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Reasons for milking system adoption: The case of Switzerland

Dierk Schmid[*,a]

[a] Agroscope, Switzerland

Abstract

This paper studies the importance that farm managers attach to investment in the milking system in terms of their (management) objectives and expectations. According to a survey of 455 Swiss farm managers, the main reasons for investment decisions for all milking systems were to reduce labour and physical stress. For milking parlours, income objectives and animal welfare were more important than for other milking systems. In the case of automatic milking systems (AMS), the focus was on making working hours more flexible and increasing family time. The study shows that higher income or production volume become less important reasons over the observed time period and that AMS are implemented by older farm managers.

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* *Corresponding author*: Dierk Schmid - Research associate, Agroscope - Swiss centre for agricultural research, Switzerland. E-mail: dierk.schmid@agroscope.admin.ch.

Introduction

Technological adoption can be accompanied by labour efficiency improvements and optimisation aspects. In most cases, the reasons for adopting a new technology are the expectations of more profitable production (Stoneman & Kwon, 1996, Michler *et al.*, 2019). This means being able to produce the same quantity with less input or produce a larger quantity with the same input. However, other non-monetary aspects play a role in an investment decision, such as a physical and psychological reduction in workload, environmental aspects, and other organisational and institutional benefits (Bocken *et al.*, 2014, Clark *et al.*, 2015).

In Switzerland today, dairy farming accounts for around 40% of all farms, and dairy farms have a significant impact on grassland use and the production of agricultural commodities for food (Agristat, 2021; Zorn & Zimmert, 2022). With an average farm size of around 21 hectares of utilised agricultural area (FOAG 2023), Switzerland's agriculture is characterised by small-scale farms compared to neighbouring EU countries. It receives substantial governmental support, accounting for 49% of gross farm receipts during the 2017–2019 period (OECD, 2020). The income of dairy farms remains below average compared to other farm types (Hoop *et al.*, 2021). In addition, input and output prices in the dairy sector have become more volatile over time (El Benni & Finger, 2013; Frick & Sauer, 2021; Kozak *et al.*, 2022). To remain or become more competitive by reducing costs, farmers need to adapt, including investing in new equipment. In the workflow of dairy farms, milking still occupies a large amount of time. On a farm with a milking parlour, the proportion of labour spent on milking can be around 30%. Investing in milking systems that are more expensive but require less labour is therefore a very important decision for dairy farmers in the long term (Gallardo & Sauer, 2018).

Recent studies on the motivations for investment in milking technology have used surveys and focused mainly on the latest investments in automatic milking systems (AMS) compared to conventional milking systems. Hogeveen *et al.* (2004) found that for Dutch farmers, in addition to organisational, procedural reasons were the most relevant motivations for investing in an AMS: less (heavy) work, the possibility of milking cows more than twice a day, the departure of an employee, and the need for a new milking system. The findings of Moyes *et al.* (2014) are similar, with improved herd management and better management of family time being the most influential reasons for considering switching to an AMS. In the context of Norwegian farmers with AMS, Hansen (2015) found that the main reasons for investing in AMS are increased flexibility, reduced workload, and AMS' potential to enable a more modern lifestyle. Vik *et al.* (2019) reported that

most motives are related to working conditions and quality of life rather than economic reasons. In addition, a better quality of life for the farm household was also noted, as farmers can easily more participate in social activities outside the farm and be more available to their families. In a study of large dairy farms in the USA, Lage (2024) reports that the main reasons for choosing the system were to reduce labour costs, improve cow welfare and increase milk production.

The heterogeneity of the results of the studies indicates the importance of the issue. However, two aspects have received little attention. Firstly, recent studies have predominantly focused on the most modern milking systems, neglecting the diversity of milking systems in use. Secondly, the potential evolution of the reasons over time has not yet been investigated. Additionally, no such study has been carried out within the Swiss context, with small farms and specific topographical conditions for technology use, ranging from lowland to mountainous areas. Given this premise, the following questions arise: What importance do farm managers attach to investment in the milking system in terms of their (management) objectives and expectations in the Swiss context? Are there common objectives for all milking systems, or are there specific objectives suited for one type of milking system? Are the objectives subject to a trend? The aim of the study is to address these questions and provide insight into which milking system is best suited to the farmers' objective structure. This also can help policymakers, particularly in structuring investment subsidies in the agricultural sector. The remainder of the paper is structured as follows. Section 2 deals with the data and the methods used. Section 3 presents the descriptive and empirical results, and Section 4 concludes with a discussion of the results and their context within the literature.

