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*Full Length Research Paper*

# Sericulture extension structural equation modeling to revitalizing silkworm cocoon production in Iranian sericulturists' view

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**Sericulture as an agrarian small-scale industry suits both marginal and small land holders because of its high returns, and it creates opportunity for family employment. Iran has long history in cocoon and silk production, but the demand for rearing silkworm during recent years has had a significant reduction. This study examines sericulture extension as a strategy for revitalizing silkworm cocoon production from sericulturists' view in Iran. Research methodology applied in this study was a combination of descriptive-analytical and quantitative methods and statistical methods included correlation and multiple regression analysis as data processing methods along with structural equation modeling (SEM). Sample size included 316 sericulturists in Iran. The results of structural equation modeling have appeared that effective training is the most important effective factor on revitalizing silkworm cocoon production. Marketing had most effect on attitude about extension. The method of acquiring sericulture information had effect on effective training. The effective training had effect on presenting technologies and participation and also the method of acquiring sericulture information had effect on effective factors of technologies adoption. On the basis of structural model, we can conclude that extension education is necessary for revitalizing silkworm cocoon production in Iran, human capital development and to mobilize sericulturists with valuable knowledge and technology through the formation of partnerships.**

**Key words:** Structural equation modeling (SEM), sericulture extension, revitalization, Iran.

## INTRODUCTION

Sericulture is one of the rural based agro industries with global reach. Some unique features of the sericulture sector are its rural nature, ecologically and economically sustainable activity for the poor, small and marginal farmers, agriculture labor and women in particular. Sericulture is a labor intensive industry in all its phases. It can generate employment up to 11 persons for every kilogram of raw silk produced; out of which more than 6 persons are women (Lakshmi, 2007).

Recently China and India are two important silk producers (FAO, 2008). Countries such as China, Japan and Brazil had crop decrease, while India with retaining previous production ceiling, have had increases, too (Hosseinimoghaddam, 2005). Already around 50 countries in the world are participating to silk production and their annual yarn production rate is reached to more than 80,000 tons raw silk which in contrast to world cotton

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production and other synthetic yarns is very small. According to international statistics, in total world productions of weaving fibers, silk share is only 0.19%. During the last decades, silk production in the world has always been increased (Bizhannia and Seidavi, 2006).

Sericulture in Iran begun from the Sassanid ages (224 to 651 A.D.) and reached its peak in the Safavid ages between 1501 and 1722 (Moradianfar, 2000). In Safavid ages, the country raw silk production has reached to 3000 tons in year and Iran was third world silk producer (Seidavi and Bizhannia, 2006). The process of silk production in Iran is currently divided into two main sections: the agricultural section run by Iran Silkworm Rearing Corporation and industrial section which is mainly invested by the private sector and which includes silk production factories (Iran Silkworm Rearing Corporation, 2007).

Iran has many abilities for production of cocoon and silk fibers. The most important these factors are cheap and abundance work force, mulberry trees, experience and acquaintance of sericulturists with this profession and carpet-weaving workshops (Pourhossein, 2003). According to statistics of Iran Silkworm Rearing Corporation, production of cocoon had been more than 5000 tons in 1980s (Iran Silkworm Rearing Corporation, 2007) and 730 tons in 2009 (Pourhossein, 2009), so production of cocoon has decreased to lower than one sixth. Also number of rearers has decreased from 80000 in 1995 (Moradianfar, 2000) to 25389 in 2007 (Iran Silkworm Rearing Corporation, 2007). The extent of Iran mulberry fields have decreased from 17000 ha in 1995 (Moradianfar, 2000) to 11305 ha in 2007 (Iran Silkworm Rearing Corporation, 2007).

The silkworm rearers in Iran still follow the hold cultivation method with age old and low yielding mulberry varieties. They also continue to practice the primitive rearing method. Further, they are not aware of the prophylactic measures to prevent and control mulberry and silkworm diseases (Pourhossein, 2003). Sericulture extension is the only way to overcome the bottleneck between lab and land.

