Value of Vocational Logging Training

by

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Abstract

Logging employees need training and most of the time the get that training on the job. Vocational logging training helps logging machine operators to improve work performance including job quality, productivity, and safety. I analyzed the value of vocational logging training in USA using data from a mixed (mail and internet) survey in 2013. The survey (N=161) was targeted at logging firm owners nationwide. The results indicated that nearly all training programs for most job positions had negative NPV, and longer programs will have even lower NPV. Respondents from the North and South have significantly different attitudes on valuing employee work performance and training program investment.

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List of Abbreviations

WTP	Willingness to pay
QA	Question A
QB	Question B
QC	Question C
QD	Question D
OJT	On-job-train

Value of Vocational Logging Training

Introduction

Although only slight changes in harvesting methods of logging occurred in the past 30 years, studies in the field of labor of logging industry continue. (Cubbage and Carter, 1994) found that adapting new logging systems, which required few machine operators, contributed to higher productivity and lower average cost in logging. Research done by (Stuart et al., 2010) suggested that economies of scale are not present in modern logging, with input-output measurement. Many studies reinforce the movement from labor to capital to control production costs. In manufacturing some jobs may have become easier and simpler as mechanization replaces repetitive, physical work. In logging many jobs became less physical but no less complex as workers guide complex operations and machines at a faster pace than ever before.

Few articles discuss the evaluation of vocational logging training programs while many authors have realized the importance of labor in logging. The raising of "Labor problem" in timber harvesting in 1950s (Bromley, 1957) should be treated as the beginning of related research. In the same period, it was shown that productivity improvements relied heavily on logging inventions and innovation in methods, meaning that the such technological improvements would bring high marginal benefits (Samset, 1992). Logging worker recruitment was not helpful (Pikl,

1960), so the logging industry turned improvement of employees' work performance potential. There has been considerable appreciation of the benefits of employee training and many reviews of logging training have been completed (e.g., Cottell and Canada, 1976; Egan et al., 1997). The studies have provided a clear view of the history and current situation of logging training programs. However, none of them have precisely evaluated vocational training programs in logging.

"Vocational training" is defined by Mariam-Webster dictionary as: *"a process by which someone is taught the skills that are needed for an art, profession, or job"*. Here, training means a trainer would instruct an employee to convey certain skills that would provide acceptable levels of job performance. It could be done by the employer, other employee, or institutes like schools and colleges.

The topic of job training has been discussed for decades since mid-twentieth century (Long and Hill, 1947). However, most studies about this topic focused on the benefits brought by training (e.g., Loewenstein and Spletzer, 1999; Mincer, 1988; Parent, 1995), but few paid attention to clarifying different types of training. Harris et al. (2003) offered clear definition between on-job training and off-job or vocational training. Detailed differences are shown in Table 1. It is easy to distinguish these two groups of training. On-job training is more flexible (meaning that it could take place anytime and anywhere) and more targeted (meaning that it is often set to solve certain work problems). Off-job training or vocational training is more systematic (meaning that it is usually thorough and is of longer duration) and more generalized (meaning its contents include most knowledge backgrounds needed in work). Choice of training solution would require

weighing the program strengths and weaknesses relative to the job requirements and training objectives. For example, if jobs in industries need more systematic knowledge, then off-job training might be a better solution (Lynch, 1992). According to (Harris et al., 1998) and (Robertson et al., 2000), both methods are effective in improving employee's work performance. A review the history of job training across U.S. and reported that most job training in U.S. organizations was on-job rather than off-job training (Knoke and Kalleberg, 1994).

Table 1. Differences between on-job and off-job training

	On-job training	Off-job training
Who receives training	Firm employees	
Who instructs	Host employers	College teacher
When does training occur	Anytime during work	Only after work
Where is it	Workplace	Training Institute
Are formal tests required	No	Yes
Relative cost	Negligible	High

Figure 1(NC Association of Professional Loggers, 2013a; NC Association of Professional Loggers, 2013b) is an example of contents of a vocational logging training program for both general logging and logging equipment operation. The vocational training programs provides mostly specific knowledge related to job tasks. The course takes long period of time (more than 4 weeks) and the instructors are professional logging with some training in adult education. Studies describe economics benefits of training programs (for both on-job and vocational). For the employer, more productivity (Bartel, 1995) and better job quality with reduced turnover

(Mincer, 1988) are two major benefits. For employee, the most significant benefit is higher wage (Mincer, 1988). In general (Van Wyk and de Villiers, 2009) have shown that certain vocational training would enhance safety by reducing injury rate. What's more, training also had impacts on increasing employment rate and sustainable development for employees in mining operation (Hilson and Murck, 2000; Lawrence, 2005). Empirical evidence has shown significant benefit of vocational training programs in fishing (Arbo and Hersoug, 1997) and oil industry (Aibieyi, 2012) which could be similar to the logging industry. There may be some risk of a negative effect from receiving too much education (Alba-Ramirez, 1993). Another finding is that tenure wage increase has no relationship with training (Brown, 1989).

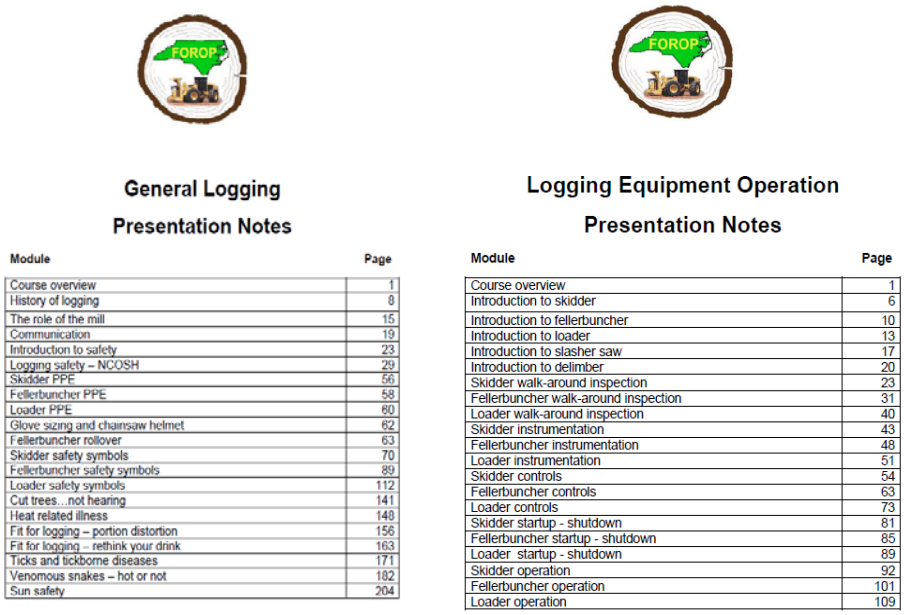

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Figure 1. Example of vocational logging training manual contents for general logging and logging equipment operation (Source: NC Association of Professional Loggers, http://www.ncloggers.com/ **)**

Some challenges exist for employers, lowering their desire to participate in training programs. Competition is a major concern (Mühlemann and Wolter, 2006) since well trained employees may join other firms inside the region with higher wages. Another factor is unbalanced demand and supply for training. In some industries employers require enhancement in skill level rather than theoretical application of related knowledge (Smith and Kemmis, 2010). In others, employers' desires are not always related to employee needs (Reed et al., 2011). Employer may participate in training only when the public subsidy is high enough (Billett et al., 2005).

In the 1970s, research tried to identify the variability of labor productivity and the effect of skill training (e.g., Garland, 1979; Scott and Cottell, 1976). According to (Garland, 1979) key factors causing low participation in employee training for logging are: time shortage (33%), money shortage (17%) and size of firm (17%). Since the 1980s, logger training has become associated with efforts to provide awareness and technology transfer to current loggers. Several surveys in the late 1990s had different findings compared with those in 1970s because of this difference. As reported in several states participation in training programs was required by public organizations like state forestry agencies or NGOs (Egan et al., 1997). On the other hand, most firms are willing to enter these programs and training goals differ among states. The training programs most refer to today are not focused on productivity enhancement but environmental compliance and safety (Shaffer and Meade, 1997).

Research regarding logger education and training programs provide limited insight regarding vocational training. (Wightman and Shaffer, 2000) and (Smidt and Blinn, 1994) pointed out that there were direct benefits to work performance. In general, many programs were well regarded

by attendees and indicate that there may be potential benefit for formal training among those who are already experienced loggers (e.g., Kinard and Brinker, 2002; Reeb, 1996). Logging training reports are usually associated with logging certification programs (e.g., Egan, 2009; Egan et al., 1997; Smidt and Blinn, 1994). Though these reports mention few details about logging training programs, they provide some useful information about acceptable job performance level. Technologies in logging training are also discussed (e.g., Haynes and Visser, 2001; Weher and Poon, 1994). These studies focus on effectiveness of specific training methods, but with no further research on training costs and employers' decision in adapting training programs. For logging nearly all training is on-job training. There is some research on formal safety training and reported gains in knowledge and self-reported behavior change (e.g., Bell, 2002; Bell and Grushecky, 2006; Lefort Jr et al., 2003).