1. Materials and methods

There are two farm accountancy datasets in Switzerland (Renner et al., 2019) one that focuses on monitoring the income situation and the farm management sample, which includes more detailed data at the product branch level, in addition to the standard accounting variables in the usual FADN dataset. This study uses the second, more detailed dataset. The dataset contains annual data on about 1600 farms (accounting year 2020) with different farm types from three regions. The data comprise detailed monetary figures and structural information, such as information on labour, land, animals, or farming systems, but no details on machinery, equipment, or buildings. To collect data on the milking system and on the importance of their investment goals, an additional survey was integrated into the normal

survey process and sent to all specialised dairy farms participating in the 2021 Farm Management Sample for the accounting period of 2020. Eighty percent of the recipients (approx. 600) answered the survey, and after a consistency check on the milking system, milking units, and barn, data from 455 farms were used for the analysis. This included 214 farms with a bucket and pipeline milking system (BPMS), 217 farms with a parlour milking system (PMS), and 24 farms with an AMS.

A three-point scale (main objective, secondary objective, and no objective) was used to answer pre-determined questions about the importance of investment objectives in the milking system at the time of investment. At least one reason had to be completed. Additionally, the survey asked when the farm had invested in the current milking system. Three types of analysis are performed: (i) group comparisons, (ii) correlation assessments, and (iii) logit modelling. Differences in structural and economic farm characteristics between the groups (milking system) were determined using statistical tests (Wilcoxon rank sum test or chi-square test). A correlation analysis was carried out to determine the relationship between the importance of the reasons for investment (e.g. improvement of working hours) and the milking systems. To analyse the evolution of the reasons for investment, the relationship between each objective and its importance and the year of investment or the age of the farm manager at the time of investment was estimated using a logit regression. A logit regression is a statistical technique for modelling a dichotomous dependent variable and predicting a categorical outcome. The relationship between the dependent variable and one or more independent variables in a logistic regression is modelled using the logistic function, which ensures that the outcome lies between 0 and 1 (Hosmer Jr *et al.*, 2013). In our model, the dependent variables are the stated reasons for the investment and whether it is a main objective, a secondary objective or no objective (for each: yes or no). The independent variables are the year of investment or the age of the farm manager at the time of investment and other covariates. The age of the farm manager at the time of the investment reflects the situation at that time better than the age of the farm manager at the time of the survey, as the farms invested at different times. Farms with inconsistent values for the age of the farm manager at the time of investment and farms that invested before 1991 were excluded from this analysis, leaving 361 farms in the sample.

In order to find the best model, four models were constructed for each investment reason that differed in terms of the interaction and a quadratic term. This resulted in the following models with variations: Without interaction:

(1a) $$Y_{iy} = b_{0iy} + b_{1iy}x_1 + b_{2iy}x_2 + b_{3iy}x_3 + e_{iy}$$

Complemented by the quadratic term:

(1b) $$Y_{iy} = b_{0iy} + b_{1iy}x_1 + b \quad x^2 + b_{2iy}x_2 + b_{3iy}x_3 + e_{iy}$$

With interaction:

(2a) $$Y_{iy} = b_{0iy} + b_{1iy}x_1 + b_{2iy}x_2 + b_{3iy}x_3 + b_{12iy}x_1x_2 + b_{13iy}x_1x_3 + e_{iy}$$

Complemented by the quadratic term:

(2b) $$Y_{iy} = b_{0iy} + b_{1iy}x_1 + b \quad x^2 + b_{2iy}x_2 + b_{3iy}x_3 + b_{12iy}x_1x_2 + b_{13iy}x_1x_3 + e_{iy}$$

With x_1 = investment year or age farm manager in investment year, x_2 = PMS milking system (dummy), x_3 = AMS milking system (dummy), i = reasons for investment (e.g. increase in income), y = type of objective (Main, secondary, no objective. In the form of a dichotomous variable, with y=1 if yes and y = 0 if "no" for each case) and the error term e.

