Impact of Agricultural Training on Farmers' Technological Knowledge and Crop Production in Bandarawela Agricultural Zone

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ABSTRACT

Farmer training programs on advanced agricultural techniques are essential for knowledge and capacity development of farmers. Impact assessments are done to measure the impacts of these programs. This study examines the impact of the training on technological knowledge of farmers imparted by In–service Training Institute Bindunuwewa, Bandarawela. About 82 farmer trainees were randomly selected for the study. Nonparametric tests were performed to check the differences in technological knowledge before and after the trainings (Chi-square and Wilcoxon sign rank tests). Chi-square test revealed that there is no association ($p>0.05$) between demographic factors and adoption of practical knowledge. Further, number of training days, time for practical and theoretical training, practical knowledge shared, and presentations by the lecturers were considered to be sufficient by farmers. The following measures were compared for before and after scenarios: From partial to full adoption: cultivation of high yield varieties; from non-adoption to full adoption: recommended seeding rate, recommended pesticide usage, new irrigation methods. Nevertheless, there is no effect from training on new packaging methods. Study concludes that there is an impact of training on farmers' technological knowledge. This study provides evidence that agricultural trainings should be continued with the aegis of the government in the future.

KEYWORDS: Agriculture technology, Crop production, Impact assessment, Technological knowledge, Training

Introduction

Sri Lanka is an agriculture-based country. According to Department of Census & Statistics, (2019) contribution of agriculture to GDP was 7.42 percent. However, the industrial contribution (27.4%) and services contribution (58.245%) are higher than that of agriculture. Therefore, country needs to pay attention on agricultural development through the next few years to improve its contribution. Technological improvements are the effective ways to achieve this objective (ODI, 2016). Provision of technological knowledge to farmers, is done by the In-Service Training Institutes (ISTI) under Department of Agriculture (DOA). According to DOA, there are nine ISTI's located around the country.

Throughout the year they conduct multitude of farmer training programs for the provincial farmers. ISTI, Bindunuwewa is the only ISTI located in Uva province. It plays major role in transferring technology to the farmers in the province.

Uva province contributes 13.2 percent to Sri Lankan GDP. Here, around 53 percent of the work force engages in agriculture or related employments. Therefore, development of the agriculture sector is important to pro-poor development of the province. Local and export market have high potential for the quality agricultural produces grown in this province. The province consists 19 agro-ecological zones out of the 46 agro-ecological zones. Therefore, different kind of crops can be cultivated with different cropping systems. Maximum utilization of the favourable environment is essential to improve yield and productivity. Provincial farmers can adopt new agricultural technologies to achieve higher yield, productivity and ultimately improve their living standard. There are 4,963 farm families and 5,955 farmers residing around Bandarawela Agricultural Zone. Total arable land area is 1,008.6 acres and out of that 414.5 acres are utilized for vegetable cultivation. Most of the farmers use traditional methods for their farming. Due to this, they face challenges regarding quality of the produce, pest and disease control, and market. To overcome these challenges ISTI has been conducting different farmer training programs.

Training is an educational method that needs more than just the provision of knowledge or the learning of skills thus it is an important concept of the food and Agriculture Organization of the United Nation' s for developing countries (. Trainings on technology adoption by farmers have been seen as an effective way to aware farmers on agricultural innovations (Asayehegn et al., 2012; Challa and Tilahun, 2014; Kinyangi, 2014). For this purpose, farmer training classes are mostly used by extension officers. They provide new technology, information, government policy, agricultural practice or idea to farmers. Number of studies in the developing country context have looked at the impact of training on agricultural productivity: Uganda (Pender et al., 2004; Kijima et al, 2012), Vietnam (Ulimwengu and Badiane, 2010) Cameroon (Djomo and Sikod, 2012), Tanzania (Nakano et al., 2015).

