Farm Work, Off-Farm Work, and Hired Farm Labor: Estimating a Discrete-Choice Model of French Farm Couples' Labor Decisions

Catherine Benjamin
Unitʼ d'Economie et Sociologie Rurales
INRA, Rennes

and

Ayal Kimhi
Agricultural Economics Department, The Hebrew University
The Center for Agricultural Economic Research
Rural Development Research Consortium
P.O. Box 12, Rehovot 76100, ISRAEL
Phone +972-8-9489376
Fax +972-8-9466267
E-mail: *kimhi@agri.huji.ac.il*

Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Montreal, Canada, July 27-30, 2003

Farm Work, Off-Farm Work, and Hired Farm Labor: Estimating a Discrete-Choice Model of French Farm Couples' Labor Decisions

by

Catherine Benjamin
Unit› d'Economie et Sociologie Rurales
INRA, Rennes

and

Ayal Kimhi
Agricultural Economics Department, The Hebrew University
The Center for Agricultural Economic Research
Rural Development Research Consortium

May 2003

Summary

We estimate jointly three types of discrete-choice labor decisions of farm couples: farm work, off-farm work, and hired farm labor. Using a 16-choice multinomial logit model, we find that operators' and spouses' farm labor are substitutes. Hired farm labor increases with farmers' qualifications, perhaps substituting for the couples' labor inputs. Other adults in the households substitute for the farm labor input of the farm couple and hired workers.

We acknowledge financial support from the Arc-En-Ciel – Keshet Program, the French-Israeli Scientific and Technical Cooperation Program, and the Yosef Nachmias Foundation.

Introduction

This paper presents the first attempt to estimate jointly three types of discrete-choice labor decisions of farm couples: farm work, off-farm work, and hired farm labor. Most empirical analyses of farmers' time allocations have focused on off-farm labor decisions. Few studies looked at either off-farm work and hired labor jointly or at off-farm work and farm work jointly. Here we estimate a model that encompasses all three decisions, using recent French farm census data.

In particular, we estimate a multinomial logit model with 16 choices, including all the permutations of four binary decisions: farm operator's off-farm work, spouse's farm work, spouse's off-farm work, and hired farm labor. All farm operators in our data set work on the farm by definition. Most previous analyses of the farmers' time allocation problem looked at the off-farm labor participation of the farm operators (e.g., Sumner 1982) or the joint off-farm labor participation of farm operators and their spouses (Huffman and Lange 1989; Tokle and Huffman 1991; Lass and Gempesaw 1992). Buttel and Gillespie (1984), Kimhi (1994) and Kimhi and Lee (1996) analyzed the joint farm labor and off-farm labor participation decisions of farm couples. Findeis and Lass (1992) and Benjamin, Corsi and Guyomard (1996) looked jointly at off-farm labor participation and the use of hired labor.

Benjamin, Corsi and Guyomard (1996), in an earlier analysis of French data, concluded that hired labor is a complement for the operator's farm work and a substitute for the spouse's farm work. However, this conclusion was reached without directly allowing for endogenous farm labor participation decisions. We believe that a more complete system of interrelations between the labor decisions can be found by adding the farm labor participation decision.

The following section provides a theoretical background and describes the empirical approach used in this paper. Most applications in the literature used a joint estimation of a system of participation equations for similar problems. Our view is that this strategy suffers from an internal incoherency problem. We described the alternative approach, which estimates a multinomial model. The paper continues with a presentation of the data used in this study and descriptive statistics of the dependent and explanatory variables. After that, the empirical results are presented and discussed.

Theory and empirical approach

Farm household models have been used for more than two decades to motivate empirical studies of farmers' time allocation. These models assume a unitary model of household utility maximization over consumption and leisure of all family members, subject to time and budget constraints. Huffman (1991) provided the most common specification of such models. Kimhi (1994) extended this specification to allow for zero farm work, after observing that in a multiple-person household, it is not necessarily true that all household members work on the family farm. There have been two opposite approaches in the literature to the treatment of hired labor. The original approach considered hired labor and family labor as perfect substitutes, and assumed that the wage of hired workers is equal to the off-farm wage of the farm family. In this case one obtains the usual separability property, that the wage determines farm labor input regardless of the off-farm participation decisions of family members. The opposite approach has been not to assume perfect substitutability, and treat hired labor as another farm input that does not deserve special attention when analyzing farmers' time allocation decisions.

In this paper, we too do not assume that hired labor and family labor are perfect substitutes, but we want to deal explicitly with hired labor for the sake of the empirical analysis. This is what Benjamin, Corsi and Guyomard (1996) did in their earlier study of French farm households, but they assumed an internal solution for the couple's farm labor input, and here we want to allow for corner solutions with respect to spouse's farm labor input. Hence, we use the concept of “effective labor input”, introduced by Deolalikar and Vijverberg (1987), which is a function of family labor input and hired labor input. Effective labor input is not necessarily measured in hours of work. In fact the unit of measurement is not important, because effective labor input appears as an argument in the farm production function only and does not have a market price. What is important for our purposes is that effective labor input is positive while individual labor inputs may be zero. Of course, at least one of the individual labor inputs must be positive.