To the end, a total of 240 (10x3x2x4) regressions were carried out for all combinations of the objectives and their binary values of importance (main yes/no, secondary yes/no, no objective yes/no), the two independent variables and all model variants. For each dependent variable the most informative model was selected based on the Akaike information criterion (AIC) which is calculated based on the number of independent variables in the model and the maximum likelihood estimate of the model. The optimal model according to AIC is the one that explains the greatest amount of variation while minimizing the number of independent variables (Bozdogan, 1987).

2. Results

Table 1 - Descriptive statistics of the three milking system groups in 2020 in the valley, hill, and mountainous regions. Mean values, standard deviation in brackets

Region	**Valley**			**Hill**		**Mountain**	
Milking system	**BPMS**	**PMS**	**AMS**	**BPMS**	**PMS**	**BPMS**	**PMS**
Farms (n)	44	86	15	86	85	84	46
Farm structure							
Organic farming system (%)	14 (35)	7 (26)	0 (0)	9^{2*} (29)	26^{1*} (44)	25 (44)	37 (49)
Year of investment in the milking system	$1999^{2***,3***}$ (10)	$2004^{1***,3***}$ (7)	$2016^{1***,2***}$ (3)	2003 (10)	2006 (8)	2003^{2**} (10)	2009^{1**} (8)

Region	Valley			Hill		Mountain	
Milking system	**BPMS**	**PMS**	**AMS**	**BPMS**	**PMS**	**BPMS**	**PMS**
Paid labour input (AWU)	0.46[2*] (0.5)	0.75[1*] (0.7)	0.42 (0.6)	0.39[2***] (0.6)	0.66[1***] (0.7)	0.26[2***] (0.4)	0.53[1***] (0.5)
Age of farm manager	50 (10)	47 (10)	48 (8)	49 (9)	47 (10)	46 (11)	46 (11)
Age of farm manager at the time of investment	37 (14)	343[***] (11)	44[2***] (9)	36 (12)	36 (10)	38 (15)	38 (12)
Utilised agricultural area (UAA) (ha)	26.54[2**,3***] (12.95)	30.23[1**] (10.15)	40.19[1***] (17.39)	20.36[2***] (9.08)	26.91[1***] (13.79)	24.13[2**] (11.33)	30.12[1**] (14.29)
Silage maize (ha)	2.16[3***] (0.06)	3.1[3**] (0.08)	6.46[1***,2**] (0.1)	0.33 (0.03)	0.71 (0.05)	0 (0.01)	0 (0.01)
Total livestock units (LU)	34.74[2***,3***] (13.63)	51.69[1***,3***] (18.85)	74.19[1***,2***] (30.1)	30.82[2***] (13.09)	45.33[1***] (25.59)	25.65[2***] (11.26)	35.30[1***] (16.11)
Dairy cows (LU)	26.81[2***,3***] (9.63)	43.00[1***,3**] (15.03)	61.59[1***,2**] (24.81)	22.13[2***] (7.2)	31.90[1***] (14.12)	17.91[2***] (7.24)	24.04[1***] (9.3)
Animal stocking (LU/ha)	1.31[2***,3**] (0.42)	1.71[1***] (0.51)	1.85[1**] (1.17)	1.51 (0.74)	1.68 (1.13)	1.06 (0.43)	1.17 (0.5)
Livestock per labour input (LU/AWU)	16.86[2***,3***] (5.3)	22.73[1***,3***] (8.46)	35.55[1***,2***] (20.93)	17.18[2*] (10.33)	20.62[1*] (8.75)	14.17[2*] (6.53)	17.02[1*] (9.29)
Milk yield (kg percow and year)	7,455[3**] (1,434)	7,899[3**] (1,311)	8,845[1**,2**] (1,514)	6,797 (1,116)	7,008 (1,244)	6,486 (1,447)	6,757 (1,386)
Family farm income per familywork unit (CHF/FWU)	47,758[2***,3**] (28,054)	68,740[1***] (37,418)	75,572[1**] (46,223)	45,139 (29,208)	57,639 (35,306)	35,233[2**] (21,247)	44,081[1**] (20,065)