(Garland, 1990) applies the sigmoid learning curve to estimate the duration of recovery of the training investment. The learning curve method provides a cost-effect comparison at during the training (not only the accumulated result, but also instant result). (Purfürst, 2010) and (Parker et al., 1996) have contributed to the development of general learning curves that can be used in logging. Because of learning curve's characteristic of time-series, general financial analysis tools could be adopted, like internal rate of return (White, 1980) and net present value.

The goal of this study is to evaluate vocational logging training programs through be determining the benefits logging employers perceive. Logging firm employers' experiences in logging performance evaluation and their appraisal of new hires in logging should allow me to address

these objectives: (1) to determine the value of job training and experience to employers; (2) to determine the types of training programs that best address employer needs.

Methods

Survey

The target population is logging firm employer or logging firm owners across the USA. Some logging firm employees may also take part in firm administration and may become an employer in the future.

The survey is designed according to (Dillman, 2011)'s study on mixed survey method. In general, the survey includes two parts: Part I: Demographic Information and Part II: Training Program (complete survey is shown in Appendix). The estimated completion time was 10-15 minutes. In the first part, I focus on respondent's background concerning education level, experience in the logging industry, the structure of the logging firms, recent hiring activity and so on. This part included 16 questions. In the second part the job performance measurement was divided into three components: Job Quality, Safety, and Productivity. At the beginning, each respondent was asked to choose the current job positions in the logging firm and these job selections will apply in each following questions. The next part included four question groups:

(1) Question A (QA) showed the minimum entry (or acceptable) level in three job performance components. It was measured with an index ranging from 0 to 100 (0 means the

lowest level and 100 means highest level or expert). It indicated employer's targeted work proficiency level for job quality, safety, and productivity, respectively.

(2) Question B (QB) showed the expected on-job experience in each selected position, measured by time period (from less than 1 month to over 4 years) for the operator to be proficient and indicated employer's minimum requirements.

(3) Question C (QC) showed the respondent's willingness to pay (WTP) for logging employees with different combinations of Productivity and Safety performance measured in hourly salary (range from $10/hr to $30/hr).

(4) In Question D (QD), Respondents stated how well the three given programs fit their demands for training inexperienced employees, measured in a 0-to-100 index. This indicated whether the training might meet the employer's expectation for starting work proficiency level. Respondents also stated whether they would participate in any of these programs and how much they would pay for each program if selected.

After finishing design, the survey was sent to the Institutional Review Board (IRB) of Auburn University and was classified as exempt. The draft was sent to state logging association directors for their input prior to dissemination. Surveys were available online and in paper format. We mailed or faxed copies to respondents who requested it. All responses were anonymous. The online-version of survey is in Appendix A.

Data

Following resources for distributing surveys were used:

(1) Contact with logging associations for their cooperation in advertising the online link (both long term and abbreviated term). Advertisements including our survey were posted on these associations' websites or included in publications. This method was non-pointed and there were no assigned potential respondents. In this method all responses were collected online. This round started on April 17th, 2013, and began receiving responses April 25th, 2013.

(2) Federal Department of Transportation registration database (D.O.T, 2013). We created a randomly selected list from DOT dataset of 1320 individuals whose firm name included "logging". We sent these individuals the survey link through mail or email. The mail survey included paper versions of survey. This round started on May 3rd, 2013.

(3) State logger training programs. This method is similar to that in (2) above. But the designed potential respondents are members of state certification programs. In this method, we mailed 300 surveys and respondents could also choose online or paper surveys. This round, through mail and postcard reminder, started May 27th, 2013.

(4) Regional logging equipment shows. I chose shows in Michigan and North Carolina as the representative of north and south, respectively. The method is face-to-face interview completing the survey paper form. The respondents were selected by asked two screening questions after approaching the display. This round happened on September 6th, 2013 (in Michigan) and on September 20th (North Carolina).

I merged all surveys for data analysis. Although possibility of repeated responses from the same person is negligible, potential respondent lists generated from these sources interacted at some level.

The response set was closed on October 1st, 2013. The process took 5 months and 14 days (from April 17th, 2013 to October 1st, 2013). All responses received during this period were aggregated.

Analysis Method

When an inexperienced employee is hired, logging firms could have two options if training programs were available. For the first option, the employee starts work with no experience or training. The employee wage would be very low, but would grow gradually with improving job performance from experience and on-job training. At some point the employee could have a performance level the same as other firm employees. For the other option, the employer would send the employee to a training program directly after hiring. After the employee completed the training program the employee would start work. The wage should be higher than that of the inexperienced employee but still lower than that of a well-qualified employee. With formal training the employee would improve more quickly and accordingly the wage would increase sooner after starting work. If training programs were constantly producing trainees the employer could have a final option of selecting an employee from this pool.

Obviously employers face trade-offs with off-job training. Off-job training has initial costs but employees could perform acceptably with less experience resulting in greater benefits in less time. On-the-job training has no initial cost but it would take more time to reach acceptable work performance. The potential financial differences in the approach can be compared with the net

present value (NPV) of aggregate wages for both options and the estimated difference would be value of training.

Figure 2 shows analysis approach. The vertical axis is proficiency level (P), and the horizontal axis is time (T). A new employee with no vocational training would start work at point where T=0. The other type of employee would start work after vocational training is finished, where $T=t_0$. Vocational-trained employee would have a higher starting P level than on-job-trained. The starting point for vocational-trained employee (A_{VT}) is projected at proficiency (P_1). The starting point for the on-job-trained employee (A_{OT}) is projected at proficiency P_0. With practice and on-job training the proficiency level will grow for both employees. After time t_0, the untrained reaches the required proficiency level P'. For the trained employee, it takes less time (t') to reach P' since the trained employee has more knowledge and more task practice in environments where best practices where enforced by coaching. B_{VT} and B_{OT} are the target points for trained and untrained employee, respectively. The next step is fitting Point A_{VT} and Point B_{VT}, Point A_{OT} and Point B_{OT} with (Purfürst, 2010)'s learning curve model, which was used to model improved performance over time or the learning curve for the jobs (see Appendix B for equation). I should be able to find the proficiency level of each time point. For example, at time t, proficiency level for vocational-trained is P_{VT} and for on-job-trained is P_{OT}. Accordingly, the asymptote is of the learning curve is estimated by the following equation:

$$Asy = 0.5 + \frac{APL}{2}$$

Where:

Asy: Asymptote

APL: Acceptable proficiency level

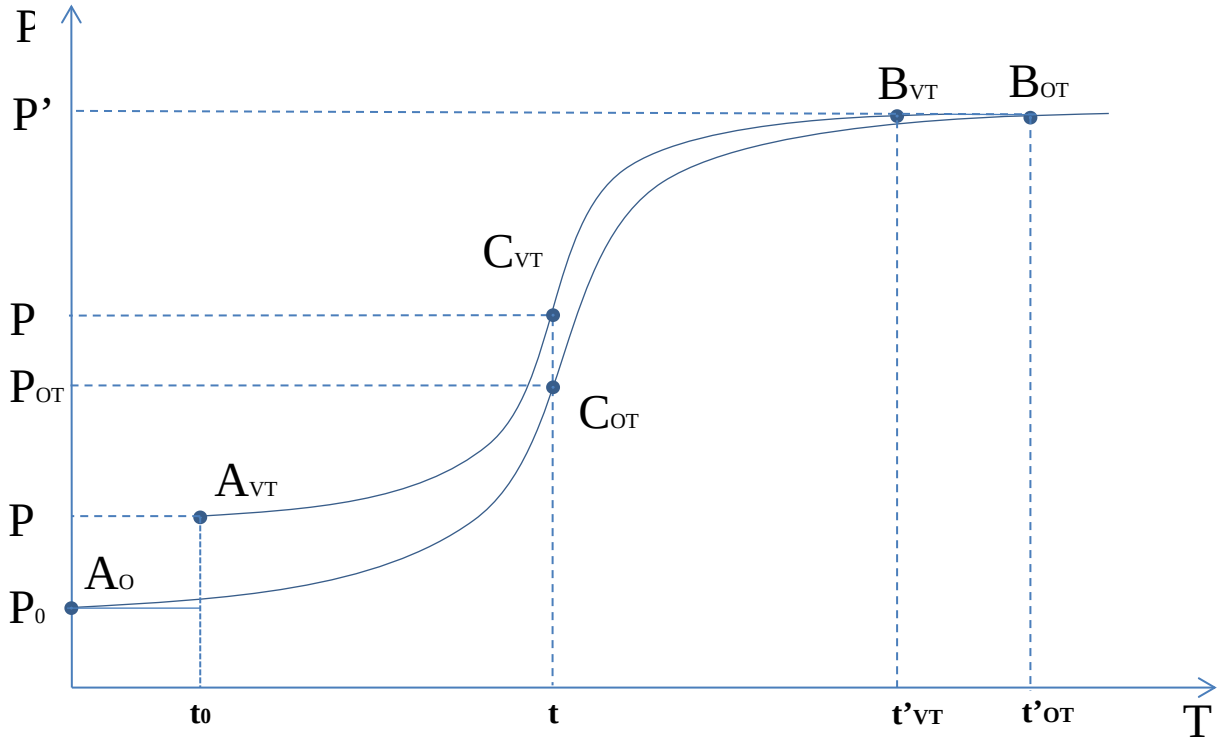

Figure 2. Theoretical learning curve The terms in the figure include performance or productivity level (P, P', P_{VT}, P_{OT}, P_1 and P_0), Time **(T, t_0, t'_{VT},** and **t'_{OT}). A_{VT}** and **A_{OT}** are the point when vocational-trained and on-job-trained employee starts working, respectively. **B_{VT}** and **B_{OT}** are the points when vocational-trained and on-job-trained employee reaches required productivity level, respectively. **C_{VT}** and **C_{OT}** compare the performance level at **Time=t**.