Specifically, we assume that household utility (U) is a function of household consumption (C) and the vector of household members' home time, $\mathbf{T}_h$ (housework and leisure). Each household member can use his time endowment (T) for farm work (T_f), market work (T_m), and/or home time. Hence, the time constraint is (in vector notation):

(1) $$\mathbf{T}_f + \mathbf{T}_m + \mathbf{T}_h = \mathbf{T}.$$

Non-negativity constraints are imposed on market work and farm work of each household member: $\mathbf{T}_f \geq \mathbf{0}$ and $\mathbf{T}_m \geq \mathbf{0}$. Consumption is constrained by household income, which is composed of: (i) net farm income, which is explained below; (ii) off-farm labor income, which is the sum of off-farm earnings of all household members (Y_{mi}); and (iii) non-labor income (Y_o). Net farm income is farm income (Y_f), which is a function of effective farm labor input (L_f), minus the expenditures on hired workers (E), which is a nonlinear function of hired labor input (H). Effective labor input is denoted as $L_f(\mathbf{T}_f,H)$. The resulting budget constraint is:

(2) $$C = Y_f[L_f(\mathbf{T}_f,H);\mathbf{Z}_f] - E(H) + \Sigma_i Y_{mi}(T_{mi};\mathbf{Z}_{mi}) + Y_o.$$

The household optimization problem is to maximize $U(C, \mathbf{T}_h; \mathbf{Z}_u)$ subject to the time, budget, and non-negativity constraints, where $\mathbf{Z}_j$ are exogenous shifters of function j. The optimal solution is characterized by the Kuhn-Tucker conditions, which are the first-order conditions for maximizing the Lagrange function:

$$(3) \qquad U(C, \mathbf{T}_h; \mathbf{Z}_u) + \lambda \cdot \{ Y_f[L_f(\mathbf{T}_f, H); \mathbf{Z}_f] - E(H) + \Sigma_i Y_{mi}(T_{mi}; \mathbf{Z}_{mi}) + Y_o - C\} + $$

$$+ \mu_t \cdot [\mathbf{T} - \mathbf{T}_f - \mathbf{T}_m - \mathbf{T}_h] + \mu_f \cdot \mathbf{T}_f + \mu_m \cdot \mathbf{T}_m + \mu_H \cdot H$$

over $\{C, \mathbf{T}_h, \mathbf{T}_f, \mathbf{T}_m, H\}$ and minimizing it over $\{\lambda, \mu_t, \mu_f, \mu_m, \mu_H\}$. The farm work and off-farm work participation conditions of family members are, respectively, a subset of the Kuhn-Tucker conditions:

$$(4) \qquad \partial Y_f / \partial L_f \cdot \partial L_f / \partial \mathbf{T}_f \leq \mu_t / \lambda$$

$$(5) \qquad \partial \mathbf{Y}_m / \partial \mathbf{T}_m \leq \mu_t / \lambda$$

(in vector notation), where $\mu_t = \partial U / \partial \mathbf{T}_h$ and $\lambda = \partial U / \partial C$. Participation (an internal solution) occurs when the equality holds. Similarly, the decision to use hired labor on the farm relies on the condition:

$$(6) \qquad \partial Y_f / \partial L_f \cdot \partial L_f / \partial H \leq E'(H) / \lambda$$

If an interior solution occurs for all choices (all household members work both on and off the farm and hired labor is used on the farm), the participation equations (4)-(6) and the constraints (1)-(2) can be solved for the endogenous variables $\{C, \mathbf{T}_h, \mathbf{T}_f, \mathbf{T}_m, H, \lambda, \mu_t, \mu_f, \mu_m, \mu_H\}$ as functions of all the exogenous variables $\mathbf{Z}_u$, $\mathbf{Z}_f$, $\mathbf{Z}_m$, Y_o, and $\mathbf{T}$. This is the reduced-form solution. Using this solution in the participation equations, we can then determine which of the labor participation conditions is satisfied. If n is the number of potential workers in the household, there are 2n+1 participation equations, taking the forms:

(4)' $f_j(\mathbf{Z}_u, \mathbf{Z}_f, \mathbf{Z}_m, Y_o, \mathbf{T}) \leq g(\mathbf{Z}_u, \mathbf{Z}_f, \mathbf{Z}_m, Y_o, \mathbf{T})$, j=1...n;

(5)' $h_j(\mathbf{Z}_{mj}) \leq g(\mathbf{Z}_u, \mathbf{Z}_f, \mathbf{Z}_m, Y_o, \mathbf{T})$, j=1...n;

(6)' $k(\mathbf{Z}_u, \mathbf{Z}_f, \mathbf{Z}_m, Y_o, \mathbf{T}) \leq m(\mathbf{Z}_u, \mathbf{Z}_f, \mathbf{Z}_m, Y_o, \mathbf{T})$.

These participation equations are obtained by inserting the internal solution in (4)-(6), and replacing the relevant variable in each equation by zero.