[1] Compared to BPMS; [2] Compared to PMS; [3] Compared to AMS; Signif. levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

As the farm structures in the regions are very different, the descriptive statistics are presented per milking system and region. There were no significant differences between the farm groups in terms of the absolute number of own and hired labour and the age of the farm manager. One of the biggest differences between the groups was the size of the farms, both in terms of land and the number of livestock. Farms with BPMS were the smallest, followed by those with PMS. Farms with AMS were the largest. The number of animals (animals per UAA) was higher on the AMS and PMS farms than on the BPMS farms. AMS farms had the highest number of

animals per labour input, with about 36 LSU per AWU, followed by parlour farms with about 23 LSU per AWU and farms with BPMS with about 17 LSU per AWU. Milk yield was highest on AMS farms, with 8800 kg/dairy cow per year, followed by PMS and BPMS farms, with an average of 7900 and 7500 kg/dairy cow per year, respectively. The number of animals per hectare and the proportion of silage maize were higher on AMS farms than on farms with the other milking systems. Labour income differed between farms with BPMS and farms with the other two milking systems.

Figure 1 - Relative number of farms with investments per milking system grouped by period of investment and region (Sample Size 456 Farms)

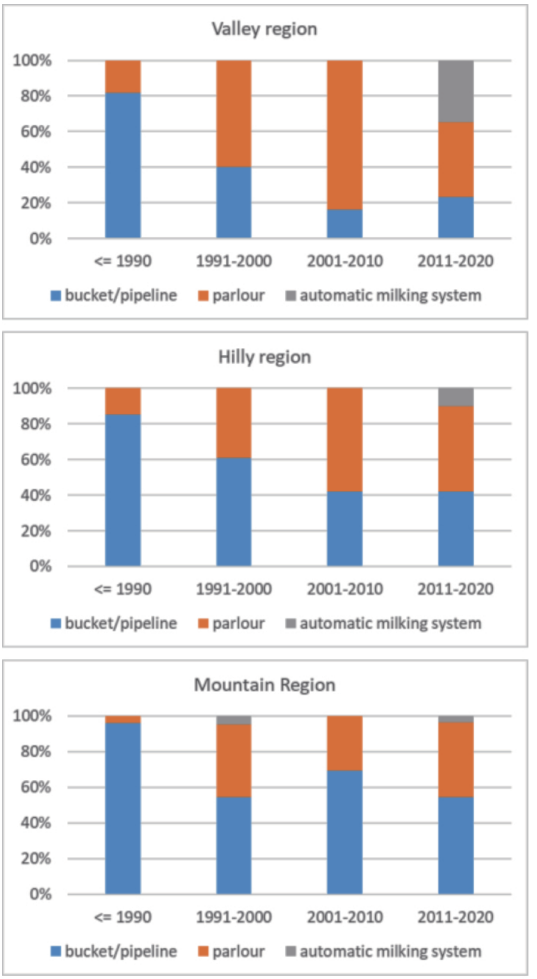

Table 2 - Relative frequencies of objectives for investing in a milking system

Milking system	**BPMS**			**PMS**			**AMS**		
Farms (n)	**214**			**217**			**24**		
objective	**main**	**secondary**	**no**	**main**	**secondary**	**no**	**main**	**secondary**	**no**
Reduce labour input	72.05	17.72	6.69	80.59	16.03	2.95	92.00	4.00	–
Reduce physical strain	71.26	15.75[2**]	9.45[2**]	69.62	25.74[1**]	4.22[1**]	64.00	32.00	–
Improve working hours	32.68[2**,3***]	39.76	23.23[2***]	43.04[1**,3***]	40.51[3**]	15.61[1***]	80.00[1***,2***]	16.00[2**]	–
Improve of animal welfare	28.74[2***]	30.31	34.25[2***]	55.7[1***]	33.33	10.13[1***]	36.00	44.00	16.00
Increase farm income per family work unit	25.98[2***]	34.65	33.86[2***]	43.04[1***]	43.88	11.81[1***]	20.00	56.00	20.00
Increase farm size/production volume	20.08[2***]	35.83	39.37[2***]	42.62[1***]	35.02	20.68[1***]	32.00	44.00	20.00
Achieve more/better family time	18.9[3***]	35.83[2**]	37.8[2***]	20.25[3**]	51.05[1**]	25.74[1***]	44.00[1***,2**]	44.00	8.00
Increase farm income	21.65[2***]	36.22	35.43[2***]	40.51[1***,3**]	41.35	16.88[1***]	16.00[2*]	60.00	20.00
Improve herd management	13.78[2***,3***]	27.56[2***]	51.57[2***]	25.32[1***]	46.41[1]	26.58[1***]	36.00[1***]	36.00	24.00
Make the farm more attractive to successors	13.39[2**]	27.17[2**]	52.36[2***]	21.1[1**]	39.24[1**]	36.29[1***,3***]	8.00	20.00	68.00[2***]

