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Learning impact of farmer field schools of integrated crop–livestock systems in Sinai Peninsula, Egypt

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Abstract Four FFSs concerning integrated crop–livestock systems were implemented by a R&D project namely "Adaptation to Climate Change in West Asia and North Africa (WANA) Marginal Environments through Sustainable Crop and Livestock Diversification (ACC project)" during the summer season 2013 in three villages namely Village 4, Village 7 and Village 1750 in Sinai Peninsula. This study aimed to do the following: (1) assess the learning impacts of farmer field schools of integrated crop–livestock package and (2) explore the factors that affect the respondents' learning index. Data were collected from the enrolled farmers (96 farmers) using an ex-post facilitator-made knowledge and implementation test during the period from April to October 2013. Mean, mode, standard deviation, range, frequencies, percentages, Learning Index (LI), and Chi-Square were used for data analysis and presentation. The study revealed that the mean scores of each item of the studied package were raised as a reason of respondents' attendance of learning modules of FSSs. With regard to learning index, results showed that the mean scores reached about 38.25 for knowledge (KLI) and decreased to 32.98 for implementation (ILI). The majority of respondents (61.5%) have moderate level of KLI. Similarly around one half of respondents (51%) have also moderate level of ILI. With respect to factors affecting respondents' learning index, the study findings indicated that number of family members, large animal ownership, leadership degree, and tendency to change were significantly related to respondents' KLI, while large animal ownership, belonging degree, leadership degree, and tendency to change were significantly related to respondents' ILI.

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Introduction

On the basis of the strategic, economic and social importance, Sinai Peninsula is considered one of the main development pillars on the national level of Egypt. The ecosystem of Sinai is considered fragile where water resources are slightly poor (saline ground water or mixed water) in addition to the low

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productivity of soils due to the low fertility with high level of salinity. In view of scarcity of water resources and possible negative impact of climatic changes, the utilization of such fragile resources (saline soils and brackish water) in growing salt tolerant fodder crops may contribute to the development of the areas and hence improve the standard of living of local inhabitants, local Bedouins and new settled farmers moved from the Nile Valley (Gehad, 2003).

Livestock production, the main activity of most of local Bedouins in Sinai Peninsula, is one of the main sources of their income; the natural vegetation is the principle feed resource for their animals. Such vegetation cover is seasonally and drastically variable depending on erratic rainfall (30 mm/year in south to 180 mm/year in north Sinai). The yield of this vegetation as animal feed does not cover the annual nutritional requirements; consequently animals suffer from a chronic feed shortage particularly in summer and autumn seasons and during prolonged dry seasons (El Shaer, 2010). Consequently, livestock numbers and their productivity are, certainly, affected significantly where animal products such as meat, cheese, milk are very expensive that has a negative impact on Bedouins health in particular their children (Anon., 2008).

Such crucial problems should find proper solutions otherwise the national program of Sinai Peninsula development will be constrained and, in turn, drastically affect the national income. However, to sustain and bring back agricultural production to acceptable economic levels and support the livelihood and settlement of the Bedouin in Sinai region, agricultural production systems must be adjusted and evolved to fit more with the current impact of climate changes in the region. Therefore, Egypt Government implemented El-Salam Canal mega project in Sinai to create new communities along the Canal and to re-chart Egypt's population map since Sinai Peninsula covers an area around 6% of Egypt's total area and represents a promising and strategic region for economic development (Ministry of Water Resources and Irrigation, 1997).

A large portion of arable terrains in the area would inevitably be flooded with blended water from the Nile River and farming waste water. It is qualified to note that the cultivating group of the proposed venture area in North Sinai (around El Salam Canal) comprises of nearby Bedouins and new settled farmers who moved as of late from Nile Valley Governorates. It is to a great extent made out of conventional little scale ranchers and is confronting numerous difficulties, for example, expanding dry season and saltiness in water, high water table level, poor soils, a long hot summer with high sun based radiation. Upgrading searches generation (grains, oil plants, medicinal plants, fodder crops, etc.) through the utilization of saline water assets and marginal lands has turned out to be a successful path for enhancing farming creation in the region (Anon., 2008, 2012) and will eventually add to the change of the occupation of neighborhood individuals in Sinai Peninsula. Along these lines, the smallholder crop–livestock production system based on ideal usage of salt influenced common assets of the region is exceedingly key for enhancing the business of the neighborhood Bedouins and settled ranchers (Anon., 2008; El Shaer, 2010; Abdou et al., 2011).

