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Farm investments under uncertainty

Pasi Lempiö

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TUTKIMUKSIA 219

Farm investments under uncertainty

Pasi Lempiö

Selostus: Maatalouden investoinnit
epävarmuuden vallitessa

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Foreword

Many farmers are considering enlargement investments in order to improve the profitability of production. However, uncertainty makes planning difficult, especially in terms of the common investment planning tools such as present value method and budgeting. An enlargement investment is crucial to the existence of investing farm if the investment is large compared to the initial firm size. This is especially true because in agriculture, investments are at least partially irreversible, i.e., the initial investment outlay cannot be recovered fully if the investment turns out to be unprofitable. However, uncertainty and risk belong to entrepreneurship. This fact has to be accepted, and an appropriate compensation for the related risks must be required. On the other hand, uncertainty creates possibilities to make profit if the future development is favourable.

As a consequence of Finland's accession to the European Union since January 1, 1995, the market conditions for agriculture changed rapidly. While the profitability of farming is decreasing due to the regressive national aid schemes, the need for making production more efficient is increasing. One way to do this is to increase the firm size. The growth of farm size is one of the most important research topics in the agenda of the Agricultural Economics Research Institute. For example, the methods for investment analysis that account for uncertainty and irreversibility of investment have been adopted.

In this report, the investment analysis is applied to farm models that represent the main production lines of the Finnish agriculture. Budgeting and profitability calculations are applied to investment problems in which a firm is assumed to grow from a small size to a larger size. The results suggest that a substantial excess liquidity is required for compensating the risks involved in the conjectured investments.

The report has been written by Pasi Lempiö. Acknowledgements are due to Kyösti Pietola whose supervising helped greatly to create the report, and to Ossi Ala-Mantila who has developed the farm models employed in the study.

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Helsinki, May 1997

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FARM INVESTMENTS UNDER UNCERTAINTY

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Abstract. The commonly used planning tools implicitly assume that the future prices and subsidies are known for sure. However, this is not very realistic. Fortunately, there is a new planning method, known as a real options approach, for investment decision-making under uncertainty. Additionally, the familiar budgeting results are simulated with different future scenarios of product prices and levels of aid in order to reveal the impact of uncertainty on liquidity. These investment analysis techniques were applied on farm models that represent the main production lines of Finnish agriculture.

The future uncertainty has a great impact on the profitability of an investment because there should be initially an adequate compensation for the related risks. The uncertainty increases the initial return requirement 1.2-2.3 times higher than that of expected returns. The initial risk compensation should be required in the cash flow budget as well. Because uncertainty makes many projects unprofitable, a stable agricultural policy would be an essential incentive for investments because it reduces the required risk compensation and, thus, improves the profitability.

As a consequence of the above, current production technologies appear to have too high investment outlays compared to the current net returns. Thus, there is a need to develop new cheaper technologies and increase the annual return per unit. Both would increase the initial return to investment. However, the existing investment aid schemes seem to make many investment projects profitable, or at least close to it.

In the cases studied here, the investment did not improve the cash flow situation of the farm household considerably if the farm was indebted prior to the new investment. As a result, the new investment will solve liquidity problems of such farms only if the economic conditions are favourable in the future.

The results clearly indicate that uncertainty has to be taken into account when investment plans are made. The methods introduced in this study appear feasible and they are applicable to actual planning situations.

Index words: budgeting, farm investment analysis, real options method, uncertainty

Contents

1. Introduction

Due to EU membership in the beginning of 1995, the future uncertainty of Finnish farms has increased and this situation is not likely to change. This has become a problem for farms, especially when an investment project is appraised, since the long-term investment decisions will influence the farm during its whole lifetime and, in particular, the outcomes of investment are crucially affected by the future uncertainty.

Traditional economic planning tools have shortages in modelling stochastic changes in the operating environment of a farm. The most commonly used planning tool is budgeting for a farm household that indicates the liquidity of household. It is rational to use the household approach in the liquidity analysis since on a family firm all income sources are typically used for the financing of major investments. But, it is essential to investigate the impact of the new investment to the liquidity situation.

The illustrated liquidity is typically connected to the future scenario of prices, aid levels, and physical productivity that are assumed when the calculations are made. The uncertainty of investment is either not analysed at all or it is analysed with expected returns, which gives correct investment recommendations only under certain restrictive assumptions.

Thus, farm managers, advisors, and authorities, who make decisions on investments and investment aids, need new methods for making correct decisions under risky circumstances. Especially investment decisions must be analysed appropriately because a decision that is made now determines to a great extent the future economic situation of the farm in question.

However, there are methods to incorporate risks in economic plans. This study makes a contribution to this by illustrating that the use of these methods is as easy as the use of the familiar ones. More specifically, investment analysis methods that incorporate uncertainty are applied to farm models developed at the Agricultural Economics Research Institute.

The results of this study are of the farm level nature. However, one should always remember that farms are heterogeneous in many aspects. Additionally, some policy impacts can be viewed. The results can be classified into two categories: the profitability of investment, and the liquidity and financing of investment.

The primary results of the profitability section are maximum bid prices that indicate how much an investment can at the most cost when a compensation is required to the risk related to the project. The outcomes of the liquidity and financial analysis indicate the borrowing capacity of the farm because this is important if the investment is financed by credit. In addition to this, such combinations of price and aid for the main product are presented that the household can just pay for all cash obligations. Thus, the difference compared to the current situation can be illustrated. What is more, the results of the profitability and liquidity calculations are compared with respect to the required compensation for risk.

The investment analysis is applied to some of the major production lines in the Finnish agriculture that are the following: dairy farming, pig husbandry, and cropping.

In Chapter 2 investment analysis methods and the data of the study are presented. From Chapter 3 to Chapter 6, these investment analysis techniques are applied to farm models representing various production lines of the Finnish agriculture. The reader can follow this report without going through all of these chapters. Chapter 7 concludes and summarises the study.

2. Method

The purpose of investment plans is to find real assets that are worth more than they cost (Brealey and Myers 1988, p. 11). The investment planning can be divided into profitability analysis and liquidity analysis. As the investment analysis methods are normative tools, example plans are made to the farm models.

2.1. Review of the farm models

The investment analysis techniques are applied to farm models (Ala-Mantila 1996). They are based on extensive physical information that is underlying behind any real farm. The farm models represent homogenous groups of Finnish farms that participate in the farm accountancy data network established on the basis of the size and the production line of the sample farms. They also provide the information on the non-agricultural income and consumption of the farm household. The household consumption is close to that of an average Finnish household.

The farms belong to the major production lines in Finnish agriculture: dairy, piglet farrowing, and pig fattening. In addition, the analysis of cereal production is based on farm level gross margin calculations.

A farm expansion is investigated by using two farm models in each expansion case. The main production line of a smaller farm model is expanded to the size of the larger one. This way the investment problem can be isolated in such way that, for instance, only the number of pigs increases on a pig farm, not the arable area. Because the models are based on operating farms the economies of scale between the two farm sizes are implicitly taken into account. The features of the farm models are presented at the beginning of each chapter.

The difference in the annual net cash flows of the two farm models is the incremental return to the expansion investment. Thus, besides cash flows, the incremental labour input is also derived from the farm models. The modelled enlargement increases the total labour use on the farm, and this is divided by additional production units. The opportunity cost of labour is assumed to be FIM[1] 40.0 per hour. The opportunity cost of labour is subtracted from the annual net cash flow when the return to the expansion investment is determined. In many cases, however, the opportunity cost of farm household labour is very low due to the restricted access to off-farm employment.

Finland is divided into three major areas, A, B and C, for the regional distribution of agricultural aid (e.g. Kettunen 1996). The investment calculations are made for Area B (Southern Finland) and Area C1 (Central Finland). Milk production is the most common production line in Area C1. Pig husbandry is concentrated in areas A and B and the west coast of Area C1.

There are no considerable differences in the aid levels between areas A and B, so the results from Area B approximate the situation in Area A as well. The extra aid for Southern Finland (Article 141 in the EU Accession Treaty) will be renegotiated in 1999. The worst possible outcome is that there would be no aid measures for animal husbandry after 1999 in areas A and B. But this is not the only policy risk facing the Finnish agriculture, since the whole CAP will undergo another reform in near future. Thus, besides the price risk, a considerable policy risk exists. The aid for young farmers (younger than 40 years) is included in the total amount of aid in both areas examined.

The market prices of inputs and products are identical in both areas examined. The prices and aids are the net of the value added tax (VAT), and, consequently, the maximum bid price does not include the VAT. The investment is planned for 1997. The assumed product prices and aid scenarios are presented in Appendix 1. Input costs and, thus, input prices are used as they were in the farm models.

Productivity increase

The concept of *productivity* is defined as an output divided by inputs used in producing the output. Increasing productivity is also referred to as *technical change*. In this study, the size of the farm and the technology are fixed after the initial investment. Thus, the sources of productivity increase are mainly restricted to the development of biological processes, that is, to animal and plant breeding.

Productivity increase is modelled in a simple manner because it is not of the main interest in this study. In the real options model, the increase in the productivity is included in the expected change in the returns of the investment.

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[1] 1 FIM = ECU 5.80

In the liquidity analysis, the productivity increase is taken into account as a decreasing operating expenditure with a constant output.

A contrary view exists of using the productivity increase, according to which, it increases the net returns to farmers, and the aggregate production volume grows, and this results in a decrease in the market prices. This might eliminate any monetary gains from productivity increase. However, the productivity increase is included in the calculations. Implicitly, it is assumed that at least part of the technical change results in lower operating costs that will not directly increase production.

2.2. Profitability of investment

This study employs the real options approach as a method for evaluating the profitability of an investment. The approach accounts for uncertainty and potential irreversibility of the initial investment outlay. The decision problem is formulated as a decision between two choices: invest now, or wait and invest later (Dixit and Pindyck 1994).

If the following inequality (1) is met the investment project is profitable and, thus, it can be carried out immediately. For more details, see Dixit and Pindyck 1994 and Pietola 1996.

$$\frac{R}{I} \geq \frac{\beta}{\beta-1}(\rho+\delta-\alpha), \tag{1}$$

$$\text{subject to } \beta = \frac{1}{2} - \frac{\alpha}{\sigma^2} + \sqrt{\left(\frac{\alpha}{\sigma^2} - \frac{1}{2}\right)^2 + 2\frac{(\rho+\delta)}{\sigma^2}}$$

where :

R = Return to capital that is defined stochastic and follows a geometric Brownian motion

I = Investment cost

ρ = Discount rate

α = Annual drift rate of R, $E(dR/R)$.

δ = Geometric depreciation rate

σ = Standard deviation of R that grows with square root rate to time, that is, the farther the returns are forecast the more uncertain the forecast is.

For maintaining internal consistency of the decision rule, the discount rate ρ must also be in real terms if the return R and its future development is determined in real terms (Brealey and Myers 1988, p. 98).[2] For instance, a nominal bank rate of 7.0 % is comparable to the discount rate of 5.9 %, given the inflation rate is 1.0 %.

The values of α are derived from the expectations of the development of aid, whereas the prices are expected to remain at the current level. The assumption of productivity increase is included in α as well.

The depreciation rate δ has to be determined without any risk adjustments since the real options model accounts for uncertainty in other respects.

The introduction of uncertainty to the return stream extends the present value investment rule by a new component. The option value multiple *OVM* ($\beta/(\beta-1)$) increases the return requirement to the present value multiple *PVM* ($\rho + \delta - \alpha$). Otherwise the project should be postponed. The more volatile (a higher σ) the returns are and the longer is the remaining life of the project, the more incentive there is to delay the investment and keep the option alive.

Rodrik (ref. Dixit and Pindyck 1994, p. 315) argues that policy uncertainty eliminates any stimulative effect of tax incentives for investments. Thus, taxes are not accounted for when the real options model is utilised. The application of real options approach is also simple when taxes are excluded.

The optimal decision rule (1) is applied for solving a maximum bid price of investment. If this exceeds the current investment cost, the model recommends investing. Thus, the current investment cost level can be appraised. Also, when I is considered as given (e.g. a current investment cost) a minimum return can be solved as easily as the maximum bid price. Minimum returns are calculated for the comparison between the liquidity analysis and the real option analysis.

2.3. Financing and liquidity constraints

Financing

After determining the profitability of the investment, its financial feasibility must be considered. Farmer's financing alternatives can be divided into equity and non-equity financing. Equity financing is typically savings or realisation of real capital, usually machinery or timber. Usually, the financing of agricultural investment is a combination of equity and credit. Besides banks, authorities who grant investment aid require that a certain portion of the investment is equity financed. Non-equity financing can be bank credit and/or public investment support.