[1] Compared to PMS; [2] Compared to PMS; [3] Compared to AMS; Signif. levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The order of the objectives corresponds to their average importance.
Source: Own calculations

The survey asked when the farm had invested in the milking technology currently available. Figure 1 shows how many farms in the 2021 sample invested in a particular milking system in different periods and regions. Prior to 1990, BPMS was clearly dominant in all regions. From the 1990s onwards, investments in milking parlours predominated in the valley region. In the first decade of the 2000s, there was a sharp decline in investment in BPMS. In the mountain region, farm managers invested more frequently in milking parlours from the 2000s onwards. However, investment in BPMS was maintained at the level of the last three decades. In the mountain region, investments in BPMS remained predominant (with 55% of all investments in 2011– 2020). However, investments in milking parlours steadily increased and accounted for about 40% of all investments in the last decade. Investments in AMS were made only in the last decade of the surveyed period. In particular, farms in the valley region invested in these milking systems. They are rarely used in hilly and mountainous regions.

Table 3 - Correlation between investment goals and milking system

Correlation			
	BPMS	**PMS**	**AMS**
Farms (n)	214	217	24
Reduce labour input	–0.08*	0.04	0.10**
Reduce physical strain	0.03	–0.02	–0.01
Improve working hours	–0.17***	0.07	0.21***
Improve animal welfare	–0.31***	0.31***	0.00
Increase farm income per family work unit	–0.24***	0.26***	–0.04
Increase farm size/production volume	–0.28***	0.26***	0.04
Achieve more/better family time	–0.17***	0.10**	0.16***
Increase farm income	–0.23***	0.24***	–0.02
Improve herd management	–0.29***	0.24***	0.10**
Make the farm more attractive to successors	–0.17***	0.22***	–0.10**

3 = main goal, 2 = secondary goal, 1 = no goal
* significant at $p < 0.10$.
** significant at $p < 0.05$.
*** significant at $p < 0.01$.
spearman

Source: Own calculations. The order of the objectives corresponds to their average importance.

Table 2 shows the relative frequency of objectives when investing in a milking system, and Table 3 shows the results of the correlation analysis with the level of investment objectives and the three milking systems. For each investment objective both results are described below. The objective of reducing labour had the greatest importance across all milking systems (average 2.7). Significant differences were observed between milking systems. For the investment in farms with AMS the goal of reducing labour input was by far the most frequently mentioned reason (92%). For the milking parlour, it was 80%, and for BPMS, it remained 70%. Reducing the physical workload was, overall, very important. This was equally true for each of the milking systems, with about 70% of the responses each, or an average importance of 2.6. The objective of improving working time ranked third. It had a positive correlation for farms with AMS and was the most frequently mentioned main objective, with 80% of all statements. When investing in a milking parlour or a BPMS, this objective had a negative correlation and was significantly lower, with 40% and 32% of all responses, respectively. A similar picture emerged for the objective of improving animal welfare. On average, it ranked fourth. It was negatively correlated with BPMS farms and positively correlated with PMS farms. Among the main objectives, it was less important on farms with BPMS (29%) than on farms with milking parlours. However, 56% of all farms with a milking parlour had it as their main objective. The results for the income and labour income targets were similar for each of the milking systems. For farms with BPMS, there was a negative correlation with the income objective; for farms with PMS, there was a positive correlation; and for farms with AMS, there was no significant correlation. Improving income is not a main objective for most farms when investing in a milking system. Farms that have invested in a milking parlour (41%) gave this objective the highest priority. For farms with BPMS or AMS, the importance as a main objective was significantly lower, but as a secondary objective, it was the highest, at around 60%. Considering the main and secondary objectives together, the proportion of farms with a milking parlour that reported improving income as an objective of the investment in the milking system was highest, at over 80%. Increasing farm size or production volume is in the middle of the range of importance. This objective is particularly important for farms that have invested in milking parlours and AMS. About 40% and 30% of all respondents mentioned it as their main objective, while over 70% mentioned it as their main and secondary objective. It was positively correlated with PMS and negatively correlated with BPMS. The objective of achieving more or better family time with the investment in a milking system was ranked seventh but was more important for the AMS farms (at 44%) than for the farms with other milking systems. This was also reflected in the stronger positive correlation for farms with AMS compared to farms with PMS and the negative correlation for farms with BPMS. There was no