It is trusted that development of salt tolerant scavengers utilizing the predominant minor assets has noteworthy social and prudent potential to give enough sustenance and to conquer the issues of urgent scarcity of food. These plants can grow in moderate to a great degree of saline natural surroundings and have specific attributes which empower them to avoid and/or oppose and endure salinity; they likewise can constitute a noteworthy piece of the yearly creature bolstering system since they give a profitable saving of food or fill consistent holes in food supply (Wassif et al., 1997; Awady et al., 2010).

So, an agreement was signed between the International Center for Bio-saline Agriculture (ICBA), Dubai, and the Desert Research Center (DRC), Cairo, to carry out the project titled "Adaptation to Climate Change in West Asia and North Africa (WANA) Marginal Environments through Sustainable Crop and Livestock Diversification (ACC project)"; the project is comprised of various activities to develop and supply integrated sustainable crop–livestock management practices to improve the Bedouins' livelihood and their resiliency to climate changes and increase the income of poor farmers relying on marginal water and soils in Sinai Peninsula.

The achievement of any practical improvement program is to a great extent controlled by the level of participation of farmers (Axinn, 1997). Extension includes the cognizant utilization of communication to help individuals to structure opinions and make sound judgment (Van den Ban and Hawkins, 1996). The FFS is a method to instruct farmers in an informal setting inside they could call their own surroundings. FFSs are "schools without walls" where gatherings of farmers meet routinely with facilitators. They are a participatory technique for learning, innovation advancement, and diffusion (FAO, 2001; Davis and Place, 2003).

The technical recommendations of the Integrated Crop–Livestock Management Package (IMP) were made by the project research team of Desert Research Center within the ACC project activities. The ACC project, as an agricultural research and development project, used Farmer Field Schools (FFS) to engage farmers into problem design, support adult education and farmer experimentation, and allow them to draw their own conclusions. This research aimed to assess the learning impact of such FFSs through achieving the following objectives:

i. Assessing the learning impacts of farmers' field schools of integrated crop–livestock package.
ii. Exploring factors affecting the farmers' learning index.

Review of literature

Approaches of agricultural extension

Agricultural extension has long been seen as a key component for empowering farmers to acquire innovation and technologies that can enhance their livelihoods (Anandajayasekeram et al., 2007). It is desperately looking for the most ideal approaches to bolster farmers regarding information, innovation, counsel, and strengthening (Braun et al., 2006). An all-encompassing way to deal with agricultural extension today goes past innovation exchange for significant yield and animal production systems. It additionally incorporates objectives for human capital improvement, regarding upgrading the administration and specialized abilities of ranch families identifying with generation and postharvest treatment of high-esteem yields, domesticated animals and fisheries, sustainable natural resource management, family well-being and nourishment, and leadership and organizational skills, notwithstanding social capital advancement, that is, arranging producer groups (Swanson, 2008).

Agricultural extension approach is the substance of an agricultural extension system. The approach is the style of activity inside of a system and exemplifies the rationality of the system. It is similar to a regulation for the system, which illuminates, invigorates and aides such parts of the system as its structure, its administration, its program, its assets and its linkages (Anandajayasekeram et al., 2008).

The project approach – i.e. extension activities within the ACC project – undertaking focuses endeavors on a specific area, for a particular time period, regularly with outside resources. Some piece of its motivation is regularly to demonstrate techniques and methods that could be amplified and managed after the undertaking period. It utilizes vast implantations of outside assets for a couple of years to exhibit the capability of innovations. Control is at the local government level and there are frequently significant monetary and specialized inputs from an universal development agency; transient change is the measure of achievement (Anandajayasekeram et al., 2008).