Empirical applications of farmers' time allocation decisions mostly focused on the off-farm participation decisions, thereby estimating equations (5)' only, after adding multivariate normal additive stochastic terms. Earlier applications looked only at the farm operator, thereby using a binary probit model. Other applications looked at the joint participation decisions of the farm couple (operator and spouse), and mostly used a bivariate probit model. This approach suffers from an internal coherency problem. Recall that the right hand side of equation (5)' is obtained by dividing the internal solutions for μ_t and λ. If one specifies the spouse's off-farm participation equation as a probit equation, the coefficients of that equation are assumed to be independent of the operator's off-farm participation status. In fact, if the operator is not working off the farm, the internal solution is not relevant for the spouse's off-farm participation decision, and what needs to be used in the right hand side of (5') is a solution that is conditioned on the operator's off-farm labor supply being zero. Benjamin, Corsi and Guyomard (1996) showed that individual A's off-farm wage is only relevant for the off-farm participation decision of individual B if in fact individual A is working off the farm. Kimhi (1999) used a similar argument for the joint estimation of farmer women's farm and off-farm work participation equations, and showed that farm attributes affects on the off-farm participation decision significantly only when the woman is working on the farm. However, the endogenous switching model of Kimhi (1999) does not solve the problem completely since it imposes a one-direction conditioning of the participation equations, while in theory all participation equations are determined simultaneously.

A different approach that does not suffer from this internal coherency problem is the indirect utility maximization approach, which has been used by Benjamin, Corsi and Guyomard (1996) and by Ahituv and Kimhi (2002). In this approach, a labor regime is defined as one combination of outcomes of all the participation equations. The solutions for consumption and leisure in each regime are inserted into the utility function to yield a regime-specific indirect utility measure. The household is assumed to choose the regime that yields the highest indirect utility. The probabilistic model is obtained after adding a regime-specific additive error term to each of the deterministic indirect utility measures. A multinomial probit is obtained if a multivariate normal distribution is assumed for the stochastic errors. Alternatively, a multinomial logit model is obtained if the errors are assumed to have i.i.d. Weibull distributions. In this paper we adopt the multinomial logit specification due to the relatively large number of regimes that makes multinomial probit impractical unless one is willing to use simulation techniques.

Data and descriptive statistics

We use data from the 2000 General French Census of Agriculture. A random sample corresponding to 10% of the whole sample was drawn from that Census, totaling 65,593 family farms. The data set includes various farm and family attributes and personal characteristics of family members. In particular, it includes information on farm labor supply of family members and hired workers, and whether the operator and/or spouse work off the farm. We selected only farms operated by couples rather than by single operators, and only those in which the operator and spouse are between 18 and 65 years of age. In order to focus on family composition effects, we also excluded families that included elderly parents or siblings (older than 65 years of age). After eliminating observations with missing data, our working sample included 35,641 farms. We divided this sample into 16 labor regimes, including all the permutations of the binary variables indicating the female's work on the farm, the male's work off the farm, the female's work off the farm, and hired labor use on the farm. Note that all males reported working on the farm. Table 1 shows the households' distribution in the sample according to the sixteen labor regimes. About 33% of the males and 42% of the females work off the farm, and about 35% of the farms use hired labor. The previous General Census of the French Agriculture was in 1988. The most significant change over the last twelve years has been the substantial growth in off-farm labor participation by farm spouses

Explanatory variables include personal characteristics, family composition indicators, and farm attributes. Personal characteristics include age, agricultural education, general education, agricultural training since 1988, and number of years on the farm. Family composition indicators include the number of family members in various age groups: 0-6, 7-12, 13-17, and 18-65. Farm attributes include size category, major crop or livestock, the existence of diversification activities (accommodations, tourism, crafts, processing or sales of farm products), participation in a structural improvement program, receiving a farm set-up subsidy since 1988, and partnership status. Table 2 includes the definitions of explanatory variables and their sample means. We consider all these variables as pre-determined, although it may be argued that some of them are determined simultaneously with the labor regimes. Given this, one should be cautious when making causal interpretation of the results. However, this assumption enables a comparison to other results in the literature, as the vast majority of earlier studies used similar sets of explanatory variables.

We divide each of the educational attainment variables into three categories. The excluded group includes with less than secondary school leaving certificate. The two included binary variables are for those with a secondary school leaving certificate, and those with higher levels of education. We can see in table 3 that males are more likely to have had agricultural education and/or agricultural training than females, while females have higher general education. Regarding the number of adult family members, we see that more than half of the farm couples did not have any other family member older that 18 years. This is the excluded category. The farm size categories are defined using the concept of Standard Gross Margin (SGM). This is the value of output less the cost of variable inputs, calculated per crop or livestock item, by regions. The calculated SGM is using a three-year average of per-unit SGM multiplied by the number of actual units in each farm. An Economic Size Unit (ESU) represents a farm that is similar in SGM to 1.5 hectares of wheat. Among the farm type variables, the excluded category includes field-crop farms.

Empirical results

The multinomial logit results are reported in table 3. The excluded labor regime is regime 9, in which neither the male nor the female works off the farm, the female does not work on the farm, and no hired labor is employed on the farm. Each coefficient therefore represents the effect of an explanatory variable on the tendency of the farm family to choose a particular regime over the alternative of regime 9. Alternatively, one can think of each coefficient as the difference between the coefficients of a particular explanatory variable in the indirect utility functions of a particular regime and regime 9. To save space, we only report whether each coefficient is statistically significant at the 5% or the 1% levels (The full results, including standard errors and t-statistics, are available from the authors upon request). We find that each of the explanatory variables has statistically significant coefficients in at least some of the regimes.