difference in the main objective between farms with parlour and BPMS, with about 20% of the farms. However, as a secondary objective, it was mentioned more frequently by farms with PMS (about 50% of all farms) than by farms with BPMS. Regarding the objective of improving herd management, farms with BPMS differ from those with PMS or AMS. For the latter two, it was more important as a main or secondary objective, with about 70% of all mentions, than for BPMS, with 40%. This was confirmed by the positive correlation between the objective and farms with PMS or AMS. Making the farm more attractive to successors through the investment in a milking system was least important for farms with any of the milking systems. It decreased from parlour farms (20%) to farms with BPMS (13%) to farms with AMS (8%). The objective was positively correlated with PMS farms and negatively correlated with BPMS and AMS farms. Across all milking systems, the focus of the farm objectives was on reducing labour input and physical stress. Farms with BPMS did not have any other major objectives for the investment. For farms with PMS, the main objectives were to increase the size of the farm, increase income, and improve animal welfare. For farms with AMS, the main objective was to improve working time and family time.

The results of a regression between the year of investment and the age of the farm manager at the time of investment showed that the age of farm managers increased when they invested in the milking system. Farm managers who invested in 2005 were on average 37 years old. Farm managers who invested in 2020 were 45 years old. In the case of an AMS, the age of the farm manager at the time of investment was around 7 years higher than for the other two milking systems.

Table 4 shows the results of the logit regressions for the reasons for investment and their farmer managers' weighting, depending on the year of investment and the age of the farm manager at the time of investment. For the sake of clarity, the results for the milking systems are shown only where they have a relevant impact on the results. For the objectives of reducing labour input, improving working hours, reducing physical strain, and improving animal welfare, a correlation with the age of the farm manager at the time of investment and the time of investment was unlikely. There were differences in the objectives of increasing farm income, increasing farm income per family work unit, and increasing the farm size/production volume with regard to the age of the farm manager at the time of investment and the time of investment. There was a negative trend for the main objectives and a positive trend for 'no objective'. The older the farm manager and the younger the investment, the less important these objectives were. However, for the age of the farm manager at the time of investment, a negative correlation for the main objective was only very likely for farms with PMS. For the secondary objective, there was a positive effect for farms with PMS.

Table 4 - Marginal effects (difference in probability) of a one-year increase in the age of the manager at the time of investment on the investment objectives and of a one-year increase in the year of investment on the investment objectives

	Age of the farm manager at the time of investment			Year of investment		
Goal/Objective	**Main**	**Secondary**	**No goal**	**Main**	**Secondary**	**No goal**
Reduce labour input	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Reduce physical strain	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Improve working hours	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Improve animalwelfare	At 20 years: +6.5%, At 60 years –17.5% Turning point: 30 years	n.s.	n.s.	n.s.	+3%	n.s.
Increase farm income per family work unit	–4%	–4%, +6.0% (PMS)	+6.6%	n.s.	n.s.	+3.4%
Increase farm size/ production volume	–4%	n.s.	+3.7%	Year 1990: –34%, Year 2020: –82%. Turning point: year 1906	n.s.	+4.7%
Achieve more/better family time	n.s.	+5.4% (PMS)	+2.3%	–7% (PMS), +52% (AMS)	–49% (AMS)	+3.4%
Increase farm income	–8% (PMS)	–6%, +8.4% (PMS)	+5.7%	n.s.	n.s.	+4.4%
Improve herdmanagement	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Make farm more attractive to successors	At 20 years –16.9%, At 60 years + 15.1%. Turning point: 41 years	n.s.	At 20 years: +13.1%, At 60 years: –18.9% Turning point: 37 years	n.s.	n.s.	n.s.