Another exceedingly fruitful augmentation and training methodology worldwide is the Farmer Field Schools (FFS) approach (Braun et al., 2006). This approach is an intuitive and commonsense strategy for training, and empowers farmers to be their own particular experts on significant parts of restricted cultivating systems. Farmers are encouraged to utilize discriminating deduction to lead their own particular research, analyze and test issues, and think of arrangements (Davis et al., 2009).

The FFS approach was started in Indonesia in 1989 because of a noteworthy vermin flare-up brought about by the abuse of pesticides on rice cultivates; a national integrated pest management (IPM) program was started, and this training program happened in farmers' fields and joined farmers' local knowledge of land management with a more exhaustive comprehension of the ecology of rice field environments, it got to be known as the farmer field school program. The field was seen as the instructor and its conditions characterized a large portion of the educational program. The plants shaped the most critical learning materials and genuine problems were observed and investigated from planting completely through utilization, handling and/or deal (Braun and Duveskog, 2008).

From 1991 to 1994, with support from the FAO Intercountry IPM Program, rice IPM-FFSs spread from Indonesia to Bangladesh, Cambodia, China, India, Lao PDR, Philippines, Sri Lanka and Vietnam. During this period, the FFS Program moved from its single-crop focus to incorporate auxiliary or turn crops within the rice-based systems furthermore vegetables in both low and highland systems. When all said is done, FFSs comprise of gatherings of individuals with a typical interest, who get together all the time to concentrate on the "how and why" of a specific subject; they ordinarily meet consistently during a yield or livestock cycle for a half-day of examination and field work. The FFS is especially suited and particularly created for field studies, where hands-on management aptitudes and conceptual understanding (taking into account non-formal adult education training standards) are obliged (Braun and Duveskog, 2008).

Evaluation of training programs

An evaluation is the methodical and target appraisal of a continuous or finished project, program or strategy, its configuration, implementation and results. The point is to focus on the pertinence and satisfaction of goals, advancement efficiency, viability, effect and manageability (OECD, 2002). Evaluation is a basic piece of most instructional configuration models. Evaluation apparatuses and approaches help focus on the adequacy of instructional intercessions. In spite of its significance, proof assessments of training programs are frequently conflicting or missing. Evaluation objectives include numerous reasons at diverse levels. These reasons incorporate assessment of learning, assessment of instructional materials, exchange of preparing, degree of profitability, etc (Eseryel, 2002).

Zinovieff (2008) reported six general types nearer for assessment as tails: (i) Goal-based assessment: that starts because of objectives and tries to figure out whether those objectives were accomplished; (ii) goal-free assessment: that does not try to affirm or deny a pre-decided result or objective. Maybe, it looks to find any advantages that resulted from the intervention; (iii) responsive assessment: that is a methodology taking into account customer prerequisites. This can show one of a kind difficulties for the evaluator, however it is a common methodology; (iv) the systems approach to assessment: that spotlights on whether the intervention was proficient and successful; (v) professional review assessment: that uses outside expert appraisal to assess rather than other ordinarily utilized and acknowledged methods; (vi) the quasi-legal approach: that is rarely honed, yet is utilized a genuine court-of request arrangement to present proof, take testimonials, and assess a mediation or product.

Goal-based approach is transcendently utilized as a part of the assessment of training. Different structures for assessment of training projects have been proposed affected by this approach. A standout among the most ordinarily utilized techniques for assessing training programs is goal-based Kirkpatrick's model (AlYahya and Mat, 2013). The four consecutive levels of assessment were initially proposed by Donald L. Kirkpatrick, Professor Emeritus at the University of Wisconsin. As per his idea, capacity development is acknowledged by the four consecutive steps (Eseryel, 2002): (i) Reaction: to accumulate information on members' responses toward the end of a training program, (ii) Learning: to evaluate whether the learning goals for the project are met, (iii) Behavior: to survey whether work execution changes as a consequence of training, and (iv) Results: to evaluate costs versus advantages of training programs, i.e., organizational impact in terms of reduced costs, improved quality of work, increased quantity of work, etc...