ISTI held 10 categorical training programs for farmers (rose cultivation, anthuriam cultivation, mushroom cultivation, fruit and vegetable nursery management, crop cultivation under polytunnel, home gardening, ornamental foliage cultivation, landscaping, food processing and soil conservation training). Institute allocated two days per one farmer training class. Within those two days Agriculture Instructors should provide both practical and theoretical knowledge for the farmers. Mahaliyanaarachchi, (2003). Emphasizes that, before scheduling the training classes extension worker must consult and discuss with farmers regarding content and value of it. The success of training is always suspected, but rarely confirmed. Therefore, trainers must conduct an impact assessment process regarding their training programs. This will reveal to which extent the ultimate goal of the training has been met. Impact assessment of training is a tool that gathers and organizes information that can lead to positive conclusions and decisions about what needs to be done in the workplace to enhance the impact of training on day-to-day work behaviours and attitudes (Das, 2019).

Impact Assessment on Technological Knowledge Application

Knowledge and capacity development on new farm technologies and techniques are essential for modern agricultural growth. And it also allows farmers to increase their production and revenue from crops. Agricultural training is a potentially effective method to diffuse relevant new technologies to increase productivity and alleviate rural poverty (Nakano et al., 2018). Training not only improves agricultural income of trained paddy farmers, but spillover effects also improve the income of relative and neighbouring farmers (Nakano et al., 2018). So, Agriculture extension serve as the means of providing this knowledge to the farmers. (Llewellyn et al., 2017). Agricultural extension has been traditionally used to overcome the constraints in technological adoption in agriculture at farm level through public sector programs (Aker, 2011). Though there are many studies on the determinants of technology adoption in agriculture, training either formal or informal has been also identified as one of the important determinants (Seelan et al., 2003). Though there have been many studies on the impact of training throughout the literature, the impact they have had on agricultural production varies. This could be attributed to the issues of high costs, problems of scale, and lower accountability (Seelan et al., 2003).

In a cross country study in Eastern Africa, Farmer field schools were beneficial to women, farmer with lower literacy levels and farmers with medium sized farmlands (Davis et al, 2012;). There were significant improvements in crops production, livestock production and agricultural income. Though there were differences among the countries, in general farmer income has improved by 61 percent. The lower performance of Uganda was attributed to the Agricultural advisory services (Davis et al, 2012). Evenson (2001) also reviews similar impact assessment studies of trainings and concludes that in general rate of returns exceed 40%, though the range of estimates were high. Khurshid et al., (2013) also concluded farmer trainings significantly improve agricultural, livestock, and poultry production activities in Northern Pakistan and improves skills of the women. Another study finds that, farmers who have a certain level of knowledge used to perform well after training, whereas farmers with poor knowledge performs less after the training. This indicates the medium and high level of knowledge groups did significantly well after the training (Kalasariya et al., 2015). Adoption of improved crop varieties (cassava) has impacted on improved asset ownership, especially among women and decreases asset poverty (Awotide et al., 2015).

Bint-Zaman et al. (2016) study the effectiveness of training on water conservation technologies among farmers. Respondents were positive about the training and skill development and were confident they could be useful in their businesses. But, study points out that to assess the impacts of these skills, investigation have to be followed up in short and long term scenarios. A similar Training on water productivity has improved awareness, attitude and skills of the farmers in India and significantly increased the farm production (Ghosh et al., 2013). Improved agricultural technologies have an impact on agricultural productivity and income among smallholder farmers (Awotide et al., 2015). On the other hand, there are some negative experiences as well.

Feder et al., (2003) find that there is not impact of farmer field schools in Indonesia especially on the training of integrated pest management. Their focus was to reduce the application of chemicals. The impacts were insignificant. But they explain this could be because the change was very small thus it could not be detected and other systemic factors could have affected the yield, and the quality and the complexity of the knowledge transfer was not successful or rather untimely. Recommended improvements were to focus training on highest priority topics; simplify presentation to increase the likelihood and speed of diffusion of new knowledge; and shorten training length by narrowing and prioritizing the curriculum. Feder et al., (2003).