In order to get credit, the farm has to possess adequate collateral and show its capability to pay back the loan. The collateral is assumed to be 60 % of the

[2] The discount rate is adjusted for inflation by the following formula (Brealey and Myers 1988, p. 97-98): $\textit{Real rate} = \frac{1 + \textit{nominal rate}}{1 + \textit{inflation rate}} - 1$

total market value of the real estate less selling costs (MAF 1996, p. 31). The market values of land are obtained from Maanmittauslaitos (1995). The value of buildings are estimates that are based on current costs. However, agricultural production buildings are not always approved for collateral at all.

The assumed financing in the following liquidity statements is such that a 25 % equity financing is used along with the non-equity financing. The nominal interest rate of the credit is assumed to be 7.0 %, which represents the cost of standard bank credit, and the repayment term is 15 years. The effect of investment aid to the liquidity situation is determined separately.

Liquidity

On a family farm, all different income sources of the farm household are typically used to finance large investments. Therefore, the financial feasibility of investment is determined by complete cash flow budgeting that includes all income sources. Taxes are computed with current tax rates and under the assumption that the taxable income is halved between two spouses. During the whole planning horizon, the non-agricultural income and household consumption are assumed to remain at the same level where they were before the investment.

A budget is needed to determine the feasibility of the investment project. The cash flow statement can be made as a break-even analysis. That is, a feasible price and aid combination of the main production line is determined for the farm household. An alternative approach would naturally be to determine a maximum bid price for the investment from the liquidity point of view. A cash flow statement requires assumptions on prices and aid levels. Thus, the maximum bid price is an outcome of these. In real world, however, the investment cost is at least approximately known but the future prices and support levels are uncertain. The break-even analysis is consistent with this fact and, consequently, it was chosen. With the break-even price and aid, the return to capital can be determined and this can be compared with the minimum return of the corresponding similar real options case. Thus, the relation of the budgeting and real option approach as planning tools for decision-making can be appraised. Also, the price and aid that produce the minimum return can be included into the liquidity model and thus an initial cash compensation for risk can be appraised.

All payments for arable land are expected to stay at their current levels in the animal husbandry cases. Further, the liquidity analysis is not separated to Area B and Area C1 because the arable payments are so close to each other in these areas that the break-even price aid combination is neutral between the these support areas.

The cash flow analysis distinguishes between two factors in the liquidity situation: the cash flow situation of the expanded farm and the impact of the new investment on the farm. The financial situation before the new investment may determine the feasibility of any new projects.

The farm model is assumed to have a certain amount of credit prior to the new investment. The amount varies between the farm models. However, it is also analysed how the break-even price and aid change if the farm had not any debt prior to the new investment.

Liquidity analysis should rather be performed in nominal terms but present expectations of inflation are low (≈1 %), and thus the inflation correction did not appear to be necessary.

The liquidity analysis is done for two cases: the current investment cost, and the maximum bid price of the real options model. For both cases, the effect of investment aid is determined. It should be noted that the investment aid also increases the maximum bid price of investment.

3. Piglet farm

Pig husbandry is typically highly specialised in Finland: one farm produces piglets that are transferred to another farm that fattens them to the slaughter weight. This chapter begins with a brief introduction of the physical aspects of the farm models that are used. The economic features appear in the following sub-chapters that present the results of the investment analysis.

The farm produces 20 piglets per sow in a year. The target production capacity is 65 sows or 1,280 sold piglets in a year (Table 1). Since pigs need all cereals that are produced on the farm as fodder piglet is the only sales product.

Table 1. Characteristics of the piggery expansion

	Starting point	Goal
Number of sows	28	65
Arable land, ha	24	24
Sows / arable ha	1.2	2.7

No additional arable land is purchased. In the base situation, the arable area is more than adequate for the fodder cereal production. Thus, some cereals are sold. The increase of sows results in a self-sufficiency in fodder cereals, nothing is sold or purchased. At the moment, the price ratios are such that it is profitable to mix the sow fodder at the farm. The piglet fodder, however, is manufactured fodder. The current arable area of the farm is sufficient to qualify for the environmental aid (GAEPS[3]) after the expansion of piglet production.

Estimating productivity increase

On a piglet farm, the most of the costs and returns accrue from pig husbandry. Therefore, the productivity of pigs is of main importance. The amount of reared piglets per sow has been found one of the key factors that affect the profitability of a sow farm. However, there is no information available on the physical productivity development of sows in the farm model. In the production recording farms, the piglet production per sow has been about the same during the past ten years. During that time, the average piglet production has been only some tenths higher than in this case farm, namely 20.3 piglets per sow in a year (Lampinen 1996). As a conclusion, the fertility of sows is not assumed to increase in the future. However, the fodder conversion ratio (FCR) and daily liveweight gain affect piglet growing as well as pig fattening, which is the subject of Chapter 4.

The productivity increase is estimated using the results of Finnish breeding pigs, although the *absolute* productivity level of an average farm is lower than that of the top breeding stock. However, the *relative* change of productivity can be assumed similar to that of the breeding stock. Finnish breeding pigs are tested in specific experimental stations for productivity (fodder conversion ratio[4] (FCR) and daily liveweight gain). After reaching the target weight, meat and carcass quality are also analysed. The factors that affect productivity the most are FCR and the percentage of the carcass weight of live weight. Also, the daily gain affects the growth time of pigs and, thus, the annual turnover. According to the results from the experiment stations, the three qualifications have advanced annually by the total of some 1 % of the level of 1995 in 1985-1995 (Kuosmanen 1995, Haltia 1996). However, since piglet is the final product for the piglet farm, it does not benefit from all progress, for instance, an increased meat percentage benefits mainly the pig fattening farm. Thus, a 0.75 % productivity increase is used for the piglet farm.

Productivity increase is applied in a simple manner because it is not of the main interest in this study. The productivity increase is included in α in the real options model. In liquidity analysis, the productivity increase is taken into account as a decreasing operating expenditure with a constant gross output.

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[3] GAEPS = General Agricultural Environmental Protection Scheme. For instance, GAEPS sets fertilization target levels. In addition, animal husbandry farms in Areas A and B (Southern Finland) are allowed to have the maximum of 1.5 LU per 1 ha of arable land (e.g. Pirttijärvi et al. 1995).

[4] Fodder usage per kg of live weight gain.

3.1. Profitability of the expansion

The investment calculation is based on the current return per sow R, which is determined first. Then, the four terms of the real options model (ρ, δ, α, and σ) that determine the required rate of return are introduced, and maximum bid prices are computed by using these terms and R. The maximum bid price is then compared with current investment costs. An alternative result is a minimum return that is required with the current investment cost. The minimum return is also used in the comparison between the real options results and the following liquidity calculations.

The incremental return for capital R is determined per an additional sow by using the information of the farm model. The piglet price is FIM 310. In both areas, A and C1, R is almost identical, which is quite natural since the aid per sow is also almost identical in 1997 (Table 2).

Table 2. Current (1997) return to the planned enlargement, FIM per sow.

	Area B	Area C1
Incremental net cash flow	3,830	3,840
Opportunity cost of labour	1,550	1,550
Return to capital, R	2,280	2,290
Incremental aid included in R	1,380	1,390

Typical piggeries are built of durable materials, such as concrete. Consequently, a low depreciation δ rate was selected. The piglet prices have been even more volatile than pigmeat prices in Germany and Denmark, i.e. the standard deviation of piglet price has been 15 % (Pietola 1996). In addition, there is a considerable policy uncertainty that is also accounted for by using a rather high standard deviation of R (σ = 30 %). The return requirement for the piggery expansion is computed using (1) in Table 3.

With the assumptions above, the return to investment R/I should exceed 25 % in Area B and 22 % in Area C1 in order to start the project (Table 3). The option value multiple *OVM* makes the difference between uncertain and certain returns: stochastic returns yield a threshold return requirement that is 1.6-1.8 times higher than the respective *expected* return (*PVM*). The reason why *OVM* is lower in Area B than in Area C1 is the fact that the expected return stream has a declining trend (negative α) in Area B. This gives an incentive to invest early in order not to lose the highest returns. In Area C1, however, the uncertainty has a greater effect than in Area B since the returns are expected to remain approximately at the current level.

Table 3. Return requirements for piggery investment per sow.

	Area B	Area C1
Current return to capital (1997), *R* (from Table 1, FIM)	2,280	2,290
Discount rate, ρ	5.9 %	5.9 %
Depreciation rate, δ	6 %	6 %
Expected rate of change of *R*, α	-0.04	0
Present value multiple, *PVM* (= $\rho + \delta - \alpha$)	15.9 %	11.9 %
Standard deviation of *R*, σ	0.3	0.3
Option value multiple, *OVM*	1.55	1.83
Required rate of return, *R/I* (*PVM* $\times$ *OVM*)	24.7 %	21.9 %
Maximum bid price, *I* [= *R*/(*R/I*), FIM]	9,250	10,490

All costs of the enlargement have to be covered by the maximum bid price, including the purchases of additional livestock, other operating capital, buildings, and machinery. The typical current prices of these required investment items are listed in Table 4.

Table 4. Investment costs per sow, FIM.

Item	Traditional building	Cheap building
Livestock (gestating young sow)	3,500	3,500
Other operating capital	880	880
Buildings and machinery	16,000	10,000
Total investment cost	20,380	14,380

Sources: Enroth 1995, Keski-Suomen MSK 1996, MAF 1996, MT 1996.

The price of sow is the current purchase price. The operating capital needed to start the production is obtained from Enroth (1995) with the modification that the opportunity cost of labour was deducted. This was done because it is already taken into account in the return *R*. The cost of piggery per sow is typically some FIM 16,000 (building and machinery). Typically, as the production capacity of the building increases, the cost per capacity decreases. Also, when an existing building is expanded and the current building is useful, the investment cost per an additional sow can be considerably lower than presented above. Additionally, the deep litter type housing for gestating sows functions better than it functions for fattening pigs. This building type can save in the costs of manure storage facilities (Keski-Suomen MSK 1996, MAF 1996).

Consider the differences between the bottom lines in Table 3 and in Table 4. Both investment costs are higher than the maximum bid price. The difference is considerable. In this case *the decision concerning the investment is to wait.* In order to start the project the investment outlay can be at its highest equal to the maximum bid price, or R has to be higher. This means that a minimum return R_m can be determined by multiplying the total investment cost in Table 4 by R/I in Table 3. R_m is FIM 5,030 in Area B and FIM 4,460 in Area C1 when the higher investment cost in Table 4 is used. For instance, R_m of Area B, the minimum return above would be reached with the piglet price of FIM 450 and aid of FIM 1,380 per sow (same as in Table 2). These figures show that this type of return is out of reach by means of high prices and returns only.

Concluding remarks

By using the current return of the farm model, the investment does not fulfil the decision criteria, and the optimal decision is to wait. However, a minimum return to capital can be also computed using a given, current investment cost. The calculations above do not include any investment aid measures. However, their effect can be taken into account in a simple manner.

The investment aid is given in two forms: an interest subsidy and a grant. Only the fixed assets, building and machinery, are eligible for the investment aid. In Table 5 the maximum bid prices are computed with the discount rate of 4 %. The differences to Table 3 are quite small: some 11 % in Area B and some 13 % in Area C1. Alternatively, the minimum return to capital R_m can be determined by using R/I in Table 5 and the current investment cost in Table 4. In Area B this minimum return would be reached if the piglet price was FIM 425 and the aid FIM 1,380 per sow.

A direct grant to the investment can be added to the maximum bid price. For example, a grant that is 30 % of the cost of fixed assets (FIM 10,000) is FIM 3,300 in monetary terms. Thus, under uncertainty the grant appears a more desirable form of investment aid from the farmer's point of view. However, even the highest investment aid level does not make the project pass the decision criteria, but they are close in Area C1. However, if the maximum investment aid levels are used, a grant may be employed in addition to the interest subsidy. In this case, the combination of an interest subsidy and grant would make the project profitable at the lower investment cost presented.

Table 5. Results of the real options model with a 4 % discount rate.

	Area B	Area C1
R/I	22.1 %	19.3 %
Maximum bid price, I (R from Table 3)	10,300	11,900
Minimum return to capital, R_m (I from Table 4)	4,500	3,930

3.2. Financing and liquidity

If the planned investment project passes the profitability criteria, the financing must be arranged and liquidity has to be determined. The borrowing capacity is briefly estimated first, but the main emphasis is on the liquidity that is determined for two investment costs: the current investment cost, and the maximum bid price of the real options model.

Table 6 presents an example of the determination of the collateral. Prior to the planned new investment, the farm model is supposed to have FIM 220,000 of debt. This is about one-third of the collateral value of the farm (Table 6). If production buildings are not approved for collateral the farm has some FIM 250,000 of borrowing capacity. This may limit the credit financing possibilities.

Table 6. Value of the piglet farm (real estate only), FIM 1,000.