Integrated crop–livestock system

Integrated crop–livestock systems (ICLS) are portrayed as frameworks intended to endeavor synergisms and emergent properties that result from collaborations of the soil–plant–animal–atmosphere compartments in zones that integrate crop and livestock production activities on distinctive spatial-worldly scales, covering the abuse of agricultural crops (cultivating and ranger service) and animal production (e.g., meat, milk) in the same territory simultaneously or consecutively in turn or progression (Moraes et al., 2014).

The expanding pressure on land and the growing demand for livestock products make it more imperative to guarantee the viable utilization of food assets, including crop deposits. An incorporated cultivating system comprises of a scope of asset sparing practices that plan to accomplish worthy benefits and high and maintained production levels, while minimizing the negative impacts of intensive cultivating and protecting the earth. In light of the guideline of upgrading regular natural procedures above and beneath the ground, the ICLS speaks to a triumphant blend that (Rota and Sperandini, 2010): (i) reduces erosion; (ii) expands harvest yields, soil organic movement and supplement reusing; (iii) increases land utilization, enhancing benefits; and (iv) can in this manner help reduce poverty and lack of healthy sustenance and fortify ecological supportability.

The advantages of ICLS include the following: (i) change of the production procedures, incorporating enhancements in the workforce, stability of monetary elements and reducing danger, (ii) greater chances of producers reaching their sociocultural aspirations in an evenhanded way and (iii) more prominent food security to address the needs of purchasers in regard to the quality of the products and production processes (FAO, 2010).

The Integrated Crop–Livestock Package, developed by the ACC project teamwork, includes introducing salt-tolerant fodder crops i.e. Pearl Millet in addition to forage processing i.e. Silage and Feed Blocks. Table 1 presents some details of each item of the package.

Methodology

The study was conducted in three villages namely: Village 4, Village 7 and Village 1750 in Sinai Peninsula. These three villages were purposely selected because they were the adopted villages for the ACC project in order to implement FFS approach. Four FFSs include 96 cultivators (36 direct and 60 indirect beneficiaries) were implemented during the summer season 2013 (Table 2).

Each FFS includes five time-specific learning cycles relevant to the following: (i) Land preparation and planting, (ii) Fertilization and irrigation, (iii) Harvesting, (iv) Silage processing, and (v) Feed Blocks processing. Table 3 summarizes number of recommendations and time of application of each learning cycle.

The study adopted learning and behavior stages of Kirkpatrick's model for evaluating the impact of FFSs (JICA, ND), in order to measure the extent to which participants improve knowledge, and/or increase skills as a result of attending the FFSs. Data were collected from enrolled farmers using an ex-post facilitator-made knowledge and implementation test during the period from April to October 2013. Mean, mode, standard deviation, range, frequencies, percentages, Learning Index (LI), and Chi-Square were used for data analysis and presentation.

Age, number of family members, number of large animals, and number of small animals were measured by direct question for the respondents to identify the number. To measure respondents' belonging degree and satisfaction on extension activities, respondents were asked to indicate their opinion

Table 1 The integrated crop–livestock package. *Source:* Desert Research Center (2013a,b,c).