Sericulture extension centers are helping people to reach higher levels of living-physically, mentally and spiritually by dissemination the improved technology, determining accurately their problems, helping them to acquire knowledge and to inspire them to take appropriate action to minimize the crop losses in order to increase the production and productivity per unit area (Singh et al., 2009). Extension is no longer simply focused on improving yields. Large numbers of subsistence farmers have to break out of not just financial but also information poverty, skill and competency poverty and cultural poverty. Extension is not only about to bring change in unfavorable present situation to stakeholders, but also to preventing problem creation for the sake of the prosperous generation as well (Malakmohammadi, 2009).

The main goal of this study was sericulture extension modeling to revitalizing silkworm cocoon production in Iranian sericulturists' view. To obtain the main goal, the sericulture extension parts, the components of revitalizing silkworm cocoon production and the effective factors on sericulture extension parts and revitalizing silkworm cocoon production should be determined. Different views about effective factors on sericulture and the extension are listed in Table 1.

## MATRERIALS AND METHODS

Research methodology applied in this study was a combination of descriptive-analytical and quantitative methods and statistical methods included correlation and multiple regression analysis as data processing methods along with structural equation modeling (SEM). The statistical population consisted of the sericulturists in Iran. Sample size included 316 sericulturists. The sericulture extension parts are measured by a collection of questions about effective training of sericulture, the rate of presenting new methods and technologies of sericulture, the effective factors on adoption of new methods and technologies, attitude about extension. A series of questions was about components of revitalizing silkworm cocoon production. Also effective factors on sericulture extension parts and revitalizing silkworm cocoon production were measured in the form of latent variables include participation, marketing, awareness, and the method of acquiring sericulture information.

The content validity of questionnaire was measured by a group of extension specialists. A pilot test was conducted to determine the questionnaire's reliability and the Cronbach's alpha and ordinal theta was obtained respectively 0.89 and 0.91. Data collected was analyzed using the Statistical Package for the social sciences (SPSS) and linear structural relationships (LISREL).

## RESULTS

The study results showed that the mean of sericulturists' age and their sericulture experiences were respectively 52.63 and 26.19 years. Of them, 61.6% were illiterate and 82.3% performed silkworm rearing by helping of their wives and children; 90% tended to take part in training programmes; 70.8% of sericulturists have performed hatching individually. Silkworm nursery situation of 83.7% of sericulturists were traditional. All sericulturists in the study have engaged in silkworm rearing just one time in a year. Of them, 50.5% use their mulberry fields for other crops in the year, and 93.1% do not change their cocoons to silk productions.

Structural equation modeling (SEM) was used to examine a series of relationship among variables simultaneously. The results of the complete structural equation model for observed and latent variables are provided in Figure 1. This model shows that revitalizing silkworm cocoon production was affected by effective training and participation. Attitude about extension was affected by awareness, marketing and participation. Participation was affected by effective training. Effective training was affected by the method of acquiring information. Presentation of technologies was affected by

**Table 1.** Views about effective factors on sericulture and the extension in the world.

| Factor / Source | Adoption of sericulture as a secondary profession | Quality increase of sapling of mulberry and silkworm eggs | Setting grassroots producer groups and cooperatives | Support for receiving credit facilities | Development of sericulture in susceptible regions | Coordination before and after cocoon harvest | Diversity in silk and silkworm crops | Description of sericulture management systems | Integrated agriculture operation | Adoption of technologies | Educational needs of sericulturists | Scientific sericulture | Knowledge ,skill and positive attitude | Participatory extension | Extension contact | Sericulturists education | Appropriate and practical methods | Presenting sericulture technologies | Focus on women in sericulture | Sericulturists women achievement to technology and education | Technology matching and adapting | Cooperatives with a complete cycle | Cooperatives with a complete cycle | Visit of sericultural pattern points | Ability of extension section on playing an effective role | Awareness about diseases and pests of silkworm and mulberry | Identification of progressive sericulturists | The method of acquiring sericulture information |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Charmchianlangerodi and Chizari, 2005 | | | | | | | | | | | * | | | | | * | * | | | | | | | | | * | | * |
| Narasaiah and Raju, 1999 | | * | | | * | | | | | | | | | | | | | | | | | | | | * | * | | |
| Norouzi, 2002 | | * | | | | | | | | | | | | | | | | | | | | * | * | | | * | | |
| Vijayakumar et al., 2008 | | * | | | | | | | | | | | | | | | | | * | * | | | | | | | | |
| Emami Yeganeh, 2002 | | | * | * | | | * | | | | | | | | | | | | | | | | | | | * | | |
| Lim, 2002 | | | | | | | * | | | * | | | | | | * | | * | | | | | | | | | | |
| Li, 2000 | | | | | * | | * | | | | | | | | | | | | | | | | | | | | | |
| Singh et al, 2009 | | | * | | | | | | | * | | * | * | * | * | * | * | * | | | | | | | | | * | |
| Lafun and Rabino, 1993 | * | | | | | | | | | | | | | | | | | | | | | * | * | * | | * | | |
| Srinivasa *et a.l*, 2007a | | | | | | | | | | | | | | | | | | | | | * | | | | | | | |
| Rani, 2007 | | | | | | | | | | | | | | | | | | | * | * | | | | | | | | |
| Neupane and Thapa, 2001 | | | | | | | | | * | | | | | | | | | | | | | | | | * | * | | |
| Khan and Dhar, 2007 | | | | | | | | | | | | | | | | | * | * | | | | | | | | | | |
| Chatterjee, 2009 | | | | | | | | | | | | | | | | * | | * | | | | | | | | | | |
| Iran Silkworm Rearing Corporation, 2007 | | * | * | * | | * | * | * | | | | | | | | * | | * | | | | | | * | | * | | |
| Dhar et al., 2008 | | | * | | | | | | | | | | | | | | | | | | | | | | | | | |