	Market value
Arable land, 24 ha	360
Forest land, 41 ha	155
House	300
Production buildings (incl. new)	400
Total	1,215
Collateral, % of total market value	60
Collateral value	730

Source: Maanmittauslaitos 1995.

3.2.1. Liquidity of the current investment cost

In this chapter, the liquidity of the current investment cost is analysed. It should be noted that the investment did not pass the real options criteria with the current return and investment cost of a conventional piggery. However, a minimum return R_m that meets the criteria was determined, and it was FIM 5,030 in Area B without the investment aid. This can be compared with the return to capital that is calculated by using the break-even results of liquidity analysis.

After taxes and household consumption are deducted from the total net cash income, the result is called the *investment and loan repayment capacity.* The residual amount after loan repayment is called the *investment and loan repayment margin.* This must be positive in order to fulfil the cash flow criteria, namely, the household is not forced to reduce its consumption in order to fulfil all cash outflow obligations.

There are two columns for each year in Table 7. The left-hand side entries are for the expanded farm, and the right-hand side column (number in parentheses) shows the difference from the situation where the current operation is continued without the expansion.

The total investment cost and the new credit are at the top of Table 7. The investment cost is the current investment cost per sow in Table 4 multiplied by the increase of sows, 37 heads. The nominal interest rate of the credit is 7 %, and the repayment term is 15 years. Table 7 illustrates a situation where the investment and loan repayment margin is set approximately to zero by changing the piglet price and the direct aid for sows. This cash flow situation was obtained when the piglet price was set to FIM 280 and annual aid was set to FIM 500 per sow. Naturally, some other combination would result in a break-even cash flow situation, for instance, FIM 305 piglet price and no aid for sow. These variables can be compared with their expected levels in 1997: FIM 310 per piglet and FIM 1,380 per sow. A safety margin exists between the current and break-even price and aid.

These break-even price and aid would result in a FIM 850 return to capital per sow. This return is FIM 4,180 (83 %) lower than the corresponding current return of the real options model above. This indicates that a liquidity calculation with expected prices that shows a break-even liquidity situation immediately after the investment as only decision criteria will result in a return that is too low to make the investment profitable under uncertainty. An estimate of the required compensation of risk in cash flow terms can be calculated with the cash flow model by using the price and aid of the real options model (FIM 450 and FIM 1,380). The use of them would result in a FIM 151,000 investment and loan repayment margin, and FIM 107,000 of this would be the contribution of the new enlargement. Thus, there should initially be a FIM 151,000 annual investment and loan repayment margin of the household for the compensation of the risk related to the investment. This would be equivalent to the risk compensation required in the minimum return of the real options model in this case.

If the farm has no credit before the investment, the break-even price and aid combination is the following: FIM 250 per piglet and FIM 250 per sow. In this case, however, the farm would have a better investment and loan repayment margin without the investment. That is, on the bottom line of Table 7, the numbers in parentheses would turn negative.

Table 7. Break-even cash flow statement for the farm household, in which the piglet price is FIM 280/head and annual aid FIM 500/sow, FIM 1,000.

	1997	1998		1999		2000		2001		2002	
Investment cost	753										
Credit	565										
Agricultural net cash income		231	(92)	232	(93)	234	(94)	236	(96)	239	(97)
Non-agricultural income		49	(0)	49	(0)	49	(0)	49	(0)	49	(0)
Total net cash income		280	(92)	281	(93)	283	(94)	285	(96)	288	(97)
Taxes (-)		43	(-1)	50	(5)	57	(10)	64	(15)	69	(19)
Household withdrawal (-)		118	(0)	118	(0)	118	(0)	118	(0)	118	(0)
Investment and loan repayment capacity		112	(90)	106	(85)	101	(81)	97	(77)	94	(74)
Interest (-)		43	(31)	39	(29)	35	(27)	31	(24)	27	(22)
Loan repayments (-)		68	(38)	68	(38)	68	(38)	68	(38)	68	(38)
Total loan payments		112	(69)	107	(67)	103	(64)	99	(62)	95	(60)
Investment and loan repayment margin		1	(21)	-1	(19)	-2	(17)	-2	(15)	-1	(14)

Effect of investment aid

If a part of the loan is interest-subsidised, the nominal weighed average interest is assumed to decrease to 5 %. The piglet price of FIM 275 and aid of FIM 500 per sow would result in a break-even liquidity situation. The interest subsidy would only yield a FIM 5 lower piglet price than in Table 7. However, the new investment has a bigger contribution to the investment and loan repayment margin because the cost of the new credit declines.

The break-even price and aid combination results in a FIM 750 return to capital as it is computed for the real options model. The comparable minimum return of the real options model was FIM 4,500 per sow. The relative difference between these is the same as without the interest subsidy, 83 %.

Now, consider the investment grant. If the investment aid is a grant that is 20 % of the cost of fixed assets, the requirement for borrowing would decrease by some FIM 120,000. In this case, the piglet price would be FIM 270 and the aid FIM 500 per sow in the break-even cash flow situation.

3.2.2. Liquidity of the maximum bid price

The maximum bid price is the highest investment cost that the real options model approves with the current returns and suggests to start the project. The piglet price was FIM 310 and the aid was FIM 1,380 when the current return was determined for the real options model. However, the maximum bid price is lower than the current prices of the required items in the case of the investment (Table 3 and Table 4).

In Table 8 a break-even cash flow situation is presented using the investment cost of FIM 370,000 (FIM 10,000 per sow). Here, the piglet price is FIM 265 and the aid is FIM 500 per sow. The difference is not wide compared with the situation in Table 7, where the piglet price is FIM 15 higher. This is the case although the new credit is FIM 290,000 smaller. One explanation to this is the fact that the lower investment cost yields a lower tax depreciation allowance. In addition, the interest on the credit is a tax-deductible expense. Consequently, despite the fact that the total net cash income is lower, the amount of paid taxes is actually higher in Table 8 than in Table 7.

The break-even price and aid would result a FIM 550 return to capital in the profitability analysis. This is FIM 1,730 (76 %) lower than the equivalent current return of the real options model.

An estimate of the initial cash compensation for risk can be computed with the cash flow model by using the current piglet price and aid for sows (FIM 310 and FIM 1,380) that were used when the current return of the real options model was determined. This results in a FIM 59,000 investment and loan repayment margin and this equals quite closely the contribution of the new investment. The result is a little over a third of the result of the previous case where the returns and the investment cost were higher.

Table 8. Break-even cash flow statement for the farm household, in which piglet price is FIM 265/kg and annual aid FIM 500/sow, FIM 1,000.

	1997	1998		1999		2000		2001		2002	
Investment cost	370										
Credit	277										
Agricultural net cash income		205	(78)	207	(79)	208	(80)	211	(81)	213	(82)
Non-agricultural income		49	(0)	49	(0)	49	(0)	49	(0)	49	(0)
Total net cash income		254	(78)	255	(79)	257	(80)	259	(81)	262	(82)
Taxes (-)		60	(19)	65	(22)	69	(25)	72	(27)	76	(29)
Household withdrawal (-)		118	(0)	118	(0)	118	(0)	118	(0)	118	(0)
Investment and loan repayment capacity		76	(59)	73	(57)	70	(55)	69	(54)	68	(53)
Interest (-)		28	(15)	25	(14)	21	(13)	18	(12)	15	(11)
Loan repayments (-)		49	(18)	49	(18)	49	(18)	49	(18)	49	(18)
Total loan payments		77	(34)	74	(33)	70	(32)	67	(30)	64	(29)
Investment and loan repayment margin		-1	(25)	-1	(24)	0	(24)	2	(24)	4	(24)

Besides the fact that the maximum bid price is lower than the current investment cost above, the credit is, accordingly, also smaller. Thus, the expansion investment contributes more to the investment and loan repayment margin of the household than with the higher investment cost in the case above. The break-even combination for a farm with no debt prior to the expansion is the following: a FIM 240 piglet price and no aid for sows. The price and aid combination results in a negative return to capital when it is measured as the *R* in the real option model. However, the net cash flow per an additional sow is some FIM 1,100.

3.3. Conclusions

Under certain future costs and returns, the calculations would recommend the implementation of the planned investment. When uncertainty is added to the consideration, the return requirement of the investment becomes 1.6-1.8 times higher than the expected ones. This implies that the cost of the conventional building type is too high or, alternatively, the return to investment is too low. Thus, technologies that are cheaper than the current ones must be carefully investigated for reducing the initial investment expenditures and risks involved in investments. The return to capital could be increased, for instance, by using a cheaper fodder mix than the barley and manufactured supplement combination that is used in the farm model. An example of lower cost fodder materials are by-products of food industry that can be utilised with a liquid feeding technology.

Because the variation in aid measures is intuitively added to the standard deviation of the piglet price and, in addition, the price development may be interlinked with fodder cereal prices, the results are simulated with different values of σ. All other assumptions are kept identical to the cases above. The return requirement with certain expected returns (*PVM*) is equal to the base calculation that is also included in Table 9. The results are calculated by using the procedures described above.

The increase of the standard deviation from 0 to 0.4 almost doubles the initial return requirement to investment or, alternatively, the maximum bid price halves. The investment and loan repayment margin is an initial cash reserve that is determined by using the maximum bid price as an investment cost. The farm household is assumed to have FIM 75,000 of equity financing available in each case. This makes the liquidity situation of different investment costs comparable since the initial cash inputs are equal.

The initial investment and loan repayment margin is determined on an after-tax basis by using the tax rates in 1997. The cash flow situation describes the expanded farm when the production is assumed to be up to the capacity. The piglet price of FIM 310 and sow aid of FIM 1,380 are assumed. The investment and loan repayment margin is also calculated without deducting the depreciation allowance and the interest payments from the taxable income when the taxes were calculated. These results are in parentheses in the liquidity section of Table 9, and they show a significant increase in the investment and loan repayment margin as the maximum bid price (investment cost) decreases. Briefly, the simulation results indicate that, the more risk is assumed, the lower investment cost is required, and the larger cash flow margins must exist.

Table 9. Simulation results with different values of σ in Area B, present value multiple PVM = 15.9 %, *FIM 1,000*

	Standard deviation of *R*, σ				
	0	0.1	0.2	0.3	0.4
Profitability, maximum bid price/sow:					
Option value multiple *OVM*	1.00	1.10	1.30	1.55	1.84
Required rate of return *R/I*, %	15.9	17.5	20.7	24.7	29.4
Maximum bid price, *I* (*R* = *2.3*)	14.3	13.0	11.0	9.3	7.8
Liquidity of farm household:					
Investment cost (*I/sow* × *37 sows*)	529	482	408	342	287
Initial investment and loan repayment margin	55 (7)	56 (12)	58 (20)	60 (28)	61 (34)
-Contribution of new investment	52 (14)	53 (20)	55 (28)	57 (35)	58 (42)

4. Pig fattening farm

The pig fattening farm is the second link in the pigmeat producing chain. From an economic point of view, pig fattening has different characteristics from piglet production. Firstly, pig fattening is more capital intensive (whereas piglet production is more labour intensive in comparison with pig fattening). Secondly, the relative gross margin is small in proportion to the gross output. This makes the net return of pig fattening highly responsive to price changes. This chapter begins with a brief introduction of the physical aspects of the farm models that are used. The economic features appear in the following sub-chapters that present the results of investment analysis.

In Table 10 the fattening pig capacity refers to the capacity of the building. The farm fattens 3 groups of piglets to the slaughter weight in a year. The target production capacity is 445 fattening pig places in the piggery or 1,335 sold pigs in a year. Since all barley that is produced on the farm is fed to pigs, the only sales produce is pigmeat.

Table 10. Characteristics of the piggery expansion

	Starting point	Goal
Number of fattening pig places	223	445
Arable land, ha	37	37
Pig places/ arable ha	6.0	12.0

No additional arable land is purchased. In the base situation, the arable land is adequate for fodder cereal production, but doubling the pig fattening capacity requires purchasing some 140,000 kg of fodder barley per annum. At the moment, the price ratios are such that it is profitable to mix the pig fodder on the farm rather than purchase manufactured fodder mix.

The owned arable area of the farm is not sufficient to qualify for the environmental aid (GAEPS) after the expansion. However, it is assumed that manure spreading contracts with neighbours will solve this problem.

4.1. Profitability of the expansion

The investment calculation is based on the current return per pig capacity, which is determined first. Then, the four terms of the real options model (ρ, δ, α, and σ) that determine the required rate of return are introduced, and maximum bid prices are computed with them. The maximum bid price is then compared with the current investment costs. An alternative result is a minimum return that is required with the current investment cost. The minimum return is also used in the comparison between the real options results and the following liquidity calculations.

The incremental return for capital R is determined per an additional pig capacity by using the information of the farm model. The pigmeat price is FIM 8.50 and the purchase price of piglet is FIM 330. In both areas, A and C1, R is slightly lower than the aid levels in 1997 (Table 11). This makes the profitability of the production highly dependent on policy decisions.