However, because of the number of regimes it is not easy to interpret the coefficients. Hence, as in Benjamin, Corsi and Guyomard (1996), we derive the marginal effects of the explanatory variables. For the continuous explanatory variables (the ages, years on farm, and the numbers of young family members) we compute the derivatives of the probabilities of the regimes with respect to each of the explanatory variables, at the sample means of the explanatory variables. For the binary explanatory variables, we take the difference between two computed probabilities, one conditional on the variable being equal to unity and one conditional on the variable being equal to zero, when all other explanatory variables are at their sample means. In this latter computation we take into account that when a variable such as a certain farm type obtains the value of unity, all other farm type variables must obtain the value of zero.

Rather than presenting all the marginal effects (they are available from the authors), we compute the marginal effects of the explanatory variables on the marginal probabilities each of the participation indicators (female's work on the farm, male's work off the farm, female's work off the farm, and hired labor use on the farm), by adding up the marginal effects on the eight categories in which the relevant participation indicator obtains the value of unity. It is easier to interpret the marginal effects in this way. These are reported in table 4. Each marginal effect is accompanied by a pair of numbers in parentheses. The first number is the number of significant coefficients that have the same sign as the marginal effect, in the eight categories in which the relevant participation indicator obtains the value of unity. The second number is the number of significant coefficients that have a sign that is opposite to the sign of the marginal effect, in these same eight categories. Hence, the most reliable marginal effects are those that are accompanied by a (8,0) pair. The least reliable would be a marginal effect that is accompanied by a (0,8) pair. The sum of the two numbers in a pair could be at most eight. Eight minus the sum is the number of insignificant coefficients.

Starting with the personal characteristics, we find that an individual's age is negatively related to his/her off-farm work participation. This is true at the sample means, note in table 3 that the effects of age are nonlinear. Male and female ages have other significant effects, but one has to be cautions about these effects because the age coefficients are potentially contaminated by multicollinearity. Male agricultural education is negatively related to his off-farm work participation, while female agricultural education is positively related to her farm work participation and to the male's off-farm work participation. Male general education, on the other hand, is positively related to his off-farm work participation and to the female's farm work participation. Female general education is positively related to her off-farm work participation. It seems like the female's farm labor substitutes for the male's farm labor when she has more agricultural education and when he has more general education. Hired labor responds positively to all levels of education, both agricultural and general, of both the male and the female. The effect of agricultural education on hired labor could be due to an income effect: more educated farmers are more efficient, make more money on the farm, and afford to hire workers while devoting part of their own labor input to managerial tasks or even increase their leisure activities. The effect of general education on hired labor could be due to both income and substitution effects, as these effects work in the same direction. Training of either the male or the female has similar effects as agricultural education, and years of farm experience have similar effects as male agricultural education.

Children and adolescents are negatively related to both spouses' off-farm labor participation. Children up to age six are also negatively related to the spouse's farm labor participation. Other adults in the household are positively related to the couple's off-farm labor participation and negatively related to the female's farm labor participation and to hired labor. It seems like other adults substitute for the farm labor input of both the farm couple and hired workers.

We now turn to the farm attributes. Receiving a set-up subsidy since 1988 is negatively related to the couple's off-farm work participation and to the use of hired labor, but also to the female's farm work participation. Perhaps this variable is correlated with being a relatively young family and hence with the number of young children. Structural improvement on the farm is also negatively related to the couple's off-farm work participation, but is positively related to the female's farm work participation and to the use of hired labor. These farms are likely to be more productive hence require more labor input due to a scale effect. Diversification activities on the farm have the same signs of marginal effects as structural improvement, and this makes sense because these activities demand labor input. Partnership farms are negatively related to off-farm work participation and to the female's farm work participation, and positively related to hired labor. Perhaps the dominant form of partnership is an intergenerational partnership where the female specializes in household tasks of the extended family. Farm size is strongly associated with lower off-farm labor participation, higher female's farm labor participation and higher use of hired labor. The type of farm is also relevant for the labor choices, with most farm types requiring more labor than the excluded type of field-crop farms.

Discussion

Most of the explanatory variables have opposite-sign correlations with the female's farm work participation and her off-farm participation. This is a direct consequence of the female's binding time constraint. Most farm attributes and family variables have same-sign correlations with the male's and the female's off-farm participation. The opposite is true for the personal characteristics, because they often indicate a comparative advantage of one individual in farm or off-farm work that leads to increased specialization within the family. The farm attributes represent the farm labor demand, and hence also have positive correlations with hired labor. Family composition variables represent the demand for labor in household tasks (children) or the supply of labor (other adults). These affect both male and female similarly, and the correlations with hired labor are similar in sign to the correlations with female's farm labor participation. The effects of the number of other adults indicate that other adult substitute for the farm labor of the farm couple and also for hired labor. This conclusion may be relevant for policies that aim to promote farm succession by adult children of farm couples, but more work is required in this direction (see Kimhi 2001).

Unlike the conclusions of Benjamin, Corsi and Guyomard (1996), we find that the females' time allocation responds to farm-related incentives just as the males', and we also find that the females' farm labor substitutes for males' farm labor in certain circumstances. In addition, we find that hired labor mostly complements both male and female farm labor. Perhaps what we see here is an increased sharing of tasks and responsibilities of males and females, both on and off the farm, relative to earlier years.