Davis et al., (2012) concluded that lack of time and information were the mains reason for farmers not participating in the farmer field schools. Also the impacts cannot be generalized as it varies based on the farm size and other determinants (Kilpatrick, 1997). Literature concludes that adoption and impact of technology are much lower among females, due to disparity in access to inputs and services. Given this variation in findings, as well as due to the dearth of studies on the impact assessment of training programs in agriculture Sri Lanka, this study focusses on the impact of agricultural training on new technologies conducted by ISTI, Bindunuwewa in Sri Lanka.

Methodology

This study was conducted on September 2020 within Bandarawela agricultural zone in Badulla district, Sri Lanka. Multistage sampling technique was used to select the sample from the population. There were 10 different training programs (10 clusters) offered for the farmers by ISTI, Bindunuwewa. Out of that, five training programs (5 clusters) were selected using simple random sampling. They are Rose cultivation, Anthuriam cultivation, Mushroom cultivation, fruit and vegetable nursery management, and Crop cultivation under polytunnel. People who were trained from these five clusters were considered as the population of the study. The sample size was 82 farmers. There were 179 Polytunnel growers (PG), 319 Mushroom growers (MG), 203 Anthuriam growers (AG), 236 Rose Growers (RG), and 75 Fruit and Vegetable nursery (FVN) farmers trained by the ISTI in 2018 and 2019. According to that following proportion was developed: PG: MG: AG: RG: FVN is 7: 12: 8: 9: 3. Finally, data were collected from 14 polytunnel growers, 28 mushroom growers, 16 anthuriam growers, 18 rose growers and 6 fruit and vegetable nursery farmers trained by the ISTI in 2018 and 2019. The population comes as 78. Given the Covid 19 pandemic the data collection was restricted with travel restrictions.

The research followed a deductive method and collected primary and secondary data. Primary data were obtained through a self-administrated questionnaire. Socio-demographic factors, monthly production, cost of production, gross income, pre-post questions relating to the application of technological knowledge, and specific features of the training program were developed as questionnaire questions. ISTI reports, records and statistics on 2018 & 2019 were used as the secondary data of the research. Especially those records and statistics on 2018 and 2019 were used to identify the population, sample size, individual farmers and study location.

In the questionnaire, likert scale questions, open ended questions and close-ended questions were used. ISTI, at the end of each training program obtains a feedback form every trained farmer with regard to the gain of knowledge and skills after the training. They have different feedback forms for the training sessions on theory and practical. But irrespective of the crop, the same feedback form is given to all the trainees, thus all the trainees will be assessed based on same set of questions. This provide the analysis to be on the same platform for all the crops.

The factors that affect farmers to participate agricultural training programs were evaluated by Rank Based Quotient (RBQ) scoring method. Five factors were used to identify the main factors which motivated the farmers to participate in these trainings. Trainees are free to give different scores (1-5 scale) for different reasons according to their perception. A score of 5 means top priority, 4-second priority, 3- third priority, 2-fourth priority and 1 for the least priority. The value of each score was then determined as follows. Factors were ranked according to the number of score values. The Excel syntax used to measure mean (average) and ranks was as follows.

=RANK (number, array, [order])
Number refers to the number to be ranked, array means number to be ranked against and order defines ascending or descending order. [1]
=AVERAGE (array of numbers) [2]
=SUM (number1, [number2], [number3]) [3]

The sum of each factor was first calculated using the 3rd syntax, and then the mean values were calculated using the 2nd syntax. Finally, 1st excel syntax was used to rank variables.

Socio-economic and cultural factors of farmers are more help for the extension officers to get better understand about farmers and their problems. Chi-square test was used to identify the correlation between demographic variables and practical knowledge application. Practical knowledge application use was as a dependent variable and socio-demographic variables were used as independent variable. Following hypothesis was tested to analyse association between demographic factors and practical knowledge application.