For determining the benefit we relied on wage changes with time and proficiency. Figure 3 shows the relationship between wage and productivity. Wage would increase in steps reflecting changes in performance. Productivity increases gradually with a typical growth model (sigmoid curve). At the very beginning, the employee may be paid more than can be justified by productivity, leading to negative net benefit to the firm. At some point (time equals T') the net benefit to the firm may be positive.

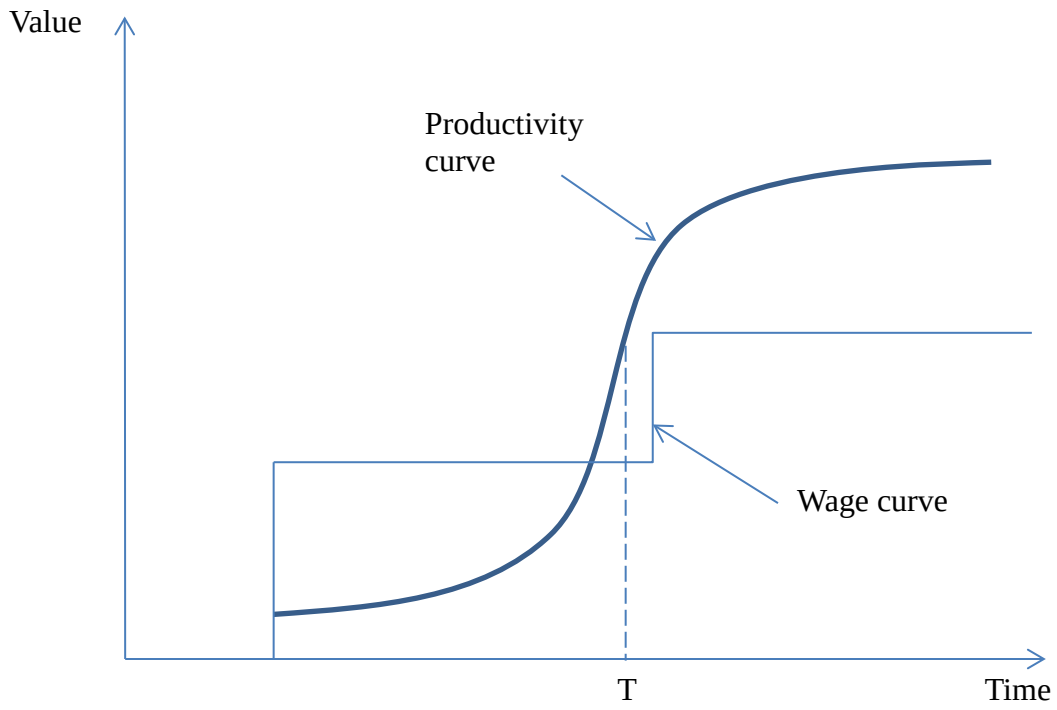

Figure 3. Wage changes over time and the theoretical learning curve (**Time=T** is the time point when aggregated productivity value begins to exceed that of wage)

When wage data was collected in the survey, it was collected in qualitative categories because it was too complex to have survey respondents provide data for many performance levels.

I discounted the wage over time for trained and untrained employees with the assumption that for most of this time wage is the most optimistic indicator of employee value to the firm. Comparison of the net present value between trained and untrained employees represents a value of training.

For the analysis I assumed that the trained employees was hired by the firm and sent to the program when the employee receives the legal minimum wage during the training ($7.25 per hour) The training was in anticipation of future openings, so there is an experienced operator paid as qualified logger in the position until training program ends.

For the supervisor I assumed that would first be experienced employees prior to their promotion. As a result training was divided into two components first as a position in the firm then as a supervisor. During the job transition, the work performance level gained as employee will be accumulated and added to the starting level of supervisor.

Results

All responses were merged to generate 161 responses. The response rate generally is difficult to estimate. For the two mail methods, the response rates were 2.5% and 5%. I searched for duplicate responses in IP addresses found none. None of the survey respondents contacted personally at the shows indicated that they had been contacted by mail or email.

Statistics concerning demographic characteristics of all respondents are summarized in Table 2. Most respondents were firm owners and the average age was about 51. Nearly half had high school degrees and 32% had at least some college. Nearly all respondents were in the logging industry for 10 years or more. Most respondents were operating small logging business, hiring 1 to 6 people. However, 17% had large firms (with 21 or more people). Most firms were located in Northern and Southern regions (Figure 4). Among these firms feller-buncher-skidder was the most frequent logging system (64%). I classified systems into 9 groups, including single or multiple options in each in Figure 5.

Table 2. Summary statistics of respondents' demographic information

Questionnaire Item	Summary statistics (N=161)
Occupation	73% Logging firm owner
Age (years)a	Mean=51.3; Minimum=18; Maximum=81; SD=11.2;
Education	51% High school; 14% Bachelor degree; 18% Some college
Experience _Logging	84% 10 years or more; 11% 4-9 years
Experience _Current position	77% 10 years or more; 13% 4-9 years
Formal training	66% yes; 33% no
Firm owner/supervisor	86% 10 years or more
People hired	50% 1-6; 13% 11-20, 17% 21 or more; 14% 7-10
Operators hired	38% 1-3; 30% 4-6; 14% 11-20
Regions	38% North; 50% South; 8% West; 3% Intermountain
Logging system (Multi)	64% Fellerbuncher-Skidder; 31% Chainsaw-Skidder ; 46% Harvester-Forwarder
Products (N=157)	42% 4-6; 40% 1-3; 18% 7 or more
Most recent hire (N=157)	50% less than 1 year; 28% 1-3 years
Most recent hire status (Multi)	62% Experienced; 36% Inexperienced
Hiring with formal training (N=157)	42% yes; 58% no
Most recent hire (N=157)	56% Equipment Operator; 13% Chainsaw operator/Feller; 18% Other

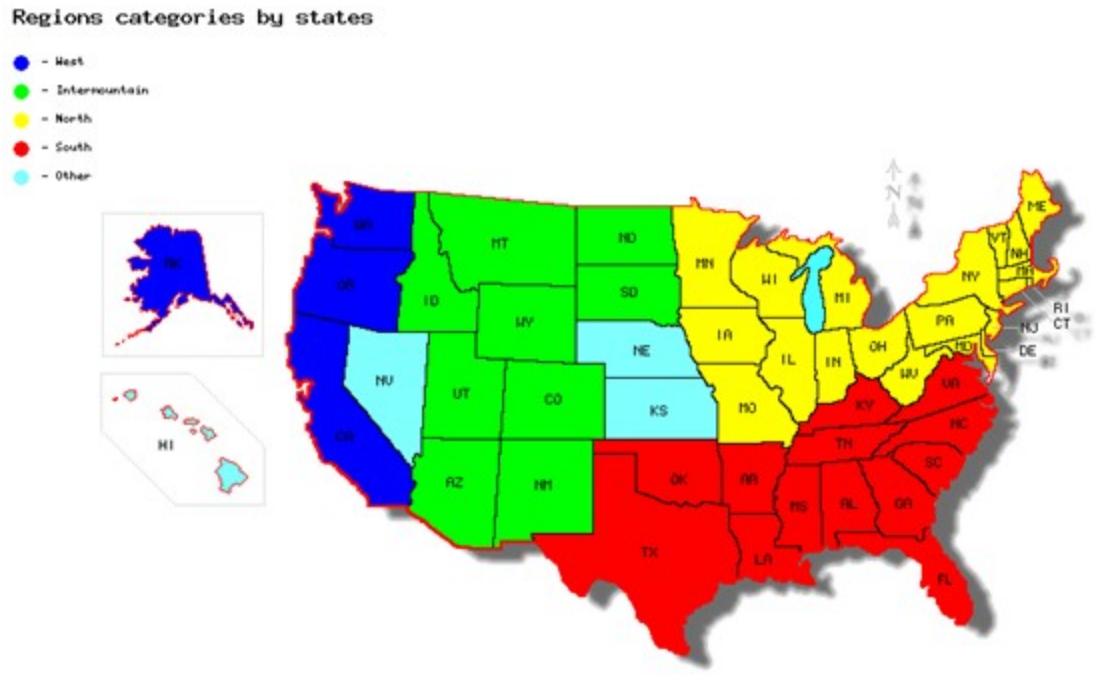

Figure 4. Regions used in the analysis where blue is west, green is intermountain, yellow is north and red is south.