Including the female's farm work participation among the dependent variables seems to be important. Not only are many coefficients of regime 1 statistically significant (table 3), it can easily be seen that the coefficients of regimes 2-8 are quite different from the coefficients of regimes 10-16. Hence, without taking explicit account of the female's farm labor participation, the results could have been qualitatively different.

References

Ahituv, Avner, and Ayal Kimhi (2002). "Off-Farm Work and Capital Accumulation Decisions Of Farmers Over the Life-Cycle: The Role of Heterogeneity and State Dependence." *Journal of Development Economics* **68**, 329-53.

Benjamin, Catherine, Alessandro Corsi, and Herve Guyomard (1996). "Modelling Labor Decisions of French Agricultural Households." *Applied Economics* **28**, 1577-89.

Buttel, Fredrick H., and Gilbert W. Gillespie (1984). "The Sexual Division of Farm Household Labor: An Exploratory Study of the Structure of On-Farm and Off-Farm Labor Allocation among Farm Men and Women." *Rural Sociology* **49,** 183-209.

Deolalikar Anil B., and Wim P.M. Vijverberg (1987). "A Test of Heterogeneity of Family and Hired Labor in Asian Agriculture." *Oxford Bulletin of Economics and Statistics* **49**, 291-305.

Findeis, Jill L., and Daniel A. Lass (1992). *Farm Operator Off-Farm Labor Supply and Hired Labor Use on Pennsylvania Farms*. Paper Presented at the Annual Meeting of the American Agriculrural Economics Association, Baltimore.

Huffman, Wallace E. (1991). "Agricultural Household Models: Survey and Critique." In M.C. Hallberg, J.L Findeis and D.A. Lass (eds.), *Multiple Job-holding among Farm Families*. Ames: Iowa State University Press, 79-111.

Huffman, Wallace E., and Mark D. Lange (1989). "Off-Farm Work Decisions of Husbands and Wives: Joint Decision Making." *Review of Economics and Statistics* **LXXXI,** 471-80.

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

Kimhi, Ayal (1999). “Estimation of an Endogenous Switching Regression Model with Discrete Dependent Variables: Monte-Carlo Analysis and Empirical Application of Three Estimators.” *Empirical Economics* **24**, 225-41.

Kimhi, Ayal (2001). *Family Composition and Off-Farm Participation Decisions in Israeli Farm Households*. Working Paper No. 15.01, The Center for Agricultural Economic Research, Rehovot, Israel.

Kimhi, Ayal, and Myoung-Jae Lee (1996). "Joint Farm and Off-Farm Work Decisions of Farm Couples: Estimating Structural Simultaneous Equations with Ordered Categorical Dependent Variables." *American Journal of Agricultural Economics* **78**, 687-698.

Lass, Daniel A., and Conrado M. Gempesaw (1992). "The Supply of Off-Farm Labor: A Random Coefficients Approach." *American Journal of Agricultural Economics* **74**, 400-11.

Sumner, Daniel A. (1982). "The Off-Farm Labor Supply of Farmers." *American Journal of Agricultural Economics* **64**, 499-509.

Tokle, J. G., and Wallace E. Huffman (1991). "Local Economic Conditions and Wage Labor Decisions of Farm and Rural Nonfarm Couples." *American Journal of Agricultural Economics* **73,** 652-70.

Table 1: Definitions and Frequencies of Labor Regimes

Regime	Female works on the farm	Male works off the farm	Female works off the farm	Farm uses hired labor	Relative Frequency (%)
1	yes	no	no	no	23.1
2	yes	no	no	yes	14.2
3	yes	no	yes	no	3.8
4	yes	no	yes	yes	2.8
5	yes	yes	no	no	6.9
6	yes	yes	no	yes	3.4
7	yes	yes	yes	no	4.5
8	yes	yes	yes	yes	1.9
9	no	no	no	no	4.2
10	no	no	no	yes	2.1
11	no	no	yes	no	10.1
12	no	no	yes	yes	7.1
13	no	yes	no	no	3.0
14	no	yes	no	yes	0.8
15	no	yes	yes	no	9.8
16	no	yes	yes	yes	2.4

Note: All males reported working on the farm.