$H1_o$: There is no association between new practical knowledge application and gender.
$H2_o$: There is no association between new practical knowledge application and age.
$H3_o$: There is no association between new practical knowledge application and marital status.
$H4_o$: There is no association between new practical knowledge application and level of education.
$H5_o$: There is no association between new practical knowledge application and employment.

To evaluate objective three, four features were selected (Premachandra, 2007). They are; (1) are the allocated no of days sufficient for training? (2) Is the allocated time sufficient for practical and theoretical training? (3) are the presentations of the lecturers sufficient? (4) is the practical knowledge sufficient?

Descriptive statistics was performed to assess the trainees view regarding the important features of the training program. Features were taken as variables that were independent. And also 4 point Likert scale were used (1=not sufficient, 2=neutral, 3=sufficient, 4=extremely sufficient). Finally the separate percentage of each feature was determined using descriptive statistics from SPSS.

Wilcoxon-signed rank test was conducted to evaluate impact of the farmer training program on application of new agriculture technologies before and after the training. In literature, paired t-tests were used to test the impact of training on the knowledge of trainees, when the distribution of the data were normal (Dubey and Srivastava, 2007; Premachandra, 2007). In this particular study, since the data were not normally distributed, Wilcoxon – signed rank test was used. A 3 point likert scale before/after questions were used to analyse this objective (3=fully adopted, 2=partially adopted, 1=none adopted).

Results and Discussion

Socio Demographic Factors of the Sample

When consider the demographic factors of the sample farmers, majority (54.9%) of them are male and 45.1% were female. Further, most of them (90.2%) were married and rest (9.8%) of them were un-married (Table 1). As this clearly indicates, the majority of trainees participating in the training program are married and male. Studies point out that in agricultural training, the impact on women has been substantial (Davis et al., 2012; Khurshid et al, 2013, Awotide et al, 2015). Five age groups were developed to analyse age distribution of the sample. From that, majority of farmers (48.8%) were above 45 age group and 18.3% were in 35-39 age group (Table 1). From rest 15.9% of farmers are in 30-34 age category and 9.8% from 40-44 age categories. So majority of farmers were in middle age (30-39) and adult age (40<) age category. This sums up, 50.1% farmers were between the ages of 25 to 45 years old. This suggest most of the respondents were within their economic active age. About 24.2% of them were in the 51-70 age group. It is generally assumed younger people are more productive than their older counter parts. The least representation of 1.2% was from farmers who were less than 25 years of age.

Education is good demographic for all trainees. Because educated farmers are more likely to feel the experience and benefit from of modern technology. And also they like to acquire different technical knowledge and information (Kilpatrick, 1997; Truong, 2008; Abdullah and Samah, 2013; Kalasariya et al., 2015). There for continuing education is required for farmers to be aware of the rapid developments in technology, science, business management and other skills affecting agriculture. Considering the level of education of the trainees in the Bandarawela agriculture zone; the majorities (53.7%) of them have only G.C.E.A/L level education. And 35.4% were educated up to G.C.E.O/L. Only 8.5% were having higher education.

This suggests respondents in Bandarawela agriculture zone obtained basic education that they required to acquire new agriculture technologies related their cultivation. When considering the farmers' employment majority (46.3%) of them were in other category. It means some of them are doing their own business and some of them have no jobs at all. Second highest majority (20.7%) was involved in farming. But the involvements of government workers were very limited (14.6%) (Table1).