Table 11. Current return (1997) to planned enlargement, FIM per piggery place.

	Area B	Area C1
Incremental net cash flow	634	629
Opportunity cost of labour	67	67
Return to capital, R	567	562
Incremental aid included in R	576	571

Piggeries are typically built of durable materials, such as concrete. Consequently, a low depreciation δ rate was selected. Besides the expected development of aid, the assumption of annual productivity increase of 1 % is included in α (see Chapter 3.2.).

In Denmark and Germany the standard deviation of pigmeat has been some 10 % in 1985-1994 (Pietola 1996). Besides price risk, there is considerable policy risk, because *R* is equal to the aid as is shown in Table 11. Both the price and policy risks are accounted for by using a rather high σ, 30 %. This is equal to the value used in piglet production, but the share of policy risk is assumed to be higher here because the standard deviation of pigmeat is lower than that of piglet. In Table 12 the return requirement for the piggery expansion is computed using (1).

With the assumptions above, the return to investment *R/I* should exceed 27 % in Area B and 23 % in Area C1 in order to start the project (Table 12). The option value multiple *OVM* makes the difference between uncertain and certain returns: stochastic returns yield a threshold return requirement that is 1.4-1.7 times higher than the respective *expected* return (*PVM*). The reason why *OVM* is lower in Area B than in Area C1 is the fact that the expected return stream has a declining trend (negative α) in Area B. This gives an incentive to invest early to not lose the highest returns. However, in Area C1 there is more incentive to wait since the returns are expected to remain approximately at the current level.

Table 12. Return requirements for piggery investment per fattening pig capacity.

	Area B	Area C1
Current return to capital (1997), *R* (from Table 11, FIM)	567	562
Discount rate, ρ	5.9 %	5.9 %
Depreciation rate, δ	6 %	6 %
Expected rate of change of *R*, α	-0.07	-0.02
Present value multiple, *PVM* (= ρ + δ - α)	18.9 %	13.9 %
Standard deviation of *R*, σ	0.3	0.3
Option value multiple, *OVM*	1.42	1.66
Required rate of return, *R/I* (*PVM* × *OVM*)	27.0 %	23.2 %
Maximum bid price, *I* [= *R*/(*R/I*), FIM]	2,100	2,420

All costs of the enlargement have to be covered by the maximum bid price, including the purchases of additional livestock, other operating capital, buildings, and machinery. The typical prices of these required investment items are listed in Table 13.

The price of piglet is the current purchase price. The operating capital that is needed to start the production is obtained from Enroth (1995) with such modification that the opportunity cost of labour was deducted. This was done because it is already taken into account in the return *R*. A fattening pig place with a liquid manure system typically costs between FIM 2,500 and FIM 3,000 (building, machinery, and manure storage) (Keski-Suomen MSK 1996). A liquid manure piggery was chosen because the operating costs of the farm model are from that type of building.

Table 13. Investment costs per pig fattening place, FIM.

Item	Cost
Livestock (piglet)	330
Other operating capital	450
Buildings and machinery	2,500
Total investment cost	3,280

Sources: Enroth 1995, Keski-Suomen MSK 1996, MAF 1996, MT 1996.

Consider the differences between the bottom lines in Table 12 and in Table 13. The investment cost of a traditional piggery is higher than the maximum bid price. The difference is considerable. In this case *the decision concerning the investment is to wait.* In order to start the project the investment has to be done at the maximum of the maximum bid price, or *R* has to be higher. That is, a minimum return R_m can be determined by multiplying the total investment cost in Table 13 by *R/I* in Table 12. R_m is FIM 886 in Area B and FIM 761 in Area C1. In Area B, for example, a pigmeat price of FIM 9.65 per kg and annual aid of FIM 600 per pig capacity would yield the minimum return above. The market price is clearly above the current price and the aid is slightly higher than the aid level in 1997.

Concluding remarks

By using the current return of the farm model, the investment does not fulfil the decision criteria, and the optimal decision is to wait. However, a minimum return to capital can also be computed with a given, current investment cost. The calculations above do not include any investment aid measures. However, their effect can be taken into account in a simple manner.

The investment aid is given in two forms: an interest subsidy and a grant. Only the fixed assets, buildings and machinery, are eligible for the investment aid. In Table 14 the maximum bid prices are computed with a discount rate of 4 %. The differences to Table 12 are quite small: some 10 % in Area B and some 12 % in Area C1. Alternatively, a minimum return to capital can be determined by using R/I in Table 14 and the current investment cost in Table 13. In Area B, this R_m is reached, for example, with a pigmeat price of FIM 9.25 and aid of FIM 600 per pig capacity.

A direct grant to the investment can be added to the maximum bid price. For example, a grant that is 30 % of the cost of fixed assets (FIM 2,500) is FIM 750 in monetary terms. Thus, the grant appears a more desirable form of investment aid from the farmer's point of view. However, even the highest investment aid level does not make the project profitable at the investment cost of a conventional piggery. In Area C1 the lower discount rate and the grant together would take the project close to the limit of profitability. In practise, however, the investment aid levels are lower in Area C1 than in Area B.

Table 14. Maximum bid prices with a 4 % discount rate.

	Area B	Area C1
R/I	24.5 %	20.7 %
Maximum bid price, *I* (R from Table 12)	2,310	2,720
Minimum return to capital, R_m (*I* from Table 13)	803	679

Specialised pig fattening is typically all-in all-out production in Finland. A temporary suspension from production does not result in considerable extra costs. Thus, after killing the investment option the farmer has a series of production options every time when he is filling the piggery: whether to take piglets or not. For instance, if price ratios seem unfavourable, the farmer can wait before buying new piglets. This feature reduces the risk of losses in pig fattening. However, the temporary suspension is not taken into account here.

4.2. Financing and liquidity

If the planned investment project passes the profitability criteria, the financing must be arranged and liquidity has to be determined. The borrowing capacity is briefly estimated first, but the main emphasis is on the liquidity that is determined for two investment costs: the current investment cost, and the maximum bid price of the real options model.

Table 15 presents an example of the determination of the collateral. Prior the planned new investment, the farm model is supposed to have FIM 400,000 as debt. This requires nearly half of the collateral value of the farm (Table 15). If the production buildings are not approved for collateral the farm has some FIM 290,000 of borrowing capacity. This would limit the extent of the credit financing possibilities.

Table 15. Value of the fattening pig farm (real estate only), FIM 1,000.

	Market value
Arable land, 37 ha	555
Forest land, 53 ha	200
House	300
Production buildings (incl. new)	500
Total	1,555
Collateral, % of total market value	60
Collateral value	993

Source: Maanmittauslaitos 1995.

4.2.1. Liquidity of the current investment cost

In this chapter the liquidity of the current investment cost is analysed. It should be noted that the investment did not pass the real options profitability criteria with the current return and investment cost of a conventional piggery. However, a minimum return R_m that meets the criteria was determined, and this was FIM 886 without the investment aid in Area B. This can be compared with the return to capital that is calculated by using the break-even results of the liquidity analysis. See Chapter 3.2.1 for the interpretation of Table 16.

The investment cost is the current investment cost per pig capacity in Table 13 multiplied by the increase in the capacity, 222 pig places. The investment and loan repayment margin is set approximately to zero by changing the pigmeat price and the direct aid for pigs. This situation was obtained when the pigmeat price was set to FIM 8.1/kg and annual aid was set to FIM 300/piggery place. The aid is equivalent to FIM 100 slaughter premium when three groups of pigs are fattened in a year. These variables were used each year, and they can be compared with their expected levels in 1997: FIM 8.5/kg and FIM 560 per piggery place. The safety margin is not wide between the current and break-even situations.

These break-even price and aid would result a FIM 240 return to capital per pig capacity. This return is FIM 646 (73 %) lower than the corresponding minimum return of the real options model above. This indicates that a liquidity calculation with expected prices that shows a break-even liquidity situation immediately after the investment as a decision criteria will result in a return that is too low to make the investment profitable under uncertainty. An estimate of the required compensation of risk in cash flow terms can be calculated with the cash flow model by using the price and aid of the real options model (FIM 9.6/kg and FIM 600 per piggery place). This would result in a FIM 145,000 investment and loan repayment margin, and FIM 80,000 of this would be the contribution of the new enlargement. Thus, there should initially be a FIM 145,000 annual investment and loan repayment margin of the household for the compensation of the risk related to the investment. This would be equivalent to risk compensation required in the minimum return of the real options model in this case.

Table 16. Break-even cash flow statement for the farm household, in which pigmeat price is FIM 8.1/kg and annual aid FIM 300/piggery place, FIM 1,000.

	1997		1998		1999		2000		2001		2002
Investment cost	728										
Credit	546										
Agricultural net cash income	231	(68)	237	(73)	244	(78)	250	(81)	257	(84)	
Non-agricultural income	73	(0)	73	(0)	73	(0)	73	(0)	73	(0)	
Total net cash income	304	(68)	310	(73)	317	(78)	323	(81)	330	(84)	
Taxes (-)	35	(-8)	46	(-3)	57	(4)	68	(9)	77	(14)	
Household withdrawal (-)	118	(0)	118	(0)	118	(0)	118	(0)	118	(0)	
Investment and loan repayment capacity	151	(76)	147	(76)	142	(74)	138	(72)	135	(70)	
Interest (-)	66	(32)	60	(30)	54	(28)	47	(26)	41	(24)	
Loan repayments (-)	86	(36)	86	(36)	86	(36)	86	(36)	86	(36)	
Total loan payments	153	(69)	146	(66)	140	(64)	134	(62)	127	(60)	
Investment and loan repayment margin	-2	(8)	0	(9)	2	(10)	4	(10)	7	(10)	

If the farm has no credit prior to the investment, the break-even price and aid combination is the following: FIM 7.75 per pigmeat kg and FIM 150 per piggery place. In this case, however, the farm would have a better investment and loan repayment margin without the investment. That is, in the bottom line of Table 16, the numbers in parentheses would turn negative.

Effect of investment aid

If a part of the loan is interest-subsidised, the nominal weighed average interest is assumed to decrease to 5 %. The pigmeat price of FIM 8.0/kg and aid of FIM 300 per piggery place would result in a zero investment and loan repayment margin of the household. The decrease of the interest rate results in a FIM 0.10 fall in the break-even price, whereas the aid is the same as in the case above.

The break-even price and aid combination results in a FIM 220 return to capital as it is computed for the real options model. The minimum return of the real options model is FIM 803. The relative difference between these two is the same 73 % as without the investment support. Thus, the interest subsidy would only yield FIM 0.1/kg lower pigmeat price than in Table 16. However, the new investment has a bigger contribution to the investment and loan repayment margin because the cost of the new credit declines.

Now, consider the investment grant. If the investment aid is a grant that is 20 % of the cost of fixed assets, the requirement for borrowing would decrease by FIM 110,000. In this case, the pigmeat price should be FIM 7.9/kg and the aid FIM 300 in the break-even cash flow situation.

4.2.2. Liquidity of the maximum bid price

The maximum bid price is the highest investment cost that the real options model approves with the current returns and suggests to start the project. The pigmeat price was FIM 8.5/kg and the annual aid was FIM 576 per pig capacity when the current return was determined for the real options model. However, the maximum bid price is lower than the current prices of the required items for the investment (Table 12 and Table 13).

In Table 17 the break-even cash flow situation is presented with the investment cost of FIM 400,000 (FIM 1,800 per pig capacity). In this case, the pigmeat price is FIM 7.9/kg and the aid is FIM 300/piggery place. The margin is small compared with the situation in Table 16; only the pigmeat price is FIM 0.2/kg lower. This is the situation despite the smaller credit, FIM 145,000. One reason to this is the fact that the lower investment cost results in a lower tax depreciation allowance. In addition, the interest on the credit is a tax-deductible expense. As a consequence, although the total net cash income is lower, the amount of taxes paid is actually higher in Table 17 than in Table 16.

The break-even price and aid would result in a FIM 200 return to capital in the profitability analysis. This is FIM 372 (65 %) lower than the equivalent current return of the real options model. The relative difference is lower than with the higher investment cost above.

An estimate of the initial cash compensation for risk can be derived with the cash flow model by using the current price and support of the real options model (FIM 8.5 and FIM 576). This results in a FIM 93,000 investment and loan repayment margin, and FIM 57,000 of this is the contribution of the new investment. These result are considerably lower than in the previous case where the returns and the investment cost were higher.

In the case of the smaller credit, the expansion investment contributes more to the investment and loan repayment margin of the household than with the current investment cost above. The break-even combination for a farm with no debt prior to the expansion is the following: FIM 7.2/kg for pigmeat and FIM 225 aid per pig capacity. The effect of the new investment would be negative. The price-aid combination results in a negative return to capital as it is determined in the real option model.