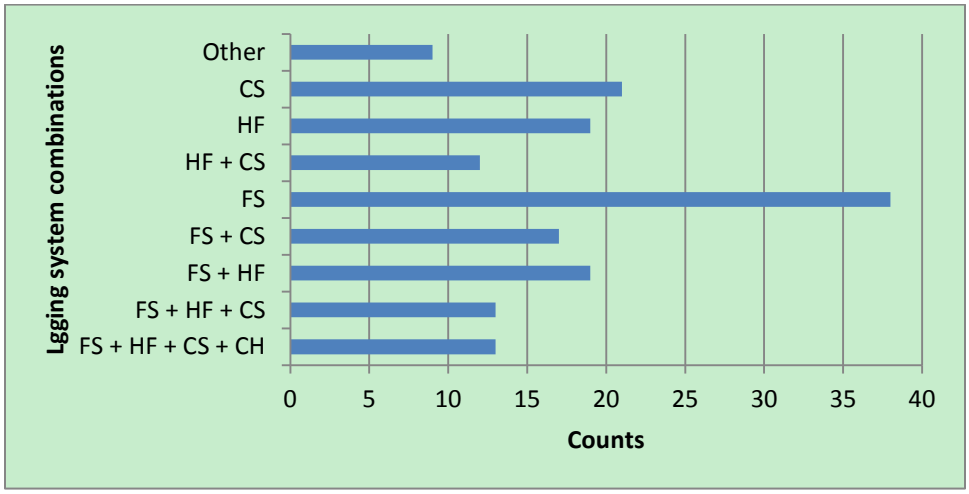

Figure 5. Frequency of logging system combinations of Fellerbuncher-Skidder (FS), Harvester-Forwarder (HF), Chainsaw-Skidder (CS), Cable/Helicopter (CH) and all selected combinations.

Less than half of firms have hired someone with formal training before hiring (42%). Respondents' firms hired experienced and inexperienced employees. Many respondents indicated their firm hired new employee(s) in the last year and equipment operators were the most frequent new hire. Most respondents indicated that equipment operator, chainsaw operator, and supervisor were jobs in their current firm (Table 3).

Table 3. Acceptable work performance for different jobs and standard deviation in parentheses

	Equipment operator	Chainsaw operator	Supervisor	Deckhand laborer	Choker setter	Chaser	Hook tender
Job Quality	67(25)	76 (23)	**86 (18)**	61 (24)	50 (33)	68 (28)	74 (19)
Safety	87 (19)	90 (16)	**92 (14)**	85 (18)	85 (22)	82 (28)	85 (22)
Productivity	70 (24)	74 (22)	**84 (18)**	66 (21)	64 (21)	74 (29)	79 (19)
Number of responses	146	105	**96**	15	10	7	8

Average acceptable work performance levels are also shown in Table 3. Respondents indicated that the supervisor should have the highest performance level. Respondents expected a higher safety performance level indicating perhaps a higher potential firm impact of low safety

performance or respondents may believe that safety performance is a personal characteristic that operators possess rather than knowledge and skill acquired by training and experience.. Productivity and job quality were similar.

Figure 6 shows the distributions of minimum experience for different jobs. Minimum experience referred to the time period the employer expects for an employee to move from no experience and untrained to an employee who can function at adequate performance levels with minimal supervision. As expected supervisor positions required the most experience (Table 4).

I tested if there was any difference in minimum experience and job performance level between North and South loggers. For experience all three positions were significantly different for North and South ($P < 0.05$).

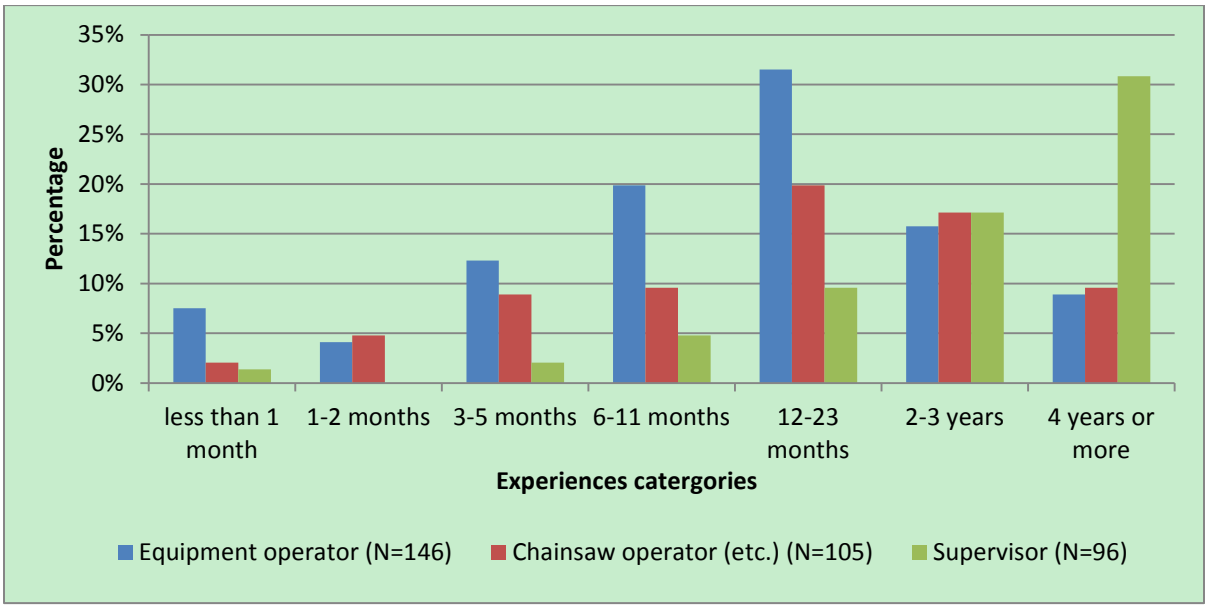

Figure 6. Minimum experience for adequate performance as equipment operator, chainsaw operator, and supervisor

Table 4. Statistical summaries for minimum experience

	less than 1 month	1-2 months	3-5 months	6-11 months	12-23 months	2-3 years	4 years or more
equipment operator (N=146)	11	6	18	29	**46**	23	13
chainsaw operator (N=105)	3	7	13	14	**29**	**25**	14
supervisor (N=96)	2	0	3	7	14	25	**45**

According to the expected monthly wage (Table 5), the pay for three jobs was nearly the same with slight differences for each work performance level (with categories of productivity index in QA). Among first three levels standard deviations (SD) are smaller than those in the highest level. When respondents completed the paper version of the survey some of recorded an hourly wage lower than $10 the lowest allowed on the online survey. Those responses were treated as $10 per hour. I believe the supervisor salary from the BLS represents a full time supervisor (SOC 45-1011) on a large firm and may not represent the part-time supervisor/equipment operator on most firms. Table 6 presents the wage changes affected by productivity and safety levels from the survey. The expected performance levels, wage, and experience are presented in Table 7.

Table 5. Expected monthly wage and standard deviation for levels of work performance for 3 main jobs based on 173 hours per month

Performance Level	Productivity index in QA	Equipment operator	Chainsaw operator	Supervisor
Low in Productivity; Low in Safety	0-30	1955 (415)	2180 (690)	1920 (391)
Low in Productivity; Medium in Safety	31-50	2076 (434)	2301 (716)	2024 (431)
Medium in Productivity; High in Safety	51-80	2526 (545)	2699 (784)	2387 (599)
High in Productivity; High in Safety	81-100	3166 (765)	3512 (894)	2993 (875)
Mean wage in BLS dataset in 2013		2896 (1.1%)	3382 (4.6%)	4538 (2.6%)

Table 6. Comparison of estimated monthly wage at key performance levels for North and South. Standard deviations are in parenthesis.