Table 1: Description of the Sample Profile

Variable	Category	Trainees' (N=82)
Age	20-24	1.2%
	25-29	6.1%
	30-34	15.9%
	35-39	18.3%
	40-44	9.8%
	45<	48.8%
Marital Status	Married	90.2%
	Unmarried	9.8%
Educational level	Up to grade 8	2.4%
	G.C.E.O/L	35.4%
	G.C.E.A/L	53.7%
	Diploma	1.2%
	Degree	7.3%
Level of employment	Farming	20.7%
	Government	14.6%
	Private	17.1%
	Other	46.3%

Factors Influenced on having Agriculture Trainings

Farmers first priority was, to gain practical and theoretical knowledge (score=311, mean=3.77, rank=1). Some of the farmers here were having ongoing cultivation while some had no cultivation at the time of the survey. But both of them do not have proper information regarding functional and theoretical data. This is why it was rated as their first priority. Their second priority was to start agribusinesses related to both local and export market (score=291, mean=3.54, rank=2). Some of them hope to start agribusiness related to value additions (chutney, *moju* and etc.). Their third priority was hoping to expand their cultivation extent (score=227, mean=2.80, rank=3) (Table 2).

According to findings of Jansen et al., (2012) 95% of farmers participated to farmer field school training classes to get knowledge and skills related to their farming, new technological skills, high yielding varieties, soil conservation methods and to learn waste management practices. Thus, with the practice of new technology, they particularly hope to increase their revenue.

Table 2: Rank Based Quotient Scoring

Factors	Score	Mean	Rank
To gain practical/theoretical knowledge	311	3.77	1
To start a agriculture business	291	3.54	2
To expand cultivation extent	227	2.80	3
To keep link with instructors	128	1.58	4
To share knowledge and experience with farmers and instructors	23	0.28	5

Significant Characteristics of the Farmers' Training Program

According to the results, figure 1 shows trainees' idea about the number of allocated time for the farmer training program. In accordance with pie chart majority (46%) of the farmers said allocated number of days were sufficient and 26% of them said allocated number of days were extremely sufficient for them.

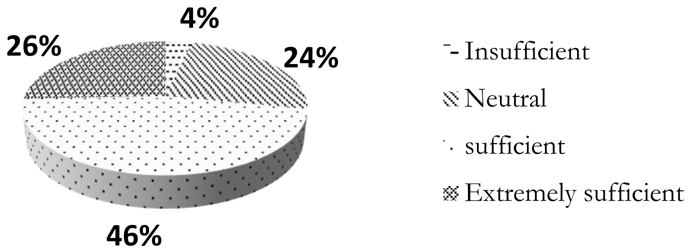

Figure 1: Farmers' Perception on Allocated Number of Days

Institute provides theoretical knowledge for the farmers within day one. And in the second day, they provide practical knowledge for the farmers. As reported by the chart majority (51%) of the trainees said allocated time for the practical and theories were sufficient.

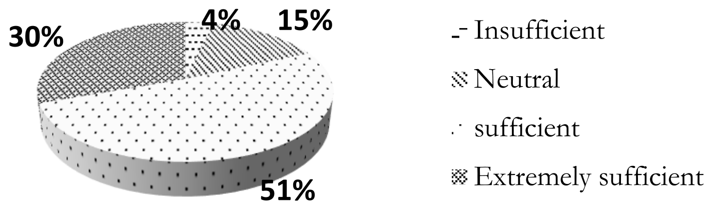

Figure 2: Farmers' Perception on Allocated Time for Practical & Theoretical Training

Following pie chart (Figure 3) shows sample farmers' idea about the presentation of the lectures (*i.e.* theoretical aspects). Majority (51%) of farmers said lecturers' presentations are sufficient. And 32% of them said, presentations were extremely sufficient.

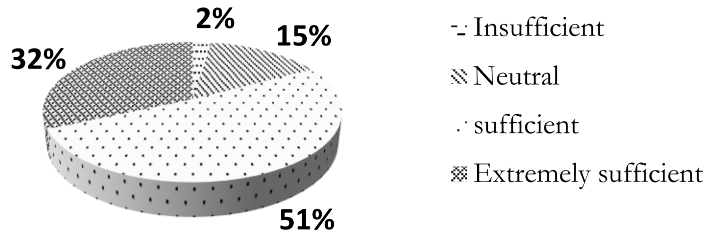

Figure 3: Farmers' Perception on Presentation of the Lectures

Institute has 48 acres with human resource, buildings and laboratories. They used this all facilities to provide better experience related to each training classes. Study result (Figure 4) shows trainees' idea about the practical knowledge given by the ISTI. As reported by the chart, majority of the trainees said practical knowledge given by the ISTI was extremely sufficient (37%).