Table 17. Break-even cash flow statement for the farm household, in which pigmeat price is FIM 7.9/kg and annual aid FIM 300/piggery place, FIM 1,000.

	1997	1998		1999		2000		2001		2002	
Investment cost	400										
Credit	300										
Agricultural net cash income		211	(58)	217	(63)	224	(68)	230	(71)	237	(74)
Non-agricultural income		73	(0)	73	(0)	73	(0)	73	(0)	73	(0)
Total net cash income		284	(58)	290	(63)	297	(68)	303	(71)	310	(74)
Taxes (-)		46	(7)	57	(12)	65	(16)	74	(20)	82	(24)
Household withdrawal (-)		118	(0)	118	(0)	118	(0)	118	(0)	118	(0)
Investment and loan repayment capacity		120	(51)	116	(51)	113	(51)	112	(51)	110	(51)
Interest (-)		52	(18)	46	(16)	41	(15)	36	(14)	30	(13)
Loan repayments (-)		70	(20)	70	(20)	70	(20)	70	(20)	70	(20)
Total loan payments		122	(38)	116	(36)	111	(35)	106	(34)	100	(33)
Investment and loan repayment margin		-2	(13)	-1	(14)	2	(16)	6	(17)	10	(18)

4.3. Conclusions

Under certain future costs and returns, the calculations recommend to invest immediately. When uncertainty is taken into consideration, the return requirement of the investment is 1.7-2.0 times higher than with the expected returns, and the investment becomes unprofitable. Consequently, cheaper technologies must be developed for reducing the initial investment costs and risks involved in investments. An alternative (or complementary) route would be to increase the return to capital.

The variation in the aid measures is intuitively added to the standard deviation of the pigmeat price and, in addition, the price development is likely to be interlinked with the piglet price and fodder cereal prices. This has been the normal trend in Europe, and the piglet price and fodder price are very significant since they account for most of the operating costs of a slaughter pig. Thus, the results are simulated with different values of σ. All other assumptions are kept identical to the cases above. The required rate of return with certain expected returns (*PVM*) is equal to the base calculation that is also included in Table 18. The results are calculated by using the procedures described above.

The increase of the standard deviation from 0 to 0.4 almost doubles the initial return requirement to investment or, alternatively, the maximum bid price halves. The investment and loan repayment margin is an initial cash reserve that is determined by using the maximum bid price as an investment cost. The farm household is assumed to have FIM 75,000 of equity financing available in each case in order to make the liquidity analysis comparable.

The initial investment and loan repayment margin is determined on an after-tax basis by using the tax rates in 1997. The cash flow situation describes the expanded farm when the production is increased up to the capacity. The pigmeat price of FIM 8.5/kg, piglet price of FIM 330/head, and direct aid of FIM 576/pig capacity are assumed. The investment and loan repayment margin is also calculated without deducting the depreciation allowance and the interest payments when the taxes were calculated. These results are in parentheses in the liquidity section of Table 18, and they show a significant increase in the investment and loan repayment margin as the maximum bid price (investment cost) decreases. Shortly, the simulation results indicate that the more risk is assumed, the lower the investment cost has to be, and the larger cash flow margin must exist.

Table 18. Simulation results with different values of σ in Area B, present value multiple PVM = 18.9 %, *FIM 1,000*

	Standard deviation of R, σ				
	0	0.1	0.2	0.3	0.4
Profitability, maximum bid price/sow:					
Option value multiple *OVM*	1.00	1.06	1.22	1.43	1.68
Required rate of return *R/I*, %	18.9	20.2	23.1	27.0	31.8
Maximum bid price, I ($R = 0.57$)	3.0	2.8	2.5	2.1	1.8
Liquidity of farm household:					
Investment cost ($I \times 222$)	664	624	545	466	396
Initial investment and loan repayment margin	79 (-4)	81 (1)	84 (10)	87 (20)	90 (28)
-Contribution of new investment	44 (-5)	46 (0)	49 (10)	52 (19)	55 (27)

On a pig fattening farm, there is an option upon every purchase of new piglets whether to buy them or not. This risk-reducing feature was not taken into account in this study.

5. Dairy farm

The examined dairy farm models were derived to describe dairy farms in Area B and Area C1. The base farm model has 13 dairy cows and 24 ha of arable land in Area B and 12 dairy cows and 23 ha of arable land in Area C1. The differences in the farm sizes between areas B and C1 result from the fact that there are separate farm models for each area.

At the expansion plan, the size of dairy herd increases from the original sizes to 18 heads. The number of young cattle increases correspondingly. In both farms, the arable area is sufficient for hay and silage production. The fodder grain is mostly purchased. The present arable land area is also sufficient to qualify for the environmental aid (GAEPS). Hence, no additional arable land is assumed to be purchased.

Table 19. Characteristics of the dairy farm expansion

	Area B		Area C1	
	Starting point	Goal	Starting point	Goal
Number of dairy cows	13	18	12	18
Arable land, ha	24	24	23	23
Cows/arable ha	0.54	0.75	0.52	0.78

Estimating productivity increase

Both dairy farms have a 6.300 kg milk yield per an additional cow. In both areas, the average milk yield of the total herd is higher than this because the productivity per cow declines slightly as a result of the expansion.

In 1985-1995 the milk yield has increased annually by an average of 1.65 % compared to the level of 1995 in milk recording farms. Simultaneously, however, the total fodder consumption has also increased by an annual average of 1.15 % (MKL 1996). Thus, the net productivity increase is 0.5 %, which is used the calculations. As above, the productivity increase is taken into account in the α of the real options model and in a decreasing operating expenditure with a constant output in the liquidity calculations.

5.1. Profitability of the expansion

The investment calculation is based on the current return per dairy cow which is determined first. Then, the four terms of the real options model (ρ, δ, α, and σ) that determine the required rate of return are introduced, and maximum bid prices are computed with them. The maximum bid price is then compared with the current investment costs. With the current investment cost, a minimum return is computed for the comparison with the liquidity calculations.

The incremental return for capital R is determined per an additional cow by using the information of the farm model. The cash flows related to the young cattle (per cow) are included to R. The market price of milk is FIM 1.85. In addition to this in 1997, the farmer gets the price aid, which is FIM 0.45/kg in Area B and FIM 0.59/kg in Area C1. In addition to the price aid, the changes in arable land payments and payments for young cattle are included in the incremental support. The support levels of 1997 are from 50 % to 60 % of *R*, depending on the area (Table 20). Thus, the a positive return to capital is not fully dependent on the aid.

Table 20. Current return (1997) to planned enlargement, FIM per cow.

	Area B	Area C1
Incremental net cash flow	7,630	8,530
Opportunity cost of labour	1,760	1,760
Return to capital, *R*	5,870	6,770
Incremental aid included in *R*	2,860	3,940

In Denmark and Germany the standard deviation of milk has been some 4.5 % in 1985-1994 (Pietola 1996). Besides the price risk, there is a policy risk because a significant portion of the net return is aid. Hence, besides the price risk, the policy risk is accounted for in σ. In Table 21 the return requirement for the cowhouse expansion is computed using (1).

The return to investment *R/I* should exceed 22 % in Area B and 18 % in Area C1 in order to start the project (Table 21). The option value multiple *OVM* makes the difference between uncertain and certain returns: the required return is 1.3-1.5 times higher than the corresponding *expected* return (*PVM*). *OVM* is lower in Area B than in Area C1 because the returns are expected to have a declining trend (negative α) in Area B. This gives an incentive to invest early in order to not to lose the highest returns. In Area C1, however, there is more incentive to wait since the returns are expected to remain at the current level.

Table 21. Return requirements for dairy investment, determined per dairy cow.

	Area B	Area C1
Current return to capital (1997), *R* (from Table 20, FIM)	5,870	6,770
Discount rate, ρ	5.9 %	5.9 %
Depreciation rate, δ	6 %	6 %
Expected rate of change of *R*, α	-0.05	0
Present value multiple, *PVM* ($= \rho + \delta - \alpha$)	16.9 %	11.9 %
Standard deviation of *R*, σ	0.2	0.2
Option value multiple, *OVM*	1.27	1.50
Required return, *R/I* ($PVM \times OVM$)	21.5 %	17.9 %
Maximum bid price, *I* [= *R/(R/I)*, FIM]	27,400	37,800

All costs of the enlargement have to be covered with the maximum bid price, including the purchases of additional livestock, other operating capital, buildings, and machinery. In Table 22 typical prices of these required investment items are listed.

Table 22. Investment costs per cowhouse place, FIM.

Item	Traditional cowhouse	Uninsulated cowhouse
Livestock (heifer)	7,500	7,500
Other operating capital	2,400	2,400
Building and machinery	30,000	15,000
Total operational investment cost	39,900	24,900
Milk quota, FIM 1.5/l and 6,300 l	9,500	9,500
Total investment cost	49,400	34,400

Sources: Enroth 1995, Keski-Suomen MSK 1996, MAF 1996, MT 1996

The price of heifer is the current purchase price. The operating capital needed to start the production is obtained from Enroth (1995) with the modification that the opportunity cost of labour was deducted. This was done because it is considered already in the return R. The cost of a warm cowhouse place (building and machinery) is average of the recommended cost by the administration and a survey on realised costs (Keski-Suomen MSK 1996; MAF 1996).

Consider the differences between the bottom line in Table 22 and the cost of the traditional cowhouse investment in Table 22. The current investment cost level is higher than the maximum bid price. The difference is close to the cost of milk quota in Area C1 and about FIM 10,000 more than that in Area B. Thus, if the milk quota was free, the investment would be nearly profitable in Area C1. In Area B *the decision concerning the investment is to wait.* In order to start the project, the investment has to be done at the maximum of the maximum bid price, or R has to be higher. The minimum return R_m can be determined by multiplying the total investment cost (warm cowhouse) in Table 22 by R/I in Table 22. R_m is FIM 10,600 in Area B and FIM 8,800 in Area C1 with the respective milk quota prices. For instance in Area B, the total producer price of milk (market price plus price aid) should be FIM 3.08 per litre would yield the minimum return above.

Uninsulated building

A cheaper alternative to the warm cowhouse is an uninsulated one. Their cost is some FIM 15,000 per cow place, including milking equipment and facilities (Keski-Suomen MSK 1996; MAF 1996). According to the current knowledge, an uninsulated cowhouse does not have noticeably higher bedding costs than the traditional facilities. However, the uninsulated buildings are built lighter than the traditional ones. As a result, the depreciation rate should be increased.

Consider the maximum bid prices in Table 23. In Area B the result is FIM 4,900 lower than above. In Area C1, however, the threshold price decreases by FIM 8,000. It appears that, if the returns are expected to decrease, a building of short duration has less effect on the threshold price of investment. Although the difference between the maximum bid price and current investment costs decreases, the cost of milk quota is still too high in order to invest.

Table 23. Maximum bid price of a uninsulated cowhouse, the absent parameters as in Table 21.

	Area B	Area C1
R, (from Table 20), FIM	5870	6770
depreciation rate, ρ	10 %	10 %
Present value multiple, *PVM*	20.9 %	15.9 %
Option value multiple, *OVM*	1.25	1.42
Required return, *R/I*	26.0 %	22.7 %
Maximum bid price, *I* (FIM)	22,500	29,900

Concluding remarks

In the examples above, the investment does not fulfil the decision criteria, and the optimal decision is to wait. The calculations do not include any investment aid measures. However, their effect can be taken into account in a simple manner.

When the maximum bid prices obtained in this study are compared with those of the previous study, there are obvious differences. In the previous study the traditional present value model was applied, and, although a significantly lower milk price was used, the maximum bid price was still much higher than here. In addition to the uncertainty, there was no opportunity cost of labour accounted for with the lower milk price. Here, the opportunity cost of labour is taken into consideration in all cases. Thus, the conclusion is that the future scenario should be very unfavourable if a traditional present value model is used. It appears more logical to start from the current return with estimates of its expected change and risk than make strict assumption for the whole planning horizon.

For dairy farms, the investment aid is a direct grant. The grant can be directly added to the maximum bid prices above and, thus, the projects would turn profitable if the conditions of the investment aid are met.

A direct grant to the investment can be added to the maximum bid price. For example, a grant of 35 % of the cost of fixed assets (FIM 15,000) is FIM 5,300 in monetary terms. This aid would make the investment project profitable in Area C1, but a FIM 6,600 deficit remains in Area B. In practise, however, the investment aid levels are lower in Area C1 than in Area B.

5.2. Financing and liquidity

If the planned investment project passes the profitability criteria, the financing must be arranged and liquidity has to be determined. The borrowing capacity is briefly estimated first, but the main emphasis is on the liquidity that is determined for two investment costs: the current investment cost, and the maximum bid price of the real options model.