Region	Work performance levels	equipment operator	chainsaw operator	supervisor
North	Low in Productivity; Low in Safety	1913 (344)	1934 (637)	2092 (469)
	Low in Productivity; Medium in Safety	2021 (306)	2064 (657)	2221 (495)
	Medium in Productivity; High in Safety	2503 (426)	2550 (652)	2630 (642)
	High in Productivity; High in Safety	3263 (702)	3273 (827)	3548 (768)
South	Low in Productivity; Low in Safety	1860 (272)	1851 (606)	2100 (299)
	Low in Productivity; Medium in Safety	1970 (330)	1922 (631)	2240 (339)
	Medium in Productivity; High in Safety	2377 (528)	2202 (777)	2630 (531)
	High in Productivity; High in Safety	2984 (763)	2682 (872)	3415 (810)

Table 7. Values for training effect and net present value of training for North and South and training program type

Region		Extended	Intermediate	Brief
North	Productivity performance expected after training	67 (29)	55 (26)	37 (31)
	Average WTP for different training programs ($)	2610 (1920)	1575 (1370)	1055 (870)
	Minimum experience for adequate performance (measured in months)	17.4 (10.2)	24.4 (12.2)	34.7 (10.1)
	Acceptable productivity performance	63 (24)	69 (24)	81 (21)
South	Productivity performance expected after training	64 (34)	61 (28)	48 (32)
	Average WTP for different training programs ($)	1813 (1550)	1388 (1250)	917 (820)
	Minimum experience for adequate performance (measured in months)	16.2 (11.3)	18.7 (11.2)	32.2 (10.2)
	Acceptable productivity performance	75 (23)	79 (21)	87 (16)

For all training programs, participation rates were below 50%. Respondents who would not choose to send employees to training programs indicated "N/A" (Figure 7), so most respondents would not send their new inexperienced employees to training. When calculating the average cost for each program, only respondents who chose training programs were considered. Willingness to pay for the extended program was the highest ($2167). The brief program was $979 and intermediate was $1454. Respondents expressed consensus in valuing the brief program but not the extended or intermediate programs. Egan et al (1997) found an average willingness to pay of $850 (in 2013 US dollar) for a brief safety training program.

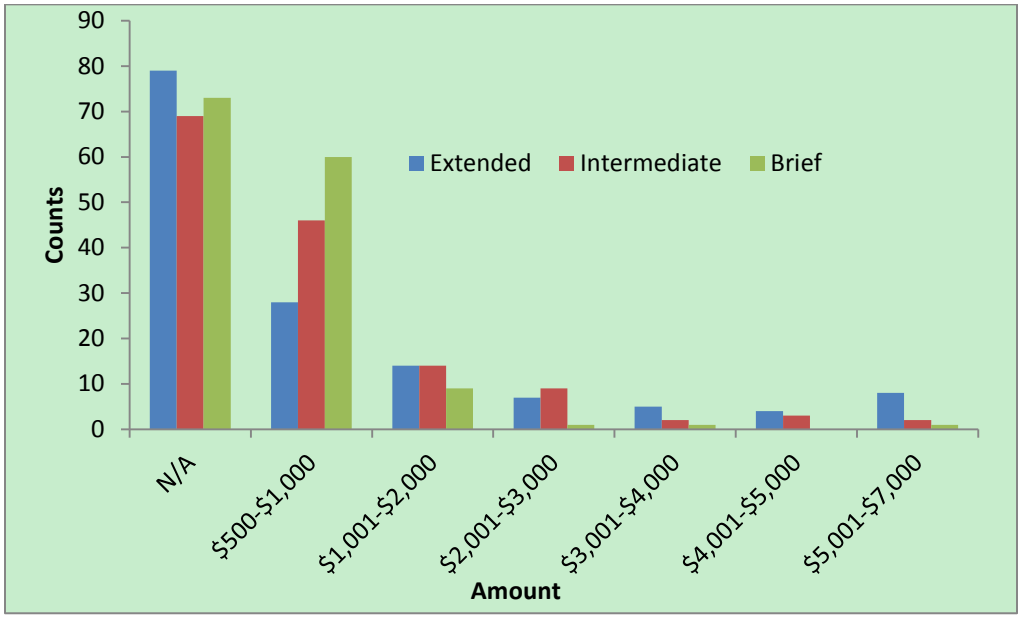

Figure 7. Distribution of respondent's willingness to pay for training programs (Here three different vocational training programs are presented: Extended, Intermediate, and Brief. And N/A means that the respondent would invest nothing for training.

Evaluating training programs

Since North (38%) and South (50%) are the two major regions, I analyzed them individually. Figures 8 to Figure 13 show assumed learning curves for equipment operator, chainsaw operator, and supervisor, respectively. And the learning curves estimation assumptions are shown in Table 8. I assumed that training made the contribution indicated by respondents in the survey. Workers skill level increases with experience at the rate determined by the learning curve model. The acceptable level of performance and the experience (on-job-training) needed to achieve the performance level were also from survey results.

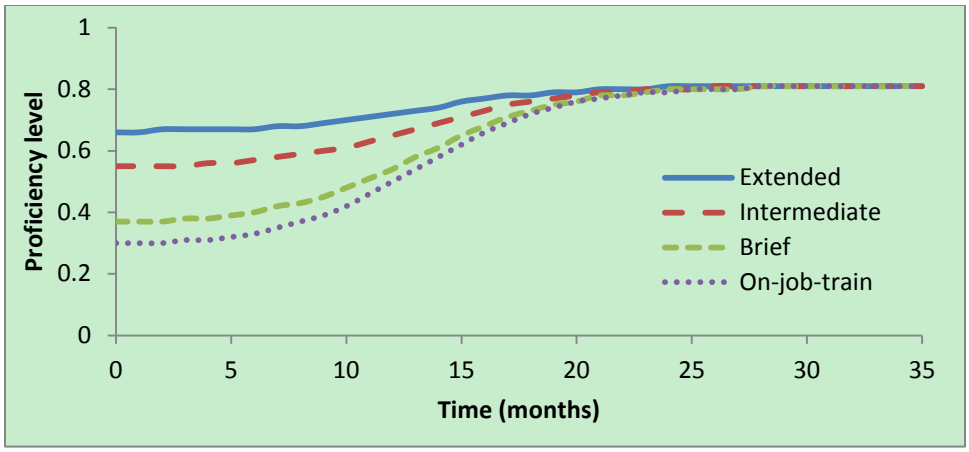

Figure 8. Learning curve of equipment operator in North for Extended, Intermediate, Brief, and On-job-train program

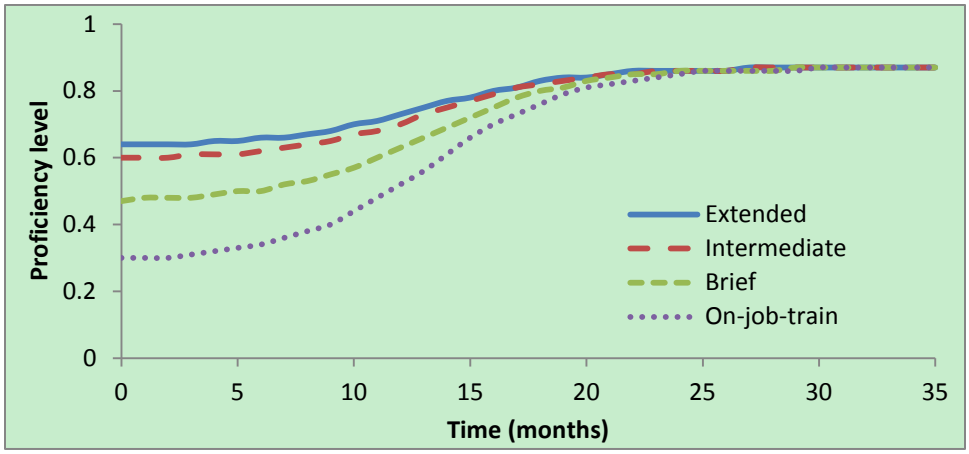

Figure 9. Learning curve of equipment operator in South for Extended, Intermediate, Brief, and On-job-train program

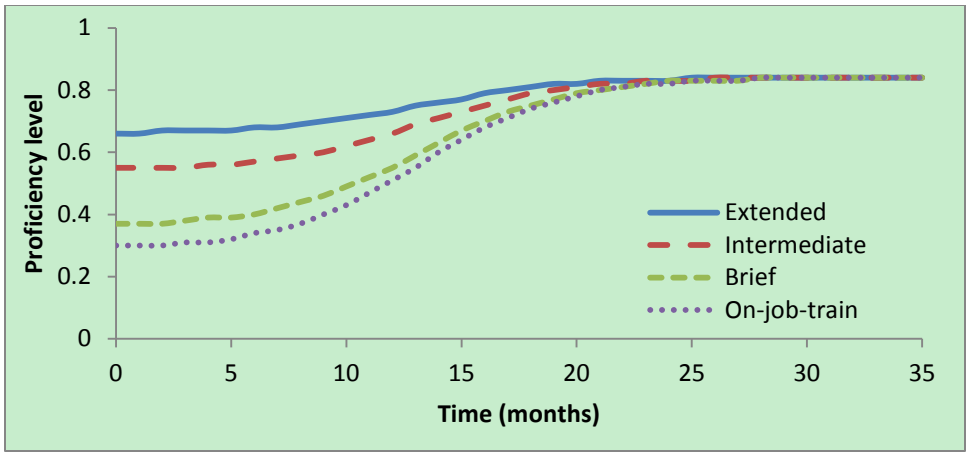

Figure 10. Learning curve of chainsaw operator in North for Extended, Intermediate, Brief, and On-job-train program