Table 2. Definitions and Means of Explanatory Variables

Variable	Description	Unit	Mean
Age male		Years	46.85
Age female		Years	44.21
Ag educ m2	Male agricultural education, secondary school leaving certificate	0/1	0.27
Ag educ m3	Male agricultural education, higher level	0/1	0.15
Ag educ f2	Female agricultural education, secondary school leaving certificate	0/1	0.07
Ag educ f3	Female agricultural education, higher level	0/1	0.04
Gen educ m2	Male general education, secondary school leaving certificate	0/1	0.43
Gen educ m3	Male general education, higher level	0/1	0.15
Gen educ f2	Female general education, secondary school leaving certificate	0/1	0.39
Gen educ f3	Female general education, higher level	0/1	0.32
Training m	Male agricultural training since 1988	0/1	0.15
Training f	Female agricultural training since 1988	0/1	0.08
Years on farm	Years since current farm operator took over the farm	Years	16.20
Family 0-6	Number of family members up to 6 years of age	Persons	0.27
Family 7-12	Number of family members from 7 to 12 years of age	Persons	0.34
Family 13-17	Number of family members from 13 to 17 years of age	Persons	0.34
One other adult	Family includes 3 members from 18 to 65 years of age	0/1	0.23
Two other adults	Family includes 4 members from 18 to 65 years of age	0/1	0.15
3+ other adults	Family includes at least 5 members from 18 to 65 years of age	0/1	0.05
Setup subsidy	Obtaining a farm set-up subsidy since 1988	0/1	0.15
Struct improv	Having a structural improvement on the farm	0/1	0.08
Diversification	Having diversification activities on the farm	0/1	0.21
Partnership	The farm is part of a partnership	0/1	0.22
Size 2-3	Standard gross margin between 4 and 16 ECU	0/1	0.15
Size 4	Standard gross margin between 16 and 40 ECU	0/1	0.13
Size 5	Standard gross margin between 40 and 100 ECU	0/1	0.26
Size 6	Standard gross margin higher than 100 ECU	0/1	0.32
Type 2	Horticulture farm	0/1	0.20
Type 3	Fruit and wine production	0/1	0.24
Type 4	Dairy and beef cattle	0/1	0.12
Type 5-6	Hogs, poultry and other cultures	0/1	0.11
Type 7	Mixed livestock farms	0/1	0.11

Table 3. Multinomial Logit Results

Variable	Regime 1	Regime 2	Regime 3	Regime 4	Regime 5	Regime 6	Regime 7	Regime 8
Intercept	-8.2797 **	-12.856 **	-9.6305 **	-14.756 **	-17.191 **	-16.319 **	-16.000 **	-18.582 **
Age male	0.0613	0.0664	-0.0902	0.1147 *	0.5551 **	0.4221 **	0.4575 **	0.3890 **
Agesq/100 male	-0.0074	-0.0338	0.1255 *	-0.1198 *	-0.6407 **	-0.4624 **	-0.5946 **	-0.4715 **
Age female	0.2879 **	0.3710 **	0.5737 **	0.4638 **	0.3608 **	0.2578 **	0.5225 **	0.5034 **
Agesq/100 female	-0.3654 **	-0.4451 **	-0.7269 **	-0.5745 **	-0.4181 **	-0.3087 **	-0.6207 **	-0.6076 **
Ag educ m2	0.0022	0.1518	0.0912	0.224 *	-0.6715 **	-0.4961 **	-0.4855 **	-0.4121 **
Ag educ m3	-0.2411 *	0.2408 *	0.0367	0.3638 **	-0.7819 **	-0.4830 **	-0.6022 **	-0.0503
Ag educ f2	0.8558 **	0.9363 **	0.5520 **	0.3321	0.9315 **	1.1205 **	0.7832 **	0.8080 **
Ag educ f3	1.2902 **	1.4291 **	1.1284 **	0.7983 **	1.6323 **	1.7324 **	1.3156 **	1.3790 **
Gen educ m2	0.0187	0.0935	-0.1654 *	0.0336	0.3770 **	0.5473 **	0.3255 **	0.6527 **
Gen educ m3	-0.0986	0.2380 *	-0.3156 *	0.0966	0.6182 **	1.1528 **	0.5421 **	0.7975 **
Gen educ f2	-0.2640 **	-0.0098	0.4066 **	0.4065 **	-0.2079 *	-0.0153	0.3232 **	0.0600
Gen educ f3	-0.4945 **	0.0414	0.8593 **	1.2206 **	-0.3963 **	-0.0089	0.8280 **	0.8117 **
Training m	-0.0750	0.0473	0.2143	0.3996 **	-0.8047 **	-0.4076 **	-0.3436 *	-0.1363
Training f	1.6170 **	1.8177 **	0.8506 **	1.0879 **	1.8566 **	1.9417 **	0.8250 **	0.9548 **
Years on farm	-0.0301 **	-0.0166 **	-0.0339 **	-0.0213 **	-0.0608 **	-0.0429 **	-0.0527 **	-0.0495 **
Family 0-6	-0.5133 **	-0.4341 **	-0.6107 **	-0.5297 **	-0.4571 **	-0.4475 **	-0.8619 **	-0.7080 **
Family 7-12	-0.2214 **	-0.1571 **	-0.4299 **	-0.3237 **	-0.2803 **	-0.2409 **	-0.5298 **	-0.3378 **
Family 13-17	-0.0591	-0.0604	-0.1857 **	-0.1172	-0.1773 **	-0.0971	-0.4050 **	-0.3129 **
One other adult	0.1075	0.0240	0.1486	-0.0318	0.4595 **	0.4250 **	0.2926 **	0.1785
Two other adults	-0.0598	-0.1951 *	0.0582	-0.3321 **	0.3178 **	0.2782 *	0.1160	0.1237
3+ other adults	-0.1359	-0.4847 **	-0.0437	-0.4375 *	0.5374 **	0.2182	-0.1625	-0.5350 *
Setup subsidy	-0.2326 *	-0.2960 *	-0.3904 **	-0.4202 **	-0.6999 **	-0.6412 **	-1.1174 **	-1.2054 **
Struct improv	0.1946	0.3800 **	0.1080	0.2523	-0.1906	0.0433	-0.9583 **	-0.1053
Diversification	0.4424 **	0.8853 **	0.2891 **	0.7348 **	0.0318	0.5338 **	-0.2058 *	0.4278 **
Partnership	-0.1618	0.3455 **	-0.4544 **	0.1533	-0.4995 **	-0.0967	-0.5830 **	0.1468
Size 2-3	1.5802 **	2.0324 **	0.9812 **	1.3134 **	1.0561 **	1.4138 **	0.2659 *	0.9333 **
Size 4	2.2353 **	2.9218 **	1.2545 **	1.755 **	0.8966 **	1.9916 **	-0.5420 **	0.8841 **
Size 5	2.7245 **	3.8496 **	1.3349 **	2.5188 **	0.1702	2.0121 **	-1.8270 **	0.6372 **
Size 6	3.1385 **	4.7917 **	1.3489 **	3.2751 **	-0.1744	2.6469 **	-2.3728 **	1.0948 **
Type 2	0.3783 **	2.1808 **	-0.2948 *	1.7554 **	-0.1598	1.8373 **	-0.4752 **	1.8826 **
Type 3	1.1475 **	0.5961 **	0.5115 **	0.3011 *	0.2100 *	-0.0058	-0.2430 *	-0.2967
Type 4	0.8999 **	1.0002 **	0.1415	0.4884 **	-0.1599	0.4069 **	-0.8267 **	0.0020
Type 5-6	0.8400 **	1.2553 **	-0.0201	0.7536 **	0.0572	0.6625 **	-0.6316 **	-0.0172
Type 7	0.6981 **	0.5379 **	0.2314	0.2868 *	-0.0170	0.0334	-0.5410 **	-0.6046 **