In brackets: Only for one milking system. Sample Size: 361 farms. The order of the objectives corresponds to their average importance. Not significant n.s.
Source: Own calculations.

In most cases, the probability of quadratic effects for these three objectives was very low. In the case of the objective of increasing the farm size or production volume, a quadratic trend was very likely for the investment year, with decreasing importance. The older a farm manager was at the time of the investment and the younger the investment, the higher the probability that achieving more family time was not an objective. However, for farms with AMS, the probability of having a main objective increased strongly (+52%) when the investment year increased by one, and decreased by 7% for farms with PMS. For farms with PMS, the probability of the secondary objective increased by 5.4% when the age of the manager at the time of the investment increased by one year.

The probability that improving animal welfare was a main objective was positive for younger farm managers at the time of investment, up to around 30 years of age (in this range, one year increased the probability of this). After that, the probability decreases again (in this range, one year decreases the probability in favour of animal welfare). For the year of the investment, an additional year reduces the probability of choosing "no goal" by more than 50 percent.

Making the farm more attractive to successors had no relationship with the year of investment in the milking system. However, the age of the farm manager at the time of the investment showed a quadratic trend in the reason categories. For the main objective, the probability of being selected decreased by one year, up to an age of about 41 years. After that, the probability increased again. If this objective were not a goal, the trend was almost exactly the opposite.

Discussion and Conclusions

The present study was the first to provide empirical results on the objectives of investments in the most common milking systems of specialised dairy farms in Switzerland. For a better understanding, these results are complemented by presenting the historical and regional distribution of the three different milking systems. Despite a downward trend, investments are still being made in "old" milking systems. Therefore, it is advantageous to take these milking systems into account when examining the motivations of investments. This makes the results more accurate and meaningful for the current situation.

In the valley and hill regions of Switzerland, the move towards more modern milking systems is progressing, and even in the mountain region, several farms in the sample already have milking parlours. These systems offer advantages in terms of labour productivity and can handle a larger

number of animals per labour input. However, the share of investment in BPMS is still quite high in the mountain region as well as in the hill region. Adherence to the BPMS is probably due to the structural conditions, which do not allow for investment and farm expansion and perhaps, to some extent, the tendency of farm managers to use more traditional construction methods. Where farm expansion is not possible, conversions tend not to involve investment in a different milking system. The large number of investment reasons negatively correlated with BPMS suggests that an investment in BPMS is more likely to be an identical replacement of the previous technology rather than a switch to a different level of technology, i.e. from milking by hand to BPMS. AMS are increasingly used on larger farms in the valley region. The fact that the profitability threshold of AMS is only reached on larger herds (from about 60 LSU) (Gazzarin & Nydegger, 2014) is probably also the reason for the lower spread of AMS in the hill region. Herd management and animal welfare goals were also related to the type of housing and could be achieved with both AMS and PMS. The individual needs of the animals are no worse met in AMS than in parlours, provided that various management measures are observed (Gygax *et al.*, 2006). The present study also indirectly examined the housing system, as this is usually linked to the milking system. It is not surprising that among the original objectives for investment in the milking system as a whole, reducing labour input and gaining physical labour relief were mentioned most frequently. Similarly, working hours were expected to improve. The use of technology otherwise makes heavy work easier while increasing productivity.

The objective of improving animal welfare was on par with the objective of improving labour income and close to the objective of increasing production volume. This is probably related to the fact that the investments are usually related to a new stable or a stable conversion, where animal welfare is now also a consideration. The objective of making the farm more attractive to successors showed a lower priority, presumably because the investments were more likely to be made at the beginning of the new generation on the farm.