**Table 1.** Contd.

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Srinivasa et al., 2004 | | | | | | | | | | | | | | * | * | * | | | | | | | | | | | | |
| Geetha et al., 2001 | | | | | | | | | | | | | | | * | * | | | | | | | | | | | | |
| Gebrekidan et al., 2005 | | | | | | | | | | | | | * | | | | | | | | | | | | | | | |
| Sujatha et al., 2006 | | | | * | | | | | | * | | * | * | * | * | * | | | | | | | | | | | | |
| Pandit et al., 2007 | | | | | | | | | | * | | | | | * | | | | | | | | | | | | | |
| Srinivasa et al., 2007b | | | | | | | | | | | * | | | | | * | * | | | | | | | | | | | |
| Chatterjee, 2007 | | | | | | | | | | | | | | | | | * | | | | | | | | | | | |
| Kasa, 2005 | | * | * | | | | | | * | | | | | | | * | * | * | * | | | | | | | | | |
| Gangopadhyay, 2009 | | * | | | | * | | | | | | | | * | | | | * | * | * | | | | | * | * | | |
| Lakshmi, 2007 | | | | | | | | | | | | | | | | * | * | * | | | | * | * | | | | | |
| Sukitanond et al., 1992 | | | | | | | | | | | | | | | | | | | * | * | | | | | | | | |
| Rao, 1986 | | | | | | | | | | | | | | | | | * | | | | | | | | | | | |
| Mathur and Vishwakarma, 1999 | | | | | | | | | | | | | | * | | | | | | | | | | | | | | |
| Lewis and Siddiqi, 2006 | | | * | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chandrakala and Sugun, 2007 | | | * | | | | | | | | | | | | | | | | | | | | | | | | | |
| Datta, 2000 | | | | | | | | | | | | * | | | | | | | | | | | | | | * | | |
| Seidavi and Bizhannia, 2006 | * | | | | | | | | | | | | | | | | | | | | | | | | | | | |

effective training. Also the effective factors on adoption of technologies were affected by the method of acquiring information (Figure 1 and Table 2).

According to Table 3, in the latent variable of the method of acquiring sericulture information, acquiring information by other sericulturists had the most power of prediction. Making occupational motivation in sericulturists was more than other variables (Integrated agriculture operation, informing about mulberry cultivation around farm lands and adoption of sericulture as a secondary profession) in prediction of awareness latent variable and in the latent variable of marketing, the observed variable of help to cocoon processing had most power of prediction.

According to Table 4, in the latent variable of effective training, the observed variable of effective training about young worms had the most power of prediction. In the latent variable of presenting new methods and technologies to sericulturists was the most important predictive observed variable of presenting new methods and technologies about silkworm nursery. In the latent variable of the effective factors on adoption of sericulture technologies, acquaintance of sericulturists about technologies had the most power of prediction. About attitude about extension, the ability of extension in making contact between executives and sericulturists had the most power of prediction. Help to establish cooperatives with a complete cycle from cocoon eggs production to processing of cocoon was more than other observed variables in prediction of participation latent variable. The decrease in the costs of cocoon production had the most importance in revitalizing silkworm cocoon production.