Before the planned new investment, the farm model is supposed to have FIM 240,000 of debt. This uses nearly half of the collateral value of the farm (Table 24). If the production buildings are not approved for collateral, the farm has only some FIM 220,000 of borrowing capacity. This may limit the size of the credit financing possibilities.

Table 24. Value of the dairy farm (real estate only), FIM 1,000.

	Market value
Arable land, 24 ha	360
Forest land, 29 ha	110
House	300
Production buildings (incl. new)	300
Total	1,070
Collateral, % of total market value	60
Collateral value	640

Source: Maanmittauslaitos 1995

5.2.1. Liquidity of the current investment cost

The liquidity of the current investment cost is analysed in this chapter. It should noted that the investment did not pass the real options profitability criteria. However, a minimum return R_m that meets the criteria was determined, and it was FIM 10,600 without the investment aid in Area B. This can be compared with the return to capital that is calculated by using the break-even results of the liquidity analysis. See Chapter 3.2.1 for the interpretation of Table 25.

The total investment cost is the current investment cost of an insulated cowhouse per cow in Table 22 multiplied by the increase in the number of cows, 5 heads. The investment and loan repayment margin is set approximately to zero by changing the milk price and the price aid for milk. This situation was obtained when the milk price was set to FIM 1.85/kg and price support was set to FIM 0.41/kg. The milk price is equal to its current level and the price aid in Area B is FIM 0.45/kg in 1997. Thus, there is hardly any safety margin to the current situation.

These break-even price and aid would result in a FIM 5,460 return to capital per cow. This return is FIM 5,100 (48 %) lower than the corresponding minimum return of the real options model above. An estimate of the required compensation of risk in cash flow terms can be calculated with the cash flow model by using the price and aid of the real options model (total producer price of milk FIM 3.08/kg). This would result in a FIM 56,000 investment and loan repayment margin, and FIM 26,000 of this would be the contribution of the new enlargement. Thus, there should initially be a FIM 56,000 annual investment and loan repayment margin of the household for the compensation for the risk related to the investment. This would be equivalent to risk compensation required in the minimum return of the real options model in this case.

Table 25. Break-even cash flow statement for the farm household, in which milk price is FIM 1.85/kg and price aid FIM 0.40/kg, FIM 1,000.

	1997	1998		1999		2000		2001		2002	
Investment cost	172										
Credit	129										
Agricultural net cash income		176	(36)	175	(36)	173	(36)	174	(36)	175	(36)
Non-agricultural income		68	(0)	68	(0)	68	(0)	68	(0)	68	(0)
Total net cash income		245	(36)	243	(36)	241	(36)	242	(36)	243	(36)
Taxes (-)		58	(10)	61	(10)	63	(11)	65	(12)	67	(12)
Household withdrawal (-)		120	(0)	120	(0)	120	(0)	120	(0)	120	(0)
Investment and loan repayment capacity		66	(27)	62	(26)	59	(25)	57	(24)	56	(24)
Interest (-)		21	(8)	19	(7)	16	(7)	14	(6)	12	(6)
Loan repayments (-)		44	(9)	44	(9)	44	(9)	44	(9)	44	(9)
Total loan payments		65	(16)	62	(16)	60	(15)	58	(15)	56	(14)
Investment and loan repayment margin		2	(10)	0	(10)	-1	(10)	-1	(10)	0	(10)

If the farm had no prior credit before the investment the break-even combination would be the following: FIM 1.63/milk kg and no price support for milk.

Effect of investment aid

If the investment aid is a grant that is 35 % of the cost of fixed assets the requirement for borrowing would decrease by some FIM 26,500. In this case, the milk price should be FIM 1.85/kg and the price aid FIM 0.30 in the break-even cash flow situation.

5.2.2. Liquidity of the maximum bid price

The maximum bid price is the highest investment cost that the real options model approves and suggests to start the project. However, the maximum bid price is lower than the current prices of the items required for the investment (Table 22 and Table 22). This is the case even when an uninsulated building is made, like here. Consequently, when new buildings are required the milk quota is too expensive. Also, new innovations are needed to be able to build cheaper than this far. An alternative (or complementary) route would be to increase the return to capital.

In Table 26 break-even cash flow situation is presented with an investment cost of FIM 112,000 (FIM 22,500 per cow). In this case, the milk price is FIM 1.85/kg and the aid is FIM 0.35/kg. The difference is not wide compared to the situation in Table 25; except that the price aid is FIM 0.05/kg. This is the situation even though the new credit is FIM 45,000 smaller. One explanation to this is the fact that the lower investment cost yields a lower tax depreciation allowance. Additionally, the interest on the credit is a tax-deductible expense. Consequently, despite the lower total net cash income, the amount of taxes paid is actually higher in Table 26 than in Table 26.

The break-even price and support would result a FIM 5,090 return to capital in the profitability analysis. This is FIM 780 (13 %) lower than the equivalent current return of the real options model. The relative difference is lower than with the higher investment cost above.

An estimate of the initial cash compensation for risk can be computed with the cash flow model by using the current total producer price of milk (includes the price aid) of the real options model (FIM 2.30). This results in a FIM 9,000 investment and loan repayment margin, and the contribution of the new investment is FIM 15,000. The result is much lower than in the previous case where the returns and the investment cost were higher.

When the credit is smaller, the expansion investment contributes more to the investment and loan repayment margin of the household than with the higher investment cost above. The break-even producer price of milk is FIM 1.55 per litre for a farm without any prior debt. In this case, the effect of the new investment would be slightly positive negative. The price-aid combination results in a FIM 1,000 return to capital as it is determined for the real option model.

Table 26. Break-even cash flow statement for the farm household, in which milk price is FIM 1.85/kg and price aid FIM 0.35/kg, FIM 1,000.

	1997		1998		1999		2000		2001		2002	
Investment cost	112											
Credit	84											
Agricultural net cash income	169	(34)	168	(34)	166	(34)	167	(34)	167	(34)		
Non-agricultural income	68	(0)	68	(0)	68	(0)	68	(0)	68	(0)		
Total net cash income	237	(34)	236	(34)	234	(34)	235	(34)	236	(34)		
Taxes (-)	56	(10)	59	(11)	61	(11)	63	(12)	65	(12)		
Household withdrawal (-)	120	(0)	120	(0)	120	(0)	120	(0)	120	(0)		
Investment and loan repayment capacity	61	(24)	57	(23)	54	(23)	52	(22)	51	(22)		
Interest (-)	18	(5)	16	(5)	14	(4)	12	(4)	10	(4)		
Loan repayments (-)	41	(6)	41	(6)	41	(6)	41	(6)	41	(6)		
Total loan payments	59	(11)	57	(10)	55	(10)	53	(10)	51	(9)		
Investment and loan repayment margin	2	(14)	0	(13)	-1	(13)	-1	(13)	0	(13)		

5.3. Conclusions

As expected, uncertainty plays an important role in the investment in dairy farming. In the case of expected returns the decision would be to invest if a uninsulated cowhouse is built in both support areas examined. In Area C1, a warm cowhouse would also be a profitable investment. When uncertainty is taken into consideration, the return requirement of the investment is 1.2-1.5 times higher than with the expected returns. As a consequence, the conventional building type is too expensive in every case.

Because the variation of aid measures is intuitively added to the standard deviation of the milk price and, in addition, the price development is likely to be interlinked with input prices, the results are simulated with different values of σ. However, on a dairy farm the share of purchased inputs in the total annual operating expenditure is smaller than in pig farms. All other assumptions are kept identical to the cases above. The return requirement with certain expected returns (*PVM*) is equal to the base calculation that is also included in Table 27. The results are calculated by using the procedures described above.

The increase of the standard deviation from 0 to 0.4 almost doubles the initial return requirement to investment or, alternatively, the maximum bid price halves. The investment and loan repayment margin is an initial cash reserve that is determined by using the maximum bid price as an investment cost. The farm household is assumed to have FIM 50,000 of equity financing available in each case. This makes the liquidity situation of different investment costs comparable since the initial cash inputs are equal.

The initial investment and loan repayment margin is determined on an after-tax basis by using the tax rates in 1997. The cash flow situation describes the expanded farm when the production is increased up to the capacity. The milk price is FIM 1.85/kg, and price aid is FIM 0.45/kg in 1997. The investment and loan repayment margin is also calculated without deducting the depreciation allowance and the interest payments when the taxes were calculated. These results are in parentheses in the liquidity section of Table 27, and they show a significant increase in the investment and loan repayment margin as the maximum bid price (investment cost) decreases. Briefly, the simulation results indicate that, the more risk is assumed, the lower the investment cost has to be, and the larger cash flow margin must exist.

Table 27. Simulation results with different values of σ in Area B, present value multiple PVM = 16.9 %, *FIM 1,000*

	Standard deviation of *R*, σ				
	0	0.1	0.2	0.3	0.4
Profitability, maximum bid price/sow:					
Option value multiple *OVM*	1.00	1.08	1.27	1.50	1.78
Required rate of return *R/I*, %	16.9	18.4	21.5	25.4	30.2
Maximum bid price, *I* (*R* = *0.57*)	34.7	32.0	27.4	23.1	19.5
Liquidity of farm household:					
Investment cost (*I* × *222*)	173	160	137	116	97
Initial investment and loan repayment margin	5 (-17)	6 (-16)	7 (-13)	8 (-11)	9 (-8)
-Contribution of new investment	12 (-4)	12 (5)	13 (8)	14 (10)	15 (12)

Some results can be used as arguments in the discussion concerning the price of a milk quota. It should be more or less free for those who make building and machinery investments. However, there are many dairy farmers who have vacant places in their cowhouses due to the increased milk yield per cow. They have to invest only to heifers, operating capital, and the quota. When using the maximum bid price of Area B (FIM 27,400), the residual price for milk quota is FIM 2.75/kg. In March 1997 a partially administrative milk quota trade system was introduced. The administrative price is set to FIM 0.65 per kg. A seller of a milk quota who sells at least half of the quota to the administration is eligible to sell the rest of the quota to another farmer. Thus, there is an administrative price and a market price for milk quotas (MAF 1997). The administrative price is lower than the price used above and, thus, helps an investor to reach the maximum bid prices.

6. Acquisition of arable land

Acquisition of arable land is the typical expansion form of a crop farm, and it may also be necessary for an animal husbandry farm for fodder production and manure spreading. Land acquisition is analysed by means of a different approach than in the previous chapters where the farm models were used to describe the base situation and the goal situation. Here, however, the land purchase is analysed only as a marginal event for the farm. In many farms some additional land can be worked with the existing equipment without new machine purchases. However, the equipment probably needs earlier replacement due to the increased usage although, in many cases, the equipment becomes outdated and is replaced before is wears out.

According to Pyykkönen (1995), the annual goal for the interest, depreciation, and maintenance field machinery and related buildings should be FIM 600 per hectare in the long run. Typically, the machine cost is much higher than this on cereal farms. Because the acquisition of additional arable land is investigated here, the assumption is that there is some over-capacity in the current set of equipment.

The annual return per hectare is determined by a summary of the gross margin calculations of Enroth (1995) in Table 28. The full calculations are presented in Appendix 2. Some updating, nevertheless, is made due to changes in cereal prices, payments for arable land, and fuel price. In addition, the interest on operating capital is deducted from the operating cost since operating capital is assumed to be covered with the maximum bid price. The return to farmland in fodder barley production appears almost identical in both support areas and, therefore, separate investment calculations were not considered necessary. The resulting *R* in Area B is used in the following calculations.

Table 28. Summary of annual returns and costs of fodder barley hectare.

	Area B, 4,000 kg/ha	Area C1, 3,500 kg/ha
Returns:		
Barley	2,800	2,450
Payments for arable land	2,810	2,640
Total return	5,610	5,090
Variable cost	2,210	1,770
Opportunity cost of labour	720	680
Increase of machinery capital cost	600	600
Return to land investment, *R*	2,080	2,040

Sources: Enroth 1995, Pyykkönen 1995

There are two obvious forms for acquiring additional land: purchase and lease. Both of these are analysed. In Chapter 6.1 the maximum bid price of arable land is determined as in the previous chapters, and liquidity is analysed as well. In Chapter 6.2 the liquidity of the lease alternative is analysed, which illustrates the profitability, too, since no long-term investments are assumed.

6.1. Purchase of arable land

Land purchase can be analysed as a similar partially irreversible investment as the animal husbandry investments presented above. Although land does not depreciate (wear), its value responds to the changes in the returns to land, as has been experienced in Finland lately. Many farmers who bought high-priced arable land in the 1980s now face the fact that the same piece of land has a current value that may be only a fraction of the purchase price (Maanmittauslaitos 1995). The real options model can be used to avoid this type of unfavourable surprises when bid prices are determined for land (Table 29).