The target of increasing income was only a secondary objective for a higher proportion of AMS farms, although in reality, they are among the best in this respect. Perhaps the surveyed farms were already earning well, and other objectives were more important. Investment in a more modern milking system was often associated with the goal of increasing farm size. Larger farms tend to have higher incomes per family worker. The results regarding the reasons for investing in AMS are essentially in line with those of existing studies (Hansen, 2015; Hogeveen *et al.*, 2004; Moyes *et al.*, 2014; Vik *et al.*, 2019). The main reasons are not so much economic but more flexibility and time for the family, as well as improved herd management. Achieving more

flexible family time showed a trend in importance, increasing from farms with BPMS to those with PMS and then AMS. On farms with AMS, this was the most important objective after replacing labour with technology (capital). On the one hand, an AMS allows a farm to reduce time- bound work, which can lead to more flexibility and more time for the family. On the other hand, the above-average size of AMS farms indicates that they use the labour capacity released by the milking robot in agriculture, for example, for more animals. The farm size effect leads to good economic indicators for AMS farms. The objectives of flexibility and freedom in the use of labour by the farm manager's family can only be achieved economically with AMS on larger farms. Despite relief from physical labour and the flexibility of working hours, farms with AMS have to cope with a high (mental) workload. In addition, it can be assumed that the demands on farm organisation will change but not decrease (Martin *et al.*, 2022).

While the evolution of the investment objective of improving family time towards greater importance only occurs on farms with AMS, the other developments can be observed in all milking systems. Income and growth objectives become less important over time. There is no access to the time series of these farms. Therefore, the background is analysed from the following perspectives. On average, dairy farms have become larger and have higher incomes over this period. The size of the farm may therefore dampen the desire to increase income when sufficient income is available. The results show that the age of the farm manager at the time of the investment increases by about 7 years over time. This is broadly in line with the general trend in Swiss agriculture. The average age of farm managers increased by 5 years between 2000 and 2018 (Zorn, 2020). A link with age is conceivable in the sense that older farmers also earn higher incomes or manage larger farms. Finally, there may have been a general change in values with regard to income.

Animal welfare was important to younger farm managers at the time of investment. However, it is possible that over the course of a farm manager's life, they may change their minds about the welfare reasons for the investment decision, as it was less important to older farm managers at the time of the investment. It is also possible that older farm managers have already given sufficient priority to animal welfare on farms. Conversely, depending on the age of the farm manager at the time of the investment, the aim was to making the farm more attractive to successors. For investment in milk systems made later in the life cycle, the well-being of the successor was more likely to be taken into account, whereas for investments made earlier, this was not the case.

The study has shown that there are common objectives for all milking systems, such as reducing labour and physical stress, and objectives that are better pursued with one milking system or another, resulting in a

milking system-specific trend. The objectives associated with PMS are farm expansion and increased income. The objectives that can be pursued with an AMS are improving working hours and increasing or improving family time, and secondarily, increasing income.

The objectives that are typical for the three types of milking systems provide a valuable basis both for individual investment decisions and for policy design, particularly in the area of investment aid. But the results of this study emphasise that there can be dynamic processes behind the objectives that influence their relevance over time. These dynamics must be taken into account when developing long-term investment strategies and policy measures. This paper complements the existing literature by showing that investment motivations in the Swiss context are in line with those in other countries. The results of this study expand the findings to the Swiss context with regard to the milking systems currently in use and in terms of evolving investment objectives.

The limitations of the study lie in the survey of farmers, which may lead to bias in the results. Firstly, the length of time that has elapsed since the investment varies. The longer the period, the more likely it is that the respondent does not remember correctly or does not know the context of former decisions. Secondly, as only closed questions were used, there may be other reasons for the investment that were not taken into account in the study. Finally, due to sample size, the results should be interpreted with caution. The changing reasons for investment in dairy farming in relation to the institutional environment and the individual situation of farmers could be explored in more detail in future research.

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Dierk Schmid
Agroscope - Swiss centre for agricultural research, Switzerland
Tänikon 1, 8356 Ettenhausen, Switzerland
E-mail: dierk.schmid@agroscope.admin.ch
Research associate, holds a diploma degree in agricultural economic science from University of Hohenheim, Germany. Current research interests are related to impact of technology adaption on farm income and farm households.