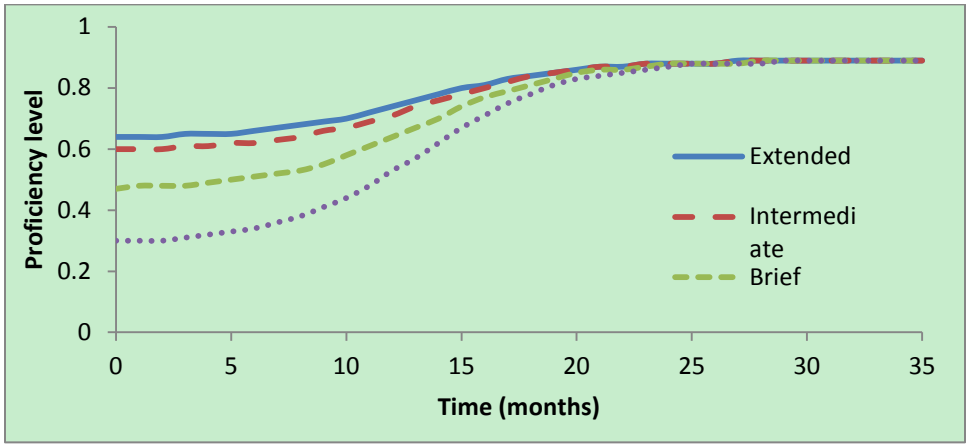

Figure 11. Learning curve of chainsaw operator in South for Extended, Intermediate, Brief, and On-job-train program

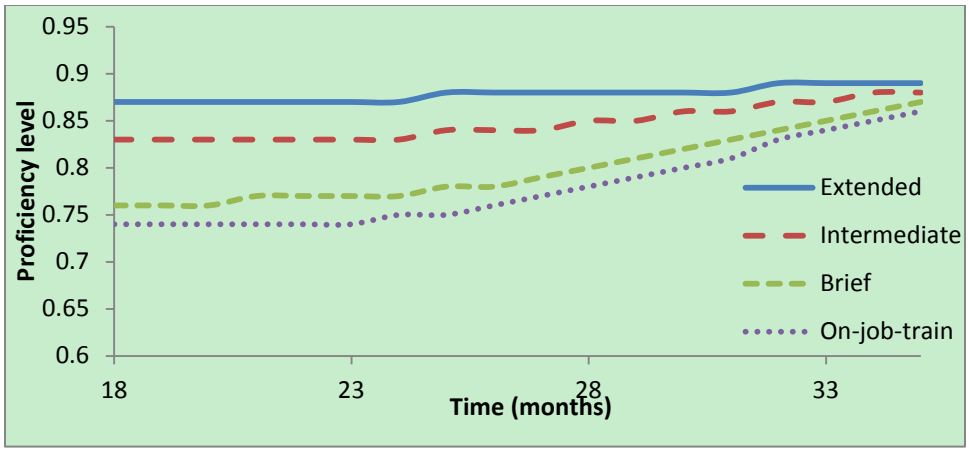

Figure 12. Learning curve of supervisor in North for Extended, Intermediate, Brief, and On-job-train program

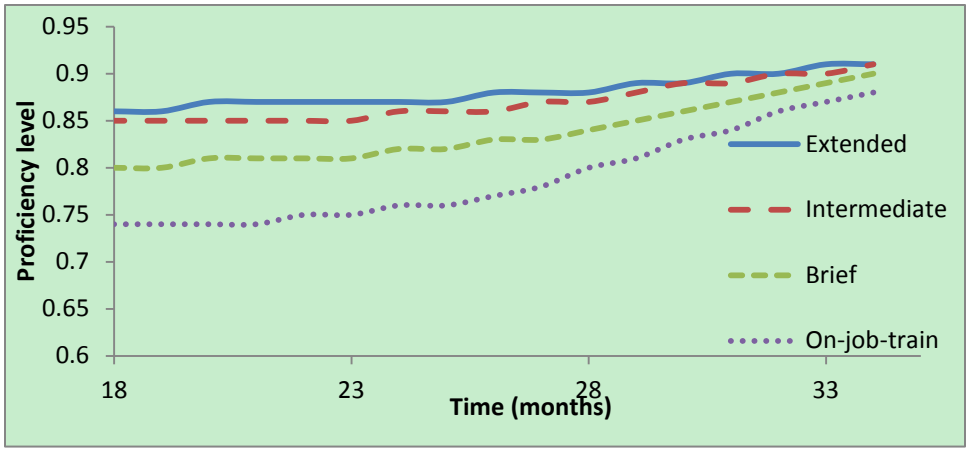

Figure 13. Learning curve of supervisor in South for Extended, Intermediate, Brief, and On-job-train program

Table 8. Learning curve assumptions for training programs and on-job-train for equipment operator in North

	i	**P0**	**a**	**b**	**c**	**t'**	**P**
Extended	0.669	0.815	0.667	70	0.32	0	0.63
Intermediate	0.553	0.815	0.549	70	0.32	11	
Brief	0.374	0.815	0.367	70	0.32	15	
On-job-train	0.3	0.815	0.293	70	0.32	18	

Equation of proficiency level at Time t

= INT(((**P0**-**a**)/(1+**b***EXP(-**c***t**))+**a**)/0.01)*0.01

and

a= (**i***(1+**b**)-**P0**)/**b**

t'	time needed for acceptable proficiency level (month)
t	Time (month)
P	acceptable proficiency level
P0	Asymptote
i	Initial proficiency level
a	intermediate variable in calculation
b	constant
c	constant

The differences in values for North and South were not great enough to produce obvious differences in most of the learning curves. In the North work performance gaps between brief and on-job training are smaller than those in South. Time (months) needed for acceptable work performance and training effect (time shortened) are shown in Table 9. In the North equipment operators could perform at the level of experienced employees at the end of the extended program according to the respondents. In general, training programs in North were projected to have better results than those in the South.

Table 9. Time (months) needed to for acceptable work performance and training effect in months (time shortened)

Region	Training	equipment operator		chainsaw operator		supervisor	
		Time	effect	Time	effect	Time	effect
North	Extended	0	100%	8	68%	17	51%
	Intermediate	11	39%	13	48%	17	51%
	Brief	15	17%	16	36%	29	17%
	On-job training	18	43%	25	16%	35	20%
South	Extended	13	24%	15	21%	20	39%
	Intermediate	14	18%	16	16%	27	18%
	Brief	16	6%	17	11%	31	6%
	On-job training	17	9%	19	5%	33	17%

For all programs supervisor requires the longest duration, and equipment operator requires the shortest. Training effects measured by time shorten compared with no training are also included in the Table 9. I analyzed the training effects caused by training types and job positions with two-factor ANOVA test (Table 10). In the test, rows are the effects of different training types, and the columns are the effects of different job positions. In both North and South, statistically significant differences exist among both training programs and job positions. Generally extended programs had the strongest effect. However, the effect differed by jobs. From the comparison, equipment operator shows greatest impact of training, implying that respondents believe that skill and knowledge needed to operate a machine were more suited to formal training.

Table 10. ANOVA test of training effect

Region	Source of Variation	SS	df	MS	F	P-value	F crit
North	Rows	510.917	3	170.306	17.669	0.002	4.757
	Columns	390.167	2	195.083	20.239	0.002	5.143
	Error	57.833	6	9.639			
	Total	958.917	11				
South	Rows	83	3	27.6667	4.812	0.049	4.757
	Columns	382.167	2	191.083	33.232	0.001	5.143
	Error	34.5	6	5.75			
	Total	499.667	11				

Table 11 shows the NPV of different training programs with an annual interest rate of 10%, and a time period of 36 months. The example of monthly calculation for proficiency level and benefit is shown in Table 12. After 36 months wages are the same for each job regardless of the training program or no-training. From the results few of training program and job combinations will bring negative benefit. Positive benefit can only be found for supervisor while participating in Intermediate program in both North and South, and the Brief program in South. For both Intermediate and Extended program, I estimated greater negative benefit for northern than southern respondents except for the Brief program which was greater in the south. In general training programs would bring similar benefit for each job in North and South.

Table 11. NPV of training programs with an interest rate of 10% and time period of 36 months.

