areas Classification 1991 Census Edition*, Australian Bureau of Statistics, Canberra.

Gould, B.W. and Saupe, W.E. 1989, 'Off-farm labor market entry and exit', *American Journal of Agricultural Economics*, vol. 71, pp. 960–9.

Gronau, R. 1977, 'Leisure, home production and work: the theory of time revisited', *Journal of Political Economy*, vol. 85, pp. 1099–123.

Gunter, L. and McNamara, K.T. 1990, 'The impact of local market conditions on the off-farm earnings of farm operators', *Southern Journal of Agricultural Economics*, vol. 22, pp. 155–65.

Heckman, J. 1974, 'Shadow prices, market wages and labour supply', *Econometrica*, vol. 42, pp. 679–94.

Huffman, W. 1980, 'Farm and off-farm work decisions: the role of human capital', *Review of Economics and Statistics*, vol. 62, pp. 14–23.

Huffman, W. and Lange, M. 1989, 'Off-farm work decisions of husbands and wives: joint decision making', *Review of Economics and Statistics*, vol. 71, pp. 471–80.

Judge, G.G., Griffiths, W.E., Hill, R.C., Lutkepohl, H. and Lee, T.C. 1986, *The Theory and Practice of Econometrics*, John Wiley & Sons, New York.

Lass, D. and Gempesaw, C.I.I. 1992, 'The supply of off-farm labor: a random coefficients approach', *American Journal of Agricultural Economics*, vol. 72, pp. 400–10.

Martin, S. and McLeay, F. 1998, 'The diversity of farmers' risk management strategies in a deregulated New Zealand environment', *Journal of Agricultural Economics*, vol. 49, pp. 218–33.

Mishra, A.K. and Goodwin, B.K. 1997, 'Farm income variability and the supply of off-farm labor', *American Journal of Agricultural Economics*, vol. 79, pp. 880–7.

Pencavel, J. 1986, 'Labor supply of men: a survey', in Ashenfelter, O. and Layard, R. (eds), *Handbook of Labor Economics*, *Vol. 1*., North-Holland Press, Amsterdam.

Pradhan, M. and van Soest, A. 1997, 'Household labor supply in urban areas of Bolivia', *Review of Economics and Statistics*, vol. 29, pp. 300–10.

Rasheed, C., Rodriguez, G. and Garnaut, J. 1998, 'Patterns of employment of men and women in farming', *Australian Farm Surveys Report 1998*, ABARE, Canberra, pp. 43–7.

Robinson, C., McMahon, P. and Quiggin, J. 1982, 'Labour supply and off-farm work by farmers: theory and estimation', *Australian Journal of Agricultural Economics*, vol. 26, pp. 23–38.

Rural Industries Research and Development Corporation 1998, *Missed Opportunities – Estimating the Current and Potential Contribution of Women in Agriculture*, Department of Primary Industries and Energy, Canberra.

Simpson, W. and Kapitany, M. 1983, 'Off-farm behavior of farm operators', *American Journal of Agricultural Economics*, vol. 65, pp. 801–5.

Sumner, D.A. 1982, 'The off-farm labor supply of farmers', *American Journal of Agricultural Economics*, vol. 64, pp. 499–509.

Tokle, J.G. and Huffman, W.E. 1991, 'Local economic conditions and wage labor decisions of farm and rural non-farm couples', *American Journal of Agricultural Economics*, vol. 73, pp. 652–69.

Weersink, A. 1992, 'Off-farm labour decisions by Ontario swine producers', *Canadian Journal of Agricultural Economics*, vol. 40, pp. 235–51.