The results of fit indices used to evaluate the adequacy of this model showed that a $\chi^2$ of 614.68, the significant level was 0.000, which means that based chi-square statistic rejects this model (Kalantari, 2009), but chi-square value is the traditional measure for evaluating overall model fit. There are also a number of severe limitations in its use: Firstly, because the chi-square statistic is in essence a statistical significance test. It is sensitive to sample size which means the chi-square statistic nearly always rejects the model when large samples are used (Bentler and Bonnet, 1980). Secondly, this test assumes multivariate normality and severe deviations from normality that may result in model rejections even when the model is properly specified (Mcintosh, 2006). Due to the restrictiveness of chi-square, researchers have sought alternative indices to assess model fit

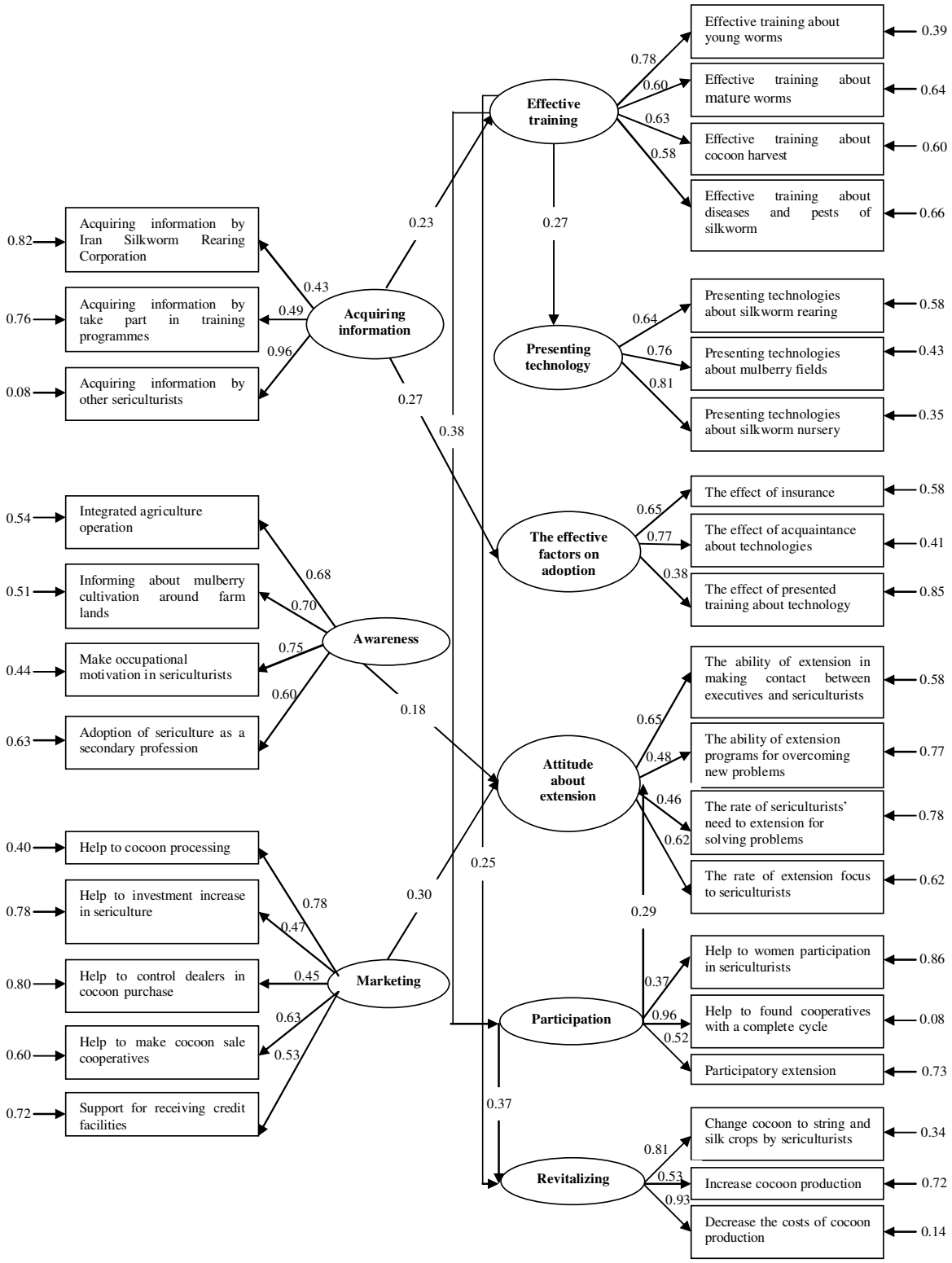


**Figure 1.** Estimation of regression weight (Standardized factor loading) of variables inter relations.

(Hooper et al., 2008). Therefore, measures of fit were examined including the incremental fit index (IFI = 0.93), comparative fit index (CFI = 0.93) and root mean square error of approximation (RMSEA = 0.036). Also the ratio of chi-square to freedom degree in model was 1.42.

This model appeared to fit well enough, with the IFI and

**Table 2.** Regression relationship of latent variables.

| The path to | The path from | | | | |
|---|---|---|---|---|---|
| | The method of acquiring sericulture information | Effective training | Participation | Marketing | Awareness |
| Revitalizing silkworm cocoon production | 0.03+0.06= 0.09 | 0.25+0.14= 0.39 | 0.37 | - | - |
| Attitude about extension | 0.03 | 0.11 | 0.29 | 0.3 | 0.18 |
| Participation | 0.09 | 0.38 | - | - | - |
| Effective training | 0.23 | - | - | - | - |
| The effective factors on adoption of technologies | 0.27 | - | - | - | - |
| Presenting technologies | 0.06 | 0.27 | - | - | - |

**Table 3.** Estimation of regression weight, t-value and R2 of X-model variables.

| Latent X | Observed X | SC1 | t | R2 |