Besides land, the maximum bid price also has to be adequate for the operating capital, which is here FIM 700 without the opportunity cost of labour.

Table 29. Return requirements for investment into a hectare of arable land (fodder barley).

	Value/ha
Current return to arable land (1997), R (from Table 28, FIM)	2,080
Discount rate, ρ	5.9 %
Depreciation rate, δ	0 %
Expected rate of change of R, α	0
Present value multiple, PVM (= $\rho + \delta - \alpha$)	5.9 %
Standard deviation of R, σ	0.3
Option value multiple, OVM	2.33
Required return, R/I ($PVM \times OVM$)	13.8 %
Maximum bid price, I [= $R/(R/I)$, FIM]	15,100

It was deducted here because it is not considered in the return R. Thus, the highest profitable bid price for land is FIM 14,400 in fodder barley production. In the case of a crop with higher return, the maximum bid price would rise accordingly.

The liquidity of credit financing is analysed in a different way than in the previous chapters. The liquidity of land purchase is analysed separately from the rest of the household under the following assumptions: the investment is 75 % credit financed, the household needs an equal amount for consumption as the opportunity cost of labour is, and the marginal tax rate is 45 %.

As it can be seen in Table 30, the consumption objective of the household will not be fulfilled, if it is derived as a residual. Thus, the return on land should not fall at all in order to pay the land with credit. However, the calculation illustrates the liquidity situation immediately after the investment. When the loan is repaid, the interest payments decrease along with the remaining loan balance.

Table 30. Liquidity statement of the land purchase.

	FIM/ha
Investment cost 15,100	
Credit 11,300	
Net cash flow (*R* + opportunity cost of labour)	2800
Interest payments, 5.9 % (-)	670
Taxable income	2130
Tax (marginal tax rate 45 %) (-)	960
Surplus after taxes	1170
Repayment, 15 year repayment term (-)	760
Residual for consumption (labour)	420

As conclusion, if the farmland is priced using the real options model, the investment is just approximately liquid when it is financed mostly with credit, given the current returns (prices and aid levels). Oltmans (1995) addressed the liquidity problems of farmland to its economic nature. He analysed the relation between the profitability and liquidity under certain returns. He found that depreciable assets, if financed with proper terms, can be expected to pay for themselves when the rates of return equal or exceed the cost of borrowed capital. Land as a nondepreciable asset cannot do that. Repayment terms normally found on financial markets do not match the nondepreciable nature of land. If the asset is priced competitively, the repayment of its capital will result in a serious cash flow problem (Oltmans 1995, p. 59-60). Here, the cash flow problem is not as severe as Oltmans found since the farmland was priced differently, namely, uncertainty reduced its maximum bid price. However, there is still no safety margin in the liquidity analysis. In addition, it should be noted that these calculations assume some unused machinery resources. If all machinery is purchased together with the land purchase, the machinery cost should be adjusted to accommodate that situation.

3

6.2. Lease of arable land

Purchase is not the only way to gain access to arable land. A lease is a potential alternative. In 1994 family farms had leased 19 % of their cultivated land on average. On farms with over 30 ha of arable land the share of leased land was larger (Statistics Finland 1996). Thus, land leasing is used as a method to expand the farm and, if it is a possible alternative in practise, it should be compared with a purchase. The lease analysis is based on the same returns as the purchase analysis above (Table 28). As a consequence, the calculation here is comparable to the liquidity statement of the purchase case is presented again here for comparison in Table 30. The lease payment is determined in such a way that the return to land is divided between the owner and the lessee.

Table 31 suggests where the difference in the liquidity of lease and purchase of arable land lies. The main difference is the repayment that is not needed in the case of lease and, thus, the residual cash flow for consumption is FIM 600 higher than in the case of purchase. This sum is higher than the opportunity cost of labour. Thus, the leasing alternative offers a safety margin, whereas a credit-financed purchase does not . Additionally, a lease contract can be made as a share-lease arrangement where the rent is tied to cereal prices, arable payments, etc. This effectively divides the risk between the owner and the lessee.

Table 31. Liquidity of lease and purchase of arable land ha in fodder barley production.

	Lease	Purchase
Net cash flow	2,800	2,800
Lease of land (Interest payment in purchase) (-)	900	670
Taxable income	1,900	2,130
Tax (marginal tax r. 45 %)	855	960
Net after taxes	1.045	1,170
Repayment of debt	0	760
Residual for consumption (labour)	1,045	420

6.3. Conclusions

A similar simulation as in the previous chapters is performed at different risk (standard deviation) levels. All other assumptions are kept identical to the cases above. The return requirement with certain expected returns (*PVM*) is equal to the base calculation that is also included in Table 29. The results are calculated by using the procedures described above.

The increase of the standard deviation from 0 to 0.4 triples the initial return requirement to investment. The investment and loan repayment margin is an initial cash reserve that is determined by using the maximum bid price as an investment cost. The farm household is assumed to have FIM 4,000/ha of equity financing available in each case. This makes the liquidity situation of different investment costs comparable since the initial cash inputs are equal.

The initial investment and loan repayment margin is determined on an after-tax basis by using the tax rates in 1997. The cash flow result describes a situation where the production is increased up to the capacity. The fodder barley price is FIM 0.70/kg, and arable payments make a total of FIM 2,810/ha in 1997. The investment and loan repayment margin is also calculated without deducting the depreciation allowance and the interest payments when the taxes were calculated. These results are in parentheses in the liquidity section of Table 27, and they show a significant increase in the investment and loan repayment margin as the maximum bid price (investment cost) decreases. Briefly, the simulation results indicate that, the more risk is assumed, the lower the investment cost has to be, and the larger cash flow margin must exist.

Table 32. Simulation results with different values of σ in Area B, present value multiple PVM = 5.9 %, FIM.

	Standard deviation of *R*, σ				
	0	0.1	0.2	0.3	0.4
Profitability, maximum bid price/sow:					
Option value multiple *OVM*	1.00	1.34	1.78	2.33	3.03
Required rate of return *R/I*, %	5.9	7.9	10.5	13.8	17.8
Maximum bid price, *I (R=2,080)*	35,300	26,400	19,900	15,100	11,700
Liquidity of land purchase:					
Initial investment and loan repayment margin	-1,560	-680	-31	440	781

7. Summary and conclusions

The object of the study was to apply investment analysis methods to some cases of farm investments. The methods used account for the future uncertainty of the economic environment, namely prices and subsidies. Additionally, there are risks related to production, such as weather and diseases. These, however, are quite familiar to farmers and the production risks are taken into account by diversifying production, as well as by using insurances and sound management practises. However, volatile prices and subsidies are not yet treated as routines in farm planning. Therefore, this study can be considered as an opening in the application of appropriate methods for this. The analysis was done from the managerial point of view. The result of profitability analysis is a maximum bid price that is the highest profitable investment cost. The maximum bid price was determined by using a real options model that implicitly accounts for the future uncertainty and the potential irreversibility of the initial investment outlay.

The results of the liquidity analysis are such break-even price and aid for the main product that set the net cash flow of the farm household to zero. The riskiness of the liquidity situation can be appraised by comparing these break-even results to current price and aid levels. Also, a cash surplus was determined with the corresponding minimum return of the real options model. Additionally, the collateral values of the farms were approximated in order to find out their borrowing capacities.

The investment analysis methods were applied on farm models that represent homogenous groups of Finnish farms that participate in the farm accountancy data network. Thus, strictly speaking, the results reflect the investment capabilities of these farms, and the calculations have to be adjusted according to the actual case under investigation. However, several conclusions can be derived from the results.

The general finding of the study was that the maximum bid prices were lower than the equivalent current investment costs. Uncertainty plays an important role here. Under certain future costs and returns, the calculations recommend investing. When uncertainty is taken into consideration, the return requirement of the investment is 1.2-2.3 times higher than with the expected returns, and most of the analysed cases become unprofitable. However, the investment aid makes a big difference in many cases. The projects come at least close to the profitability limit.

Because of the great influence of uncertainty, the goal in agricultural policy-making should be the establishment of long run stability in order to decrease the policy risk. In addition, rapid policy changes are also likely to affect the market prices. However, uncertainty of some degree will be a permanent condition, whatever the source.

Given the current knowledge on future returns, a general conclusion is that the conventional building types are too expensive or, alternatively, returns to investment are too low. Thus, cheaper technologies must be carefully investigated in order to reduce the initial investment expenditures and the risks involved in investments. An alternative (or complementary) route would be to increase the return to capital. For instance, increased physical productivity and cheaper fodder would be beneficial.

Large farm size may help to attain some advantages that influence the return per unit. Namely, machinery cost per unit of production is likely to decrease since machinery is typically under-utilised on small farms where machinery typically becomes outdated before it wears out. Also, the labour input per unit of production usually decreases when the unit size grows, which would decrease the opportunity cost of labour per unit. Quantity discounts are larger in inputs and producer prices may be higher when larger quantities are sold.

Also, many similar factors that appear to have only a minor effect taken together may make the difference between a profitable and unprofitable investment project. However, most of these economies of scale can be achieved by co-operation between farmers.

In a large investment compared to the original size of a farm there might be difficulties to have access to adequate credit since the collateral values of farms have declined along with the market value. These difficulties may occur, in particular, if the farm has previous credit liabilities and production buildings are not approved for collateral. Young farmers have the longest farming career ahead, but they also have the highest debts due to the recent purchase of their farms. Thus, the access to financing may restrict the development of their farms and future income. If the investment plan indicates adequate profitability and liquidity under uncertainty and the collateral is not adequate for financing, the problem lies in asymmetric information between the farmer and the lender. A public guarantee for the missing collateral could provide a solution for this type of problem.

However, the results indicate that if the future price development is unfavourable, the new enlargement will not help the overall cash flow situation of a highly indebted farm household. Consequently, the collateral problem is relevant only when the farm will have a profitable and financially feasible investment but does not posses adequate collateral, and the liquidity situation of the household is feasible even without the new investment.

An investment project should not be started if the liquidity statement appears like a break-even situation already at the beginning. By using the price and aid assumption of the real options model, the initial cash compensation was computed to show the analogy of the compensation for risk in the real options model and the liquidity analysis. The outcome was that the initial cash surplus should be considerable. Consequently, an unfavourable future would not immediately result in cash flow problems. In the beginning, there may also be unexpected adjustment costs that can be covered with the planned cash flow surplus.

The result of the cash flow analysis supports the result of the real options model: there should be an initial compensation for risk since relatively small changes in prices and aid levels would lower the returns considerably. The project could become unprofitable and unfeasible immediately if an adequate initial compensation for risk does not exist.

The results were simulated using different risk levels. The increase of the standard deviation from 0 to 0.4 doubles or triples the initial return requirement to investment. However, the increase of tax deductions makes the initial cash reserve quite unresponsive to the investment cost. But in the longer run, when the possibility of return fluctuation increases and the tax provisions are decreasing, an investment with a lower cost can bear a greater annual return decrease than an expensive investment before having liquidity problems.

Additionally, if the income decreases significantly there may not be any taxable income to make deductions from and, in this situation, cash flow problems are more than likely to occur. Therefore, investment and loan repayment margin is also calculated without deducting the depreciation allowance and the interest payments when the taxes were calculated. These results show a significant increase in the investment and loan repayment margin as the investment cost decreases.

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Maatalouden investoinnit epävarmuuden vallitessa

Pasi Lempiö

Tutkimuksen tavoitteena oli soveltaa maatalouden investointien tarkasteluun uusia analyysimenetelmiä, jotka ottavat huomioon maatilan taloudellisen toimintaympäristön riskejä, kuten hintojen ja tukien vaihtelut. Riskeihin voidaan varautua investointipäätöstä tehtäessä soveliaita investointilaskelmia apuna käyttäen.

Tässä tutkimuksessa esitettiin esimerkkejä siitä, miten riskejä voidaan ottaa huomioon investointien suunnittelussa. Tutkimuksessa sovellettiin reaalioptiolaskelmaa, joka ottaa huomioon tulevien tuottojen epävarmuuden, investointipäätöksen siirtämismahdollisuuden ja investoinnin peruuttamattomuuden. Viimeksi mainittu seikka tarkoittaa sitä, että alkuperäistä investointimenoa ei ole mahdollista saada kokonaisuudessaan takaisin, jos investointi osoittautuu kannattamattomaksi. Reaalioptiolaskelma antaa tuloksena kynnysarvon investoinnin tuottovaatimukselle, joka on investointihetken kate pääoman korolle ja poistolle (*R*) jaettuna investointikustannuksella (*I*). Tuottovaatimuksen kynnysarvosta (*R/I*) voidaan helposti määrittää, kuinka paljon investointi saa korkeintaan maksaa ollakseen kannattava (ylin kannattava investointihinta). Jos vaihtoehtoisesti investointikustannus tunnetaan, voidaan ratkaista investointihetken vähimmäiskate investoinnille.