	North			South		
	equipment operator	chainsaw operator	supervisor	equipment operator	chainsaw operator	supervisor
Extended	-16503	-16896	-1184	-16721	-17176	-3079
Intermediate	-6211	-6604	6001	-6394	-7846	3567
Brief	-2416	-2847	-176	-680	-1044	5253

Table 12. Example of monthly calculation for proficiency level and benefit (measured in monthly wage) for equipment operator in North (negative values refer to training time before hiring; and OJT means on-job train)

T	Proficiency level				Benefit (measured in wage)			
	Extended	Intermediate	Brief	OJT	Extended	Intermediate	Brief	OJT
-12			0	0.3	1296	1296	1296	1934
-11			0.37	0.3	1296	1296	2064	1934
-10			0.37	0.3	1296	1296	2064	2064
-9		0	0.37	0.31	1296	1296	2064	2064
-8			0.38	0.31	1296	1296	2064	2064
-7			0.38	0.32	1296	1296	2064	2064
-6	0	0.55	0.39	0.33	1296	2550	2064	2064
-5		0.55	0.4	0.35	1296	2550	2064	2064
-4		0.55	0.42	0.37	1296	2550	2064	2064
-3		0.55	0.43	0.39	1296	2550	2064	2064
-2		0.56	0.45	0.42	1296	2550	2064	2064
-1		0.56	0.48	0.46	1296	2550	2550	2550
1	0.66	0.58	0.54	0.54	2550	2550	2550	2550
2	0.67	0.59	0.58	0.58	2550	2550	2550	2550
3	0.67	0.6	0.61	0.62	2550	2550	2550	2550
4	0.67	0.61	0.65	0.66	2550	2550	2550	2550
5	0.67	0.63	0.68	0.69	2550	2550	2550	2550

6	0.67	0.65	0.71	0.72	2550	2550	2550	2550
7	0.68	0.67	0.73	0.74	2550	2550	2550	2550
8	0.68	0.69	0.75	0.76	2550	2550	2550	2550
9	0.69	0.71	0.76	0.77	2550	2550	2550	2550
10	0.7	0.73	0.78	0.78	2550	2550	2550	3273
11	0.71	0.75	0.78	0.79	2550	2550	3273	3273
12	0.72	0.76	0.79	0.79	2550	2550	3273	3273
13	0.73	0.77	0.8	0.8	2550	2550	3273	3273
14	0.74	0.78	0.8	0.8	2550	3273	3273	3273
15	0.76	0.79	0.8	0.8	2550	3273	3273	3273
16	0.77	0.79	0.8	0.81	2550	3273	3273	3273
17	0.78	0.8	0.81	0.81	2550	3273	3273	3273
18	0.78	0.8	0.81	0.81	3273	3273	3273	3273
19	0.79	0.8	0.81	0.81	3273	3273	3273	3273
20	0.79	0.81	0.81	0.81	3273	3273	3273	3273
21	0.8	0.81	0.81	0.81	3273	3273	3273	3273
22	0.8	0.81	0.81	0.81	3273	3273	3273	3273
23	0.8	0.81	0.81	0.81	3273	3273	3273	3273
24	0.8	0.81	0.81	0.81	3273	3273	3273	3273

Discussion

The low participation rate of training program may be related to an appreciation that productivity can be enhanced by machines more easily than by training. Another explanation could be that only a few logging firms could pay for those programs or have ever had access to training programs.

Another key issue in training decision is about who should pay for training program. One economic analysis concluded that employers should pay training cost in order to get higher surplus (Stevens, 2001). Furthermore, training cost would lower the starting wage for employees since it might lower the demand for experienced employees. Conversely the employer might be able to increase their wages as a reward for gaining knowledge and skill (Parent, 1999). Certainly, logging firm employers would only choose programs when additional cost is below potential benefit. As a result training program providers' decisions about offering services may depend highly on employers' demand. Probably the most important driver for training is the intangible benefits society and the firm might receive by increasing safety or the societal benefits by increasing performance reducing the environmental impacts of logging.

Employees with the highest work performance level had highly variable wages, so respondents' attitudes about paying highly experienced operators varied. However, wage of supervisor was lower than the other two jobs for nearly all work performance levels. This could represent a lack of experience hiring supervisors since many firm owners are also the crew supervisors. This could also be reflected in the difference in supervisor pay from the BLS (Table 5).

Most respondents indicated that they have formal logging training, but in this context it probably reflects the certification training most are required to attend. Few of them hire logging machine operator with formal training because there are few training programs available and those employees are usually not required to attend the certification trainings. Additionally some may not be aware of training value or have a negative attitude toward it. Given the nature of the industry and the long reliance on on-the-job training is may be accepted that vocational training could only bring limited benefit. This may be also a reasonable explanation of why most respondents reject investment in training programs. Finally training program designs and outcomes may not be optimal for the loggers that would choose training.

There are some notable differences between North and South. The most reasonable explanation would be the different logging systems in two regions. In North, the options of Fellerbuncher-Skidder (43%), Harvester-Forwarder (57%), and Chainsaw-Skidder (52%) are evenly reported. However, in South, the rate is 79%, 8%, and 40%, respectively. Because people are using different methods in different places, individual's attitude could be different. There might also be other economic explanations, like local demand/supply of wood product, public policy (subsidy, tax), or situation of local labor market.

Most NPVs are negative and the longer training programs had less benefit. The increased wage caused by training program cannot cover the loss of revenue during the training courses since the potential wage range was small. Positive NPVs are only for supervisor because supervisors wage is the highest and their performance levels are quite high for the whole time.

In this study, it was assumed that employer pay for training. If the training cost the circumstances are even worse since it is unlike they could bear the training cost burden and lost wages during training.

Unlike most research on logging training programs, I did not conduct experiments with control and experimental groups. So I relied on Purfürst (2010) learning curve model results. It is possible that these learning curves may not be completely appropriate for the situation or that more model parameters should be changed to model training effects. I also did not apply estimates of job survivorship or the rate that trainees may quit new jobs (Garland 1990). I assumed employees stay at the job position for at least 36 months.

For future research there may be obstacles that affect employer's decision in utilizing training programs. In the surveys I found respondents stating "my company is small and I cannot afford for training". According to White (1980), four factors may influence employer's choice (occupational characteristic; labor market characteristics; technological change rate).

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Default Question Block

Logging Training Program Survey

The survey includes two parts: *Part I* and *Part II*. You can change your answers any time. After you finished each page, just click the ">>" button in the lower-right corner to go on. Thank you for your cooperation.

Please answer ALL questions. If you have any problems dealing with the questions, please read the explanations and notes of each question carefully.

Part I: Demographic Information

This part includes questions about you.

IF you do not want to answer certain questions in this part, please select "Not Applicable/ No Answer" in options.

Which term best describes you?

- Logging firm owner
- Logging firm supervisor
- Logging firm employee
- Other (Please describe below)
- Not Applicable/No Answer

What is your age? (Please type your age in the box)
If you do not want to answer this question, you can skip it and go to the next question.

Which best describes your education level?

- High school
- Some college
- Associates degree
- Bachelors degree
- Graduate training/degree
- Not Applicable/No Answer

How many years of experience do you have in logging or related industries?

- less than 1 year
- 1-3 years
- 4-9 years
- 10 years or more
- Not Applicable/No Answer

How many years of experience do you have in your current job or position?

- less than 1 year
- 1-3 years
- 4-9 years
- 10 years or more
- Not Applicable/No Answer

Do you have any formal training in logging, forestry, or wood products?

- Yes
- No
- Not Applicable/No Answer

How long has your firm been in logging?

- 0-5 years
- 6-9 years
- 10 or more years
- Not Applicable/No Answer

How many people are usually employed by your firm?

- 1-6
- 7-10
- 11-20
- 21 or more
- Not Applicable/No Answer

How many logging machine operators are usually employed by your firm?

- 1-3
- 4-6
- 7-10
- 11-20
- Not Applicable/No Answer

In which region does your firm operate? Please select region where the firm spends more than half the time.

- West – AK, CA, OR, or WA
- Intermountain – AZ, CO, ID, MT, ND, NM, SD, UT, or WY
- North – CT, DE, IA, IL, IN, MA, MD, ME, MI, MN, MO, NH, NJ, NY, OH, PA, RI, VT, WI, or WV
- South – AL, AR, FL, GA, KY, LA, MS, NC, OK, SC, TN, TX, or VA
- Other

Which logging systems are used by your firm on a regular basis (Check all that apply)

- Fellerbuncher-Skidder
- Harvester-Forwarder
- Chainsaw-Skidder
- Cable/Helicopter
- Other (Please describe below)

How many different products are merchandised and hauled from a typical harvest area?

- 1-3
- 4-6
- 7 or more

How long ago was the most recent new hire in your firm?

- less than 12 months
- 1-3 years
- 3-4 years
- 5 years or more
- Not Applicable/No Answer

Which terms describe the most recent new hire? (Check all that apply)

- Inexperienced
- Experienced
- Trained (With formal training before)

To your knowledge has the firm ever hired someone with formal training in logging

- Yes
- No

What term best describes the job of the most recent logging hire? (Please choose from the drop-down list)

Part II: Training Program

This part includes questions about options for training program. Please answer ALL questions. Thank you.