|---|---|---|---|---|
| The method of acquiring information | Acquiring information by Iran silkworm rearing corporation | 0.43 | RV | 0.18 |
| | Acquiring information by take part in educational course | 0.49 | 8.41 | 0.24 |
| | Acquiring information by other sericulturists | 0.96 | 11.97 | 0.92 |
| Awareness | Integrated agriculture operation | 0.68 | RV | 0.46 |
| | Informing about mulberry cultivation around farm lands | 0.7 | 12.68 | 0.49 |
| | Make occupational motivation in sericulturists | 0.75 | 13.5 | 0.56 |
| | Adoption of sericulture as a secondary profession | 0.6 | 10.52 | 0.37 |
| Marketing | Help to cocoon processing | 0.78 | RV | 0.6 |
| | Help to investment increase in sericulture | 0.47 | 7.74 | 0.22 |
| | Help to control dealers in cocoon purchase | 0.45 | 7.38 | 0.2 |
| | Help to make cocoon sale cooperatives | 0.63 | 10.67 | 0.4 |
| | Support for receiving credit facilities | 0.53 | 8.85 | 0.28 |

1: Completely standardized solution; 2: reference variable.

CFI both greater than 0.90, RMSEA less than 0.05 (Hooman, 2008). Also the ratio of chi-square to freedom degree was less than 2 (Mansourfar, 2006). Based on the afore-mentioned fit indices, it can be concluded that the final model fits the proposed model.

## DISCUSSION

The study results showed that 82.3% of sericulturists performed silkworm rearing by helping of their wives and children. An approach in mulberry sericultural development in Jammu and Kashmir is client system and farm women. The client system and farm women is composed of farmers, family members and their social, cultural, economic, and prevailing technological environment (Dhar et al., 2008). Of them, 50.5% use their mulberry fields for other crops in the year. However, five or six other products can be harvested in one year in a mulberry garden (Hosseinimoghaddam, 2005). In addition, 90% of sericulturists tended to take part in training programmes. Research conducted by Charmchianlangerodi and Chizari (2005) also show that about 90% of sericulturists would like to take part in training courses.