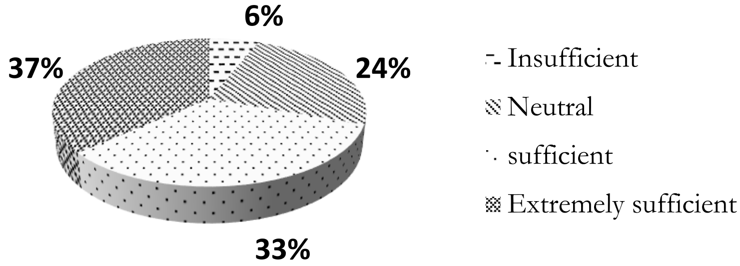

Figure 4: Farmers' Perception on Practical Knowledge given by ISTI

According to study of Olusola et al., (2020) majority (70.5%) of the trainees said GAP technologies intervention program was very effective for them. Since awareness and skills relevant to GAP technologies have been easy to get. Further Jansen et al. (2012), concluded 90 percent of farmers were satisfied with training curriculum and specific topics and 80 percent of them satisfy or over satisfy about commercial activities of farmer field schools. Based on the farmers' discussion in Bandarawela, majority of them have positive image on this two-day training class. Since through this training class, they learned new technology, crop selection, planting methods, propagation, harvesting methods, pest and disease control method. Moreover, they said earlier that they had bad cultivation experience related to the harvesting process, and some of them are addicted to using high quantities of pesticides and herbicides. After participating to the training class they have learned new things as a result now they increased their cultivation and profit. Therefore, farmers were sufficiently satisfied about the training class. These findings were similar to Bint-Zaman et al. (2016).

Impact of Agricultural Training on Farmers' Technological Knowledge Application

Wilcoxon-signed rank test was conducted in this section to compare the technological knowledge of the farmers before and after the training program. Researcher used seven pairs of question with 3 point likert scale. Only six pairs were showed significant different between before the training and after the training (*p<0.05).

Table 3: Results of the Wilcoxon Signed Rank Test

Statement	Before		After		Z Value	P Value
	Mean	SD	Mean	SD		
Do you grow high yielding varieties?	1.70	0.77	2.73	0.61	-6.72	0.00*
Do you follow seed rate/plant rate according to scientific recommendation?	1.45	0.77	2.80	0.51	-7.32	0.00*
Do you use recommendations of Department of Agriculture regarding pesticide and herbicide usage?	1.41	0.67	2.82	0.48	-7.53	0.00*
Do you follow new irrigation methods? (Drip/Sprinkler)	1.17	0.47	1.88	0.94	-5.32	0.00*
Do you adapt with new equipment or machines? (Harvesting/Processing)	1.17	1.13	1.34	0.63	-2.98	$3*10^{-3}$*
Do you use new packaging methods or materials?	4.79	33.01	1.32	0.63	-1.56	0.12
Do you use online market to sell your products?	1.10	0.37	1.60	0.75	-4.88	0.00*

Note: Not adapted = 1, partially adapted =2, fully adapted = 3
**p<0.05 means significantly different*

Before the training program all farmers partially adopted cultivation of high yielding varieties (mean=1.70, sd=0.77) and they did not adopt with the seed rate/plant rate recommendation according to the DOA recommendation (mean=1.45, sd=0.77), regarding pesticide and herbicide usage (mean=2.82, sd=0.48), new irrigation methods (mean=1.17, sd=0.47), new harvesting/ processing equipment or machines (mean=1.17, sd=1.131), online marketing (mean=1.10, sd=0.372) (Table 3). Whereas, after the training program all farmers fully adopted high yielding varieties (mean=2.73, sd=0.61), recommendation of seed rate/ plant rate (mean=2.80, sd=0.51), recommendation of DOA regarding pesticide and herbicide (mean=2.82, sd=0.48). Moreover, after participate to the training, all farmers were partially adopted with new irrigation methods (mean=1.88, sd=0.94), new harvesting/ processing equipment or machines (mean=1.34, sd=0.63) and online marketing (mean=1.60, sd=0.75).