Notes:
For the following questions these descriptions will apply:

Label name	Description
Job Quality	**Minimize damage to equipment, products, and site, production within defined specifications.**
Safety	**Have knowledge, attitude and behavior that support job procedures and requirements (e.g. PPE use) concerning safety.**
Productivity	**Perform in a way that meets the production capacity of the rest of the crew.**

First of all, please select current job positions in your firm (Check all that apply)

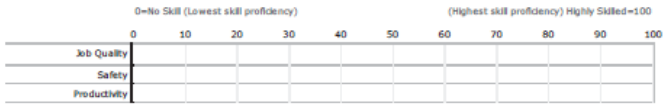
- ☐ Equipment operator
- ☐ Chainsaw operator (etc)
- ☐ Supervisor
- ☐ Deckhand/laborer
- ☐ Chokersetter
- ☐ Chaser
- ☐ Hooktender

Question A

Equipment operator

For Equipment operator, please indicate the lowest acceptable level of performance expected of a new hire at the time of employment.
Here, 100 grades are presented. 0 is the LOWEST proficiency level, and 100 is the HIGHEST proficiency level.

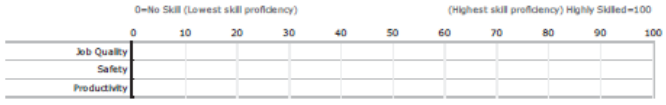
Place the mouse at the appropriate level and click, or you can drag the bar to the appropriate amount.



Chainsaw operator (ect)

For Chainsaw operator (ect), please indicate the lowest acceptable level of performance expected of a new hire at the time of employment.
Here, 100 grades are presented. 0 is the LOWEST proficiency level, and 100 is the HIGHEST proficiency level.

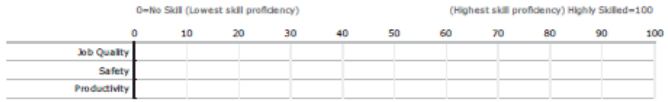
Place the mouse at the appropriate level and click, or you can drag the bar to the appropriate amount.



Supervisor

For Supervisor, please indicate the lowest acceptable level of performance expected of a new hire at the time of employment.
Here, 100 grades are presented. 0 is the LOWEST proficiency level, and 100 is the HIGHEST proficiency level.

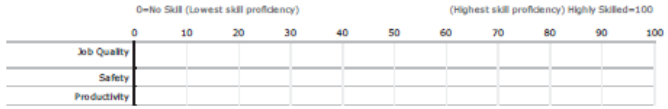
Place the mouse at the appropriate level and click, or you can drag the bar to the appropriate amount.



Deckhand/laborer

For Deckhand/laborer, please indicate the lowest acceptable level of performance expected of a new hire at the time of employment.
Here, 100 grades are presented. 0 is the LOWEST proficiency level, and 100 is the HIGHEST proficiency level.

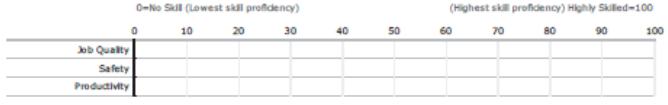
Place the mouse at the appropriate level and click, or you can drag the bar to the appropriate amount.



Chokersetter

For Chokersetter, please indicate the lowest acceptable level of performance expected of a new hire at the time of employment.
Here, 100 grades are presented. 0 is the LOWEST proficiency level, and 100 is the HIGHEST proficiency level.

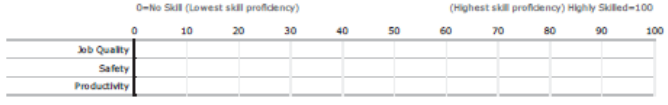
Place the mouse at the appropriate level and click, or you can drag the bar to the appropriate amount.



Chaser

For Chaser, please indicate the lowest acceptable level of performance expected of a new hire at the time of employment.
Here, 100 grades are presented. 0 is the LOWEST proficiency level, and 100 is the HIGHEST proficiency level.

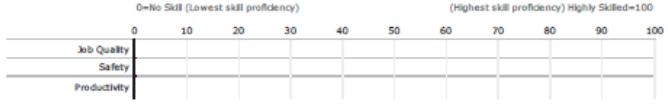
Place the mouse at the appropriate level and click, or you can drag the bar to the appropriate amount.



Hooktender

For Hooktender, please indicate the lowest acceptable level of performance expected of a new hire at the time of employment.
Here, 100 grades are presented. 0 is the LOWEST proficiency level, and 100 is the HIGHEST proficiency level.

Place the mouse at the appropriate level and click, or you can drag the bar to the appropriate amount.



Question B

In your opinion how much previous job experience is needed for someone to perform acceptably for each one of the jobs listed.

	less than 1 month	1-2 months	3-5 months	6-11 months	12-23 months	2-3 years	4 years or more
Equipment operator	○	○	○	○	○	○	○
Chainsaw operator (etc)	○	○	○	○	○	○	○
Supervisor	○	○	○	○	○	○	○
Deckhand/laborer	○	○	○	○	○	○	○
Chokersetter	○	○	○	○	○	○	○
Chaser	○	○	○	○	○	○	○
Hooktender	○	○	○	○	○	○	○

Question C

Question C:
Equipment operator

What would you expect to pay an equipment operator measured in DOLLARS PER HOUR ($/hr) with different combinations of Productivity and Safety performance?
Please estimate the hourly wage of every combination of performance Here you can choose the wage range between $10 per hour and $30 per hour.

Place the mouse at the appropriate level and click, or you can drag the bar to the appropriate amount.
For, example if you are hiring an Equipment operator with Low performance level in Productivity but Medium performance level in Safety, and you will pay this employee $15 per hour, then choose the second row and click on the bar of "15".

Expected wage $/hr

	10	15	20	25	30
Low in Productivity; Low in Safety					
Low in Productivity; Medium in Safety					
Medium in Productivity ; High in Safety					
High in Productivity; High in Safety					

Question C:
Chainsaw operator (etc)

What would you expect to pay a chainsaw operator measured in DOLLARS PER HOUR ($/hr) with different combinations of Productivity and Safety performance?
Please estimate the hourly wage of every combination of performance Here you can choose the wage range between $10 per hour and $30 per hour.

Place the mouse at the appropriate level and click, or you can drag the bar to the appropriate amount.
For, example if you are hiring a Chainsaw operator with Low performance level in Productivity but Medium performance level in Safety, and you will pay this employee $15 per hour, then choose the second row and click on the bar of "15".

Expected wage $/hr

	10	15	20	25	30
Low in Productivity; Low in Safety					
Low in Productivity; Medium in Safety					
Medium in Productivity; High in Safety					
High in Productivity; High in Safety					

Question C:
Supervisor

What would you expect to pay a supervisor measured in DOLLARS PER HOUR ($/hr) with different combinations of Productivity and Safety performance?
Please estimate the hourly wage of every combination of performance. Here you can choose the wage range between $10 per hour and $30 per hour.

Place the mouse at the appropriate level and click, or you can drag the bar to the appropriate amount.
For, example if you are hiring a Supervisor with Low performance level in Productivity but Medium performance level in Safety, and you will pay this employee $20 per hour, then choose the second row and click on the bar of "20".

Expected wage $/hr

	10	15	20	25	30
Low in Productivity; Low in Safety					
Low in Productivity; Medium in Safety					
Medium in Productivity; High in Safety					
High in Productivity; High in Safety					

Question D

The descriptions below refer to Question D (Question D1 and Question D2).

Program name	Description
Extended	**12-month-program, with basic forestry, equipment operation, basic maintenance training, safety, Training goal would be equivalent to experienced employee.**
Intermediate	**6-month-program, with equipment operation, basic maintenance training, safety, Training goal to insure safety andsome experience in work methods.**
Brief	**1-month-program, Training goal to introduce job tasks and basic procedures.**

Question D1

If training programs were available please rate how well each of the following would suit your needs for inexperienced employees. Grade 0 means INADEQUATE; 100 means EXCEED.

All you need is to point your mouse to the amount you have selected and left click it.

	0	10	20	30	40	50	60	70	80	90	100
Extended											
Intermediate											
Brief											

Question D2

In Column 1:
For each of the three programs (*Extended*, *Intermediate* and Brief), please select if you are willing to send a inexperienced new hire to it in (Please select between "Yes" or "No").

In Column 2:
If you choose "Yes", please select the amount of maximum fee you would expect to pay in the drop-down list.
If you choose "No", please select "N/A" in the drop-down list.

	Column 1: Would you send the new inexperienced hire to this program? Yes	No	**Column 2:** The maximum fee you are willing to pay. (In U.S. dollar, $)
Extended	○	○	
Intermediate	○	○	
Brief	○	○	

Thank you for completing the survey.

Just click the ">>" to finish.
If you would like to see a preliminary summary of the survey information please email smidtmf@auburn.edu.
Forward the link "http://goo.gl/NvuKJ" to other logging firm owners and supervisors who might be willing to complete the survey
For a brief description of study objectives go "https://fn.auburn.edu/autorestops/survey.htm"

Appendix B

Equation of learning curve:

$$PL(t) = \frac{PL_{max} - a}{1 + 70 * e^{-0.32*t}} + a$$

and

$$PL_{start} = \frac{PL_{max} + 70 * a}{71}$$

Where:

$PL(t)$ Proficiency level of time *t*

$PLmax$ Maximum proficiency level

$PLstart$ Starting proficiency level

a Variable (it will change in different training program)

t Time