* significant at 5%; ** significant at 1%.

Table 3. Multinomial Logit Results (continued)

Variable	Regime 9	Regime 10	Regime 11	Regime 12	Regime 13	Regime 14	Regime 15	Regime 16
Intercept	0	-4.9545 **	-6.564 **	-11.845 **	-13.014 **	-11.707 **	-13.6 **	-17.926 **
Age male	0	0.0872	-0.05	0.0661	0.7263 **	0.4035 **	0.504 **	0.4418 **
Agesq/100 male	0	-0.0971	0.0289	-0.0954 *	-0.8644 **	-0.4451 **	-0.6506 **	-0.5595 **
Age female	0	-0.0034	0.4713 **	0.4388 **	0.05	0.1036	0.451 **	0.4743 **
Agesq/100 female	0	0.002	-0.5929 **	-0.5546 **	-0.0554	-0.166 *	-0.5614 **	-0.5605 **
Ag educ m2	0	0.1134	0.1146	0.1534	-0.238 *	-0.3631 *	-0.2851 **	-0.1992
Ag educ m3	0	0.3848 **	0.2319 *	0.5813 **	-0.0751	-0.3385	0.2918 *	0.4685 **
Ag educ f2	0	0.0624	-0.3143 *	-0.6965 **	-0.3593	-1.4609 *	-0.4542 *	-0.2735
Ag educ f3	0	0.637 *	0.0336	0.4816 *	-0.2428	0.6861	-0.0236	0.6677 *
Gen educ m2	0	0.0619	-0.1231	0.1212	0.2785 **	0.4801 **	0.0961	0.1514
Gen educ m3	0	0.3839 *	-0.3393 **	0.0327	0.2669 *	1.2104 **	0.1278	0.4835 **
Gen educ f2	0	-0.0329	0.5463 **	0.802 **	-0.0639	-0.1979	0.5133 **	0.2961 *
Gen educ f3	0	0.3933 **	1.3752 **	1.9524 **	-0.0352	0.3069	1.1504 **	1.4327 **
Training m	0	0.2481 *	0.2869 **	0.4123 **	-0.3619 *	-0.3087	-0.2352 *	0.2657 *
Training f	0	0.3677	-1.0754 **	-1.0853 **	-0.5633	0.0745	-1.1677 **	-0.3766
Years on farm	0	-0.0018	-0.0155 **	-0.004	-0.0241 **	-0.0226 **	-0.0303 **	-0.0252 **
Family 0-6	0	0.0246	-0.3965 **	-0.3028 **	0.0571	-0.1186	-0.5959 **	-0.3652 **
Family 7-12	0	-0.0733	-0.3491 **	-0.2192 **	-0.1719 *	-0.059	-0.5966 **	-0.505 **
Family 13-17	0	-0.0686	-0.2348 **	-0.174 **	-0.0002	-0.1552	-0.3663 **	-0.3708 **
One other adult	0	-0.1584	0.2455 **	0.1117	0.2364 *	0.3609 *	0.3614 **	0.1398
Two other adults	0	0.0259	0.2257 *	0.0511	0.3821 **	0.461 *	0.1142	-0.0643
3+ other adults	0	0.0019	0.4701 **	0.3249 *	0.5793 **	0.2952	0.3721 *	0.576 **
Setup subsidy	0	-0.768 **	-0.1354	-0.26 *	-0.7511 **	-0.6217 *	-0.886 **	-1.0497 **
Struct improv	0	-0.0556	0.0413	0.2588 *	-1.3517 *	-0.1907	-0.4588 *	-0.0715
Diversification	0	0.4619 **	-0.0659	0.4468 **	-0.3514 **	0.2244	-0.5251 **	0.2097 *
Partnership	0	0.6595 **	-0.0692	0.3659 **	-0.2026	0.2627	-0.2379	0.1352
Size 2-3	0	0.7374 **	0.3824 **	0.9007 **	-0.3959 **	0.5488 **	-0.3173 **	0.3017 *
Size 4	0	0.8271 **	0.6466 **	1.3287 **	-1.3793 **	-0.0304	-1.2947 **	-0.1521
Size 5	0	1.825 **	0.7131 **	2.0088 **	-2.6457 **	-0.1819	-2.4698 **	-0.355 *
Size 6	0	2.626 **	0.7115 **	2.5154 **	-3.9624 **	0.5749 *	-3.5556 **	-0.0233
Type 2	0	2.1436 **	-0.3176 **	1.7151 **	-0.7942 **	1.6712 **	-1.3847 **	1.4696 **
Type 3	0	-0.2432	0.1465	0.0363	-1.146 **	-0.7175 **	-1.1077 **	-0.4665 **
Type 4	0	0.2222	-0.2523 *	-0.0766	-1.2366 **	-0.3365	-1.5017 **	-0.7912 **
Type 5-6	0	0.6597 **	0.0237	0.6732 **	-1.3505 **	-0.0151	-1.4311 **	-0.1393
Type 7	0	0.0456	0.1019	0.1271	-0.6927 **	-1.0915 **	-0.8154 **	-0.5214 **