The study model shows that revitalizing silkworm cocoon production was affected by effective training and participation. Findings by Srinivasa et al. (2004) indicate that the variables like participatory extension and training were found to have a significant influence on the cocoon yield. Also, presentation of technologies was affected by effective training. Singh et al. (2009) believes that sericulturists should be trained on the improved technology profits, cultivating mulberry varieties with high yield and appropriate hybrid of seasonal and regional silkworms.

**Table 4.** Estimation of regression weight, t-value and R2 of Y-model variables.

| Latent Y | Observed Y | SC | t | R2 |
|---|---|---|---|---|
| Effective training | Effective training about young worms | 0.78 | RV | 0.61 |
| | Effective training about mature worms | 0.6 | 8.7 | 0.36 |
| | Effective training about cocoon harvest | 0.63 | 8.91 | 0.4 |
| | Effective training about diseases and pests of silkworm | 0.58 | 8.19 | 0.34 |
| Presenting technology | Presenting technologies about silkworm rearing | 0.64 | RV | 0.42 |
| | Presenting technologies about mulberry fields | 0.76 | 9.99 | 0.57 |
| | Presenting technologies about silkworm nursery | 0.81 | 9.89 | 0.65 |
| The effective factors on adoption of technology | The effect of sericulture insurance | 0.65 | RV | 0.42 |
| | The effect of acquaintance about technologies | 0.77 | 6 | 0.59 |
| | The effect of presented training about technology | 0.38 | 5.41 | 0.15 |
| Attitude about extension | The ability of extension in making contact between executives and sericulturists | 0.65 | RV | 0.42 |
| | The ability of extension programs for overcoming new problems | 0.48 | 6.1 | 0.23 |
| | The rate of sericulturists' need to extension for solving problems | 0.46 | 5.94 | 0.22 |
| | The rate of extension focus to sericulturists | 0.62 | 6.95 | 0.38 |
| Participation | Help to women participation in sericulturists | 0.37 | RV | 0.14 |
| | Help to found cooperatives with a complete cycle | 0.96 | 5.75 | 0.92 |
| | Participatory extension | 0.52 | 5.96 | 0.27 |
| Revitalizing silkworm cocoon production | Change cocoon to string and silk crops by sericulturists | 0.81 | RV | 0.66 |
| | Increase cocoon production | 0.53 | 10.37 | 0.28 |
| | Decrease the costs of cocoon production | 0.93 | 14.99 | 0.86 |

## Conclusion

This research provides guides for revitalizing silkworm cocoon production by helping sericulture extension. The most important effective factor on revitalizing silkworm cocoon production and presenting technologies was effective training. The methods of acquiring sericulture information (include other sericulturists, Iran Silkworm Rearing Corporation, training programmes) had effect on effective training. So extension education programs have vital roles to play in sericulture.

Marketing had the most important effect on attitude about extension. About marketing, help to cocoon processing had the most power of prediction. To process cocoon, to make cocoon sale cooperatives, to support for receiving credit facilities, to increase investment in sericulture and to control dealers in cocoon purchase should be helped to sericulturists. Participation had effect on both revitalizing silkworm cocoon production and attitude about extension and also effective training had the most effect on participation. Help to found sericulture cooperatives with a complete cycle, participatory extension and help to women participation in sericulture respectively had predictive power in participation latent variable.

Extension support to foundation and organization of sericulture groups and formation of cooperatives with a complete output cycle (production of silkworm eggs, cocoon to silk transformation, production of silk yields and supply to market) that are on the way of costs reduction and income increase which eventually cause to economic profits. Participatory extension is a nonformal and continuous process on which sericulturists and extension agents learn from each other. The system integrates sericulturists, educators, researchers and extension personnel to harness knowledge and information from various sources for better sericulture and improved livelihood. Empowering of all family members (especially women) in sericulture is a considerable subject.

The method of acquiring sericulture information had the most effect on effective factors on adoption of technologies. In the method of acquiring sericulture information, the observed variable of acquiring sericulture information by other sericulturists had most predictive power. Therefore the progressive sericulturists should be identified. The progressive sericulturists are innovators. They adopt improved package of practices and set examples for others which play an important role for diffusion of technology among the masses.

On the basis of the results of the research, extension education is necessary for revitalizing silkworm cocoon production in Iran, human capital development and to mobilize sericulturists with valuable knowledge and technology through the formation of partnerships.

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