Findings of Dubey and Srivastava (2007) prove there was significant difference between trainees and non-trainees regarding knowledge about wheat technology. According to that trainee had higher technological knowledge than the non-trainees. The present results were line with the results of (Dubey and Srivastava, 2007; Awotide et al. 2015).

Difference in Gross Income

Before the training program majority of the farmers had many problems related to their current cultivation (Table 4). Around 31.7% farmers said they had lack of fundamental knowledge to start new cultivation, 68.3% farmers said they had problem related to their present cultivation. And also 74.4% farmers had lack of theoretical knowledge regarding their related cultivation. Majority (82.9%) of them haven't sufficient field practical knowledge.

Table 4: Farmer Problems before the Training

Problem	Frequency	Percentage
Lack of fundamental knowledge to start new cultivation	26	31.7%
Problem in the present cultivation	56	68.3%
Lack of theoretical knowledge	61	74.4%
Lack of practical knowledge	68	82.9%

However, after the training program 100% of the farmers said they got extremely sufficient knowledge regarding their problems and 41.5% of farmers mentioned they do not require more training for their current cultivation. And they are all satisfied and got maximum benefit from this training program. Therefore, part of this research was to analyze average gross income per month. It was calculated through indirect steps. Because most of the farmers were reluctant to answer direct questions related to their income. According to the p value resulted from the Wilcoxon signed-rank test null hypothesis (H_0) was rejected and alternative (H_a) was accepted (Table 5). That is to say that there is significant difference in monthly gross income before and after the training. Farmers increased their gross income up to Rs. 83, 704.02 (average).

Table 5: Results of the Wilcoxon Signed-Rank Test

Pair number	Before the Training	After the Training	Z Value	P value (2- tailed)
	Mean	Mean		
Gross income per month	22177.43	83704.02	-7.32	0.00*

*Note: *p<0.05 means significantly different*

According to author's point of view, use of high yielding varieties, following scientific recommendation related to pesticide and herbicide usage, adoption of new irrigation methods, equipment and machines and online market were the main reasons that affect farmers to increase their gross income.

Conclusion and Policy Implications

Agricultural training is important to disseminate the knowledge of new technology. This study looked into the effectiveness and impact of agricultural training related to agricultural technologies offered by the ISTI, Bindunewewa in Sri Lanka. It is expected that the trainings have a positive impact on farmers. According to final conclusion there was no association between demographic factors (age, gender, marital status, educational level, employment, number of family members) and new agricultural technology application in the field. When consider the trained farmers point of view regarding the training program, majority of them were happy about the allocated number of days, allocated time for the practicals and theory part and presentation. Trained farmers thought that the practical knowledge provided by the institution were extremely sufficient.

With regard to the impact of the study, training programs increased the usage of high yielding varieties, following DOA recommendation regarding seed and plant rate, herbicide and pesticide usage, new irrigation methods, and new machines and equipment. Finally, the study reveals there is a significant difference on individual's gross income before and after the farmer training. With the right instructions and guidance of the agriculture instructors, farmers achieved higher yields and thereby higher income. Further, more awareness should be conducted to increase the participation of more farmers in to the training programs. Though this study checked the before and after comparisons within the short time period of one to two years, this may not be sufficient to check the impact, rather a long term mechanism should be there to measure the impact in the long term. The implication of this study is that, since public funded agricultural training programs are bringing in more returns, these programs should be continued, and further cost benefit analysis would reveal the magnitude of the impact of these training programs.

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