* significant at 5%; ** significant at 1%.

Table 4. Marginal Effects

Variable	Female farm work	Male off-farm	Female off-farm	Hired labor
Age male	0.013 (5,0)	-0.015 (8,0)	-0.013 (6,1)	-0.001 (6,0)
Age female	0.001 (8,0)	0.003 (7,0)	-0.006 (8,0)	0.002 (0,7)
Ag educ m2	-0.021 (4,1)	-0.097 (7,0)	0.020 (1,3)	0.019 (1,3)
Ag educ m3	-0.100 (3,4)	-0.063 (3,2)	0.095 (5,1)	0.080 (4,1)
Ag educ f2	0.214 (7,0)	0.013 (4,2)	-0.165 (3,3)	0.013 (3,2)
Ag educ f3	0.210 (8,0)	0.049 (5,0)	-0.151 (0,6)	0.042 (7,0)
Gen educ m2	0.022 (4,1)	0.062 (6,0)	-0.023 (1,2)	0.035 (3,0)
Gen educ m3	0.041 (5,1)	0.136 (7,0)	-0.056 (2,3)	0.101 (6,0)
Gen educ f2	-0.092 (2,3)	0.002 (2,2)	0.133 (7,0)	0.031 (3,0)
Gen educ f3	-0.257 (2,4)	0.006 (4,1)	0.351 (8,0)	0.101 (5,0)
Training m	-0.061 (3,1)	-0.080 (3,3)	0.080 (4,2)	0.036 (4,1)
Training f	0.316 (8,0)	0.015 (4,1)	-0.287 (3,4)	0.048 (4,1)
Years on farm	-0.004 (8,0)	-0.004 (8,0)	0.001 (0,7)	0.002 (0,6)
Family 0-6	-0.048 (8,0)	-0.013 (6,0)	-0.019 (8,0)	0.015 (0,6)
Family 7-12	0.008 (0,8)	-0.024 (7,0)	-0.047 (8,0)	0.015 (0,6)
Family 13-17	0.020 (0,4)	-0.024 (6,0)	-0.041 (7,0)	0.004 (0,3)
One other adult	-0.005 (0,3)	0.047 (6,0)	0.012 (3,0)	-0.021 (0,2)
Two other adults	-0.032 (2,2)	0.044 (4,0)	0.020 (1,1)	-0.027 (2,2)
3+ other adults	-0.108 (3,1)	0.067 (4,1)	0.068 (4,2)	-0.049 (3,2)
Setup subsidy	-0.014 (8,0)	-0.097 (8,0)	-0.023 (7,0)	-0.032 (8,0)
Struct improv	0.037 (1,1)	-0.075 (4,0)	-0.033 (2,1)	0.044 (2,0)
Diversification	0.095 (6,1)	-0.063 (3,3)	-0.075 (2,5)	0.110 (7,0)
Partnership	-0.035 (3,1)	-0.044 (3,0)	-0.008 (2,1)	0.112 (3,0)
Size 2-3	0.248 (8,0)	-0.156 (2,6)	-0.135 (1,7)	0.079 (8,0)
Size 4	0.384 (7,1)	-0.395 (3,3)	-0.264 (2,5)	0.156 (6,0)
Size 5	0.454 (6,1)	-0.601 (4,2)	-0.352 (3,5)	0.282 (6,1)
Size 6	0.518 (6,1)	-0.648 (3,3)	-0.423 (2,5)	0.427 (7,0)
Type 2	0.136 (5,2)	-0.092 (3,4)	-0.140 (4,4)	0.477 (8,0)
Type 3	0.209 (5,1)	-0.196 (5,1)	-0.173 (3,2)	-0.040 (2,2)
Type 4	0.230 (4,1)	-0.202 (4,1)	-0.220 (4,1)	0.066 (3,1)
Type 5-6	0.180 (4,1)	-0.188 (3,1)	-0.183 (2,2)	0.135 (5,0)
Type 7	0.133 (4,2)	-0.167 (6,0)	-0.122 (4,2)	0.001 (2,3)