Investointianalyysimenetelmää sovellettiin esimerkkitapauksiin, jotka muodostettiin MTTL:n tilamallien avulla. Tämän tutkimuksen tulokset edustavat tarkasteltujen tilojen investointimahdollisuuksia ja tuloksia hyödynnettäessä niitä tulee päivittää tapauskohtaisesti tarkasteltavan investointihankkeen mukaan. Useita johtopäätöksiä voitiin kuitenkin tehdä saatujen tulosten pohjalta.

Oheiseen taulukkoon on koottu eräitä keskeisiä tuloksia. Kun diskonttokorko (ρ) oli 5,9 %, eri tuotantosuuntiin saatiin seuraavia tuloksia B-alueen tukien mukaan laskien. Investoinnin poisto-osuutta (δ) ei saa reaalioptiomenetelmää käyttäen yliarvioida, koska riskit otetaan huomioon muulla tavoin. Katteen (*R*) odotetun suhteellisen muutoksen (α) erot johtuvat alenevien tukien erilaisista vaikutuksista eri tuotantosuuntiin. Nykyarvokerroin (*PVM*) on investoinnin tuottovaatimus ilman riskin huomioon ottamista. Optiokerroin (*OVM*) korottaa investoinnin tuottovaatimusta riskin vuoksi ja määritetään edellä mainittujen muuttujien (ρ, δ ja α) sekä katteen suhteellisen keskihajonnan (σ) avulla. *R/I* on investoinnin tuottovaatimus investointihetkellä, josta määritettiin ylin kannattava investointihinta, kun kate *R* tunnetaan. Kyseisillä summilla pitää kiinteiden rakennus- ja koneinvestointien lisäksi pystyä hankkimaan liike- ja eläinpääoma sekä maidontuotannossa maitokiintiö. Lisäpellon tapauksessa lisääntyvät konekustannukset on otettu huomioon *R*:ssä, eli ylimmällä kannattavalla hinnalla tulee voida hankkia pelto ja liikepääoma.

Epävarmuus tulevaisuuden tuloista vaikuttaa ratkaisevasti investoinnin tuottovaatimukseen kasvattaen sitä 1,2-2,3-kertaiseksi tunnettuihin tuottoihin verrattuna. Tunnetuin tuotoin laskelmat olisivat suosittaneet investoinnin toteuttamista, mutta epävarmoin tuotoin määritetyt ylimmät kannattavat investointihinnat olivat alempia kuin vastaavat tämänhetkiset investointikustannukset. Tämä viittaa siihen, että investoinnit ovat kannattamattomia. Investointitukien vaikutus oli kuitenkin huomattava. Investointituet paransivat tarkasteltuja investointeja ainakin lähelle kannattavuusrajaa.

	R, mk	δ, %	α	*PVM*, %	σ	*OVM*	*R/I*, %	*MBP*, mk
Emakkopaikka	2 280	6,0	-0,04	15,9	0,3	1,55	24,7	9 250
Lihasikapaikka	567	6,0	-0,07	18,9	0,3	1,42	27,0	2 100
Lehmäpaikka	5 870	6,0	-0,05	16,9	0,2	1,27	21,5	27 400
Lehmäpaikka, kylmäpihatto	5 870	10,0	-0,05	20,9	0,2	1,25	26,0	22 500
Peltohehtaari, rehuohra	2 080	0,0	0,00	5,9	0,3	2,33	13,8	15 100

R = Investointihetken (1997) kate pääoman korolle ja poistolle
δ = Poisto-osuus
α = Katteen *R* odotettu suhteellinen vuotuinen muutos
PVM = Nykyarvokerroin (*present value multiple*) (= ρ + δ - α), tunnetuin tuotoin määritetty investoinnin tuottovaatimus
σ = Odotetun katteen suhteellinen vaihtelu (keskihajonta), joka kasvaa ajan funktiona.
OVM = Optiokerroin (*option value multiple*) on riskin aiheuttama korotus *PVM*:n mukaiseen tuottovaatimukseen.
R/I = Investoinnin tuottovaatimus investointihetkellä
MBP = Ylin kannattava investointihinta (*maximum bid price*), kun *R* on tunnettu

Tilakokoa kasvattamalla on saavutettavissa mittakaavaetuja, jotka alentavat tuotantokustannuksia. Konekustannukset tuotettua yksikköä kohti ovat usein alhaisemmat suurilla tiloilla, koska pienillä tiloilla konekapasiteettia ei tyypillisesti ole pystytty hyödyntämään yhtä hyvin kuin suurilla tiloilla. Lisäksi tekniikan kehittymisen myötä kalusto tulee usein vanhanaikaiseksi ennen loppuunkulumistaan. Myös työmenekki tuotettua yksikköä kohti alenee tilan kasvaessa, mikä alentaa työn vaihtoehtoiskustannusta. Tuotantopanosten määräalennukset ovat suurempia ja myytävien tuotteiden hinnat korkeampia suurilla tiloilla, joilla kauppamäärät ovat suuria. Monen pieneltä vaikuttavan tekijän summa saattaa tehdä erotuksen kannattavan ja kannattamattoman investoinnin välillä.

Useimpia edellä mainittuja mittakaavaetuja pystytään saavuttamaan myös viljelijöiden välisen yhteistoiminnan avulla.

Tehtyjen laskelmien valossa monet perinteiset tuotantomenetelmät ovat investointikustannuksiltaan liian kalliita, tai investoinnille saatavat tuotot ovat liian alhaiset. Investointikustannusten alentamiseksi tulisikin kehittää aiempaa halvempia tuotantomenetelmiä.

Investointien rahoitus saattaa kärsiä vakuuksien puutteesta. Korkea sukupolvenvaihdoshinta rajoittaa nuorten viljelijöiden tilan kehittämis- ja laajentamismahdollisuuksia. Jos kuitenkin velkaisella viljelijällä on investointisuunnitelma, joka epävarmuus huomioon otettuna osoittaa hankkeen olevan kannattavan ja perheen maksuvalmiuden olevan riittävän, valtiontakaus (tai vastaava) olisi tarpeellinen investointituen muoto vakuusvajeen täyttämiseksi.

Myös perinteistä kassavirta-analyysiä tarvitaan edelleen investoinnin maksuvalmiuden selvittämiseksi varsinkin silloin, kun käytetään lainarahoitusta. Maksuvalmiuslaskelman herkkyyden selvittämiseksi laskelmasta tehtiin versioita vaihtoehtoisia hinta- ja tukitasoja käyttäen. Lisäksi maksuvalmius laskettiin käyttämällä investointikustannuksena reaalioptiomallin ylintä kannattavaa investointihintaa, jotta nähtäisiin miten paljon riskille on vaadittava korvausta kassavirroilla mitattuna. Tilojen vakuustilanne arvioitiin niiden lainarahoitusmahdollisuuksien selvittämiseksi.

Investointia ei tulisi aloittaa, jos maksuvalmiuslaskelma näyttää tiukalta heti investoinnin jälkeen. Käyttämällä reaalioptiolaskelman hinta- ja tukioletuksia laskettiin eräänlainen käteiskorvaus riskille reaalioptiolaskelman ja maksuvalmiuslaskelman suhteen havainnollistamiseksi. Tulosten mukaan myös maksuvalmiuspuolella pitää lainanhoitomenojen jälkeen olla huomattava turvamarginaali. Tällöin epäsuotuisa tulevaisuus ei johda välittömiin maksuvalmiusongelmiin. Investoinnin jälkeen voi esiintyä myös odottamattomia uuteen yksikkökokoon siirtymisestä aiheutuvia sopeutumiskustannuksia, joista voidaan selviytyä suunnitelman kassavirtaylijäämällä.

Tehtyjen kassavirtalaskelmien tulokset tukevat reaalioptiolaskelman tuloksia: riskille pitää vaatia korvaus, koska suhteellisen pienet hinta- ja tukimuutokset muuttavat kassavirtoja huomattavasti. Investointi tulee helposti sekä kannattamattomaksi että rahoituksellisesti epäsuotuisaksi, jos riskejä ei oteta huomioon.

Verotuksen poistot ja lainojen korkojen vähennysoikeudet saattavat tehdä koko tilan maksuvalmiuslaskelman vain vähän riippuvaiseksi siitä, onko investointi kallis vai halpa. Pitkällä aikavälillä tuottojen epävarmuus kasvaa ja veroedut vähenevät, jolloin halvempi investointi kestää suuremman tuottojen alenemisen ennen maksuvalmiusongelmia. Lisäksi tuottojen aletessa merkittävästi verovähennysmahdollisuuksia ei välttämättä pystytä täysin hyödyntämään. Vaikka verotusjärjestelmä on tehty investointeihin kannustavaksi, ei verotus saa olla määräävä tekijä investointipäätöksen yhteydessä.

Riskit kuuluvat yritystoimintaan ja ne tuovat myös voiton mahdollisuuksia, jos tulevaisuus on odotettua suotuisampi. Maatalouspoliittisilla toimenpiteillä riskejä voidaan kasvattaa tai pienentää. Pitkäjänteinen politiikka ja poliittisten toimenpiteiden ennustettavuus pienentäisivät riskille laskettavaa korvausta. Tämä alentaisi investointikynnystä ja edistäisi maatalouden rakennekehitystä.

Appendix 1. Price and aid scenarios that were used when the current returns and future expectations for the real options model were determined.

The aid levels of 1997 are confirmed by government (MAF 1996). The coming years are estimated by using the realised cuts to maximum allowed aid levels in 1997.

Arable land: ha of fodder barley in 1997

	area B	area C1
Fodder barley FIM/kg	0.70	0.70
Direct payments, FIM/ha		
CAP reform	917	917
LFA	950	950
Environmental	597	400
Transitional period	125	125
National crop production	70	70
Young farmers (under 40 years)	150	180
Total aid, FIM/ha	2,809	2,642

Arable land: grassland, product has no market value since it is assumed to be used as an input on the farm.

	Area B	Area C1
Direct payments, FIM/ha		
CAP reform		
LFA	950	950
Environmental	850	850
Transitional period	125	125
National crop production		
Young farmers (under 40 years)	150	180
Total aid, FIM/ha	2,075	2,105

Pig husbandry

Piglet sell price, FIM/head	310
Piglet purchase price, FIM/head	330
Pigmeat price, FIM/kg	8.50

	1997	1998	1999
Aid measures in Area B:			
Sow	1,380	1,246	1,122
Slaughter premium of pig	192	167	149
Aid measures in Area C1:			
Sow	1,132	712	333
Slaughter premium of pig	163	110	55
Nordic aid per Livestock Unit (LU)	355	900	1,300

Continues

Dairy farming

Milk, market price for producer, FIM/litre	1.85		

	1997	1998	1999
Aid measures in Area B:			
Transitional period aid of milk, FIM/l	0.45	0.42	0.39
Aid measures in Area C1:			
Transitional period aid of milk, FIM/l	0.33	0.22	0.11
Nordic aid of milk, FIM/l	0.26	0.36	0.46
Total	0.59	0.58	0.57

Appendix 2. Gross margin statement of fodder barley in Area B and Area C1.

Gross margin calculation: fodder barley

		Area B			Area C1		
		FIM/			FIM/		
Return, FIM/ha	Unit	Unit	Amount	FIM	Unit	Amount	FIM
Barley, 4000 kg/ha	kg	0,70	4000	2800	0,70	3500	2450
CAP reform	ha	917	1	917	917	1	917
LFA aid	ha	950	1	950	950	1	950
National payments	ha	195	1	195	195	1	195
Aid for young farmers	ha	150	1	150	180	1	180
Environmental aid (GAEPS)	ha	597	1	597	400	1	400
Total gross return				**5609**			**5092**
Variable costs, FIM/ha							
Own seed	kg	1,05	143	150	1,05	143	150
Purchased seed	kg	2,70	47	127	2,70	47	127
Fertilizer	kg	1,39	459	638	1,39	333	463
Chemicals	unit	90,00	1	90	90,00	1	90
Tractor work	h	22,00	12,0	264	22,00	12,0	264
Harvesting	h	80,00	1,5	120	80,00	1,5	120
Drying	kg	0,06	4000	240	0,06	3500	210
Shipping and handling charges	kg	0,07	4000	280	0,07	3500	245
Costs of GAEPS	FIM	450,00	1	450	250,00	1	250
Interest of Operating Capital (IOC)	FIM	0,05	924	46	0,05	780	39
Total variable cost				**2255**			**1808**
Cash cost (IOC)				2209			1769
Gross Margin (GM)				**3354**			**3284**
Net Cash flow (GM + IOC)				3400			3323
Opportunity cost of labour h	40,00		18,0	720		17,0	680
Return to machinery and land				2680			2643
Increased fixed costs of machinery				600			600
Return to land				2080			2043

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