Technology	Description of the technology
Peal Millet cultivation	Pearl millet is a forage crop that is a warm season annual grass. It is well adapted to growing areas characterized by drought, low soil fertility, and high temperature. It performs well in soils with high salinity or low pH. Optimum planting time should be 15 April to June. Millets are generally grown on less fertile soils, but respond well to heavy fertilization. About 25 kg of seeds is sufficient to planting one feddan (2–3 seeds in the upper third of the line at a distance of 15–20 cm). Fertilizer requirements for feddan seedbed preparation are 15–20 m^3 of organic matter, 200 kg calcium phosphate, 100–150 kg metal sulfur. Then it needs about 20 unit of Nitrogen after each cutting. Pearl millet can be cut using a knife, sickle, or a combine harvester when its height reaches 110–120 cm. Pear millet produces up to five cuts per season. It produces about 40–50 tons of green forage per season
Silage	Forage that has been grown while still green and nutritious can be conserved through a natural 'pickling' process. Lactic acid is produced when the sugars in the forage plants are fermented by bacteria in a sealed container ('silo') with no air. Forage conserved this way is known as 'ensiled forage' or 'silage' and will keep for up to three years without deteriorating. Silage is very palatable to livestock and can be fed at any time. Silage can work in a meter deep hole far away from the ground water level and this place is called silo; 10 cm of hey or firewood in the ground of the silo. To manufacture 1 ton of silage, 20 kg of Urea is dissolved in 40 l of water. And 70 kg of Molasses is dissolved in 70 l of water and then the two solutions are placed into other with well flipping. After cutting the forage crop or farm residuals, placing in the silo in layer thickness of 10–15 cm and then composting well the right amount of molasses and urea solution is then added to that class followed by another layer and so on until the near to height of silo. A layer of hay about 5 cm thick covered the silo and then it is covered with greenhouse plastic. A layer of sand thickness of 20–30 cm is placed above the plastic coverage or layer of bricks to ensure good compressing. The silage will be ready for feeding after two months
Feed Blocks	The use of solid feed blocks offers several advantages: ease of transport, storage and use, and reduced risks compared with other approaches, such as giving a small amount of urea in drinking water, sprinkling of urea solution on fibrous feeds before feeding, or urea-ammonization of crop residues; these advantages, together enhanced productivity in terms of increased milk and meat production and higher reproductive efficiency in ruminant animal. Manufacturing process includes cutting fodder crops and farm residuals using shredder machine, then adding 10 kg wheat flour or bran per 100 kg of the mixture. Molasses is added to the dissolved Urea. The solution is sprayed on the mixture with appropriate quantity without water leak down. The mixture should be compressed using small cooking utensils or molds of a plastic sheet or of thick pipes. Blocks are placed on shady and water imbibing floor (concrete or rice straw or hay) for a week in summer or two weeks in winter, with flipping every 24 h. The blocks could be stored after completely dry up to more than two years

Table 2 Distribution of the study sample by village and farmer field school.

Village	Land holders	Farmers field school	Beneficiaries	
			Direct	Indirect
1750	332	1st	9	15
		2nd	9	14
4	399	3rd	10	17
7	278	4th	8	14
Total	1009	–	36	60

Table 3 Distribution of learning cycles topics by number of recommendation and time of application. *Source:* developed from Desert Research Center (2013a,b,c).

No.	Learning cycle	No. of recommendations	Time of application & data collection
1	Land preparation and Planting	14	Apr.–May
2	Fertilization and irrigation	9	Jun.–Jul.
3	Harvesting	7	Jul.–Oct.
4	Silage processing	17	Aug.–Oct.
5	Feed Blocks processing	12	Aug.–Oct.

on eleven statements developed to measure each variable. Responses to these statements ranged from agree, not identified, and disagree. Scores were assigned to these responses as 2, 1, and 0 respectively. With regard to the degree of leadership, respondents were asked to state their opinion on three statements developed to assess their leadership degree. Respondents' tendency to change was measured through asking them to express their opinions about five sentences related to tendency to change. Responses ranged from implement immediately, wait for others, and does not implement. Scores were assigned as 2, 1, and 0 respectively.

The Learning Index (LI) was measured by the following formula for calculating the learning score (Varghese, 2010; Shanthy and Thiagarajan, 2011; Shanthy et al., 2010).

Learning Index (LI)

$$= \frac{(\text{post training scores "\%"} - \text{pre training scores "\%"})}{(100 - \text{pre training scores "\%"})} \times 100$$

Results

Characteristics of respondents

Results in Table 4 show that the age of respondents ranged between 29 and 60 years. The majority (67.7%) are over 40 years old. More than 55% have more than 7 children. More than half of respondents (52%) hold large animal herds of 8 or more animals while the majority (52.1%) has 4 or less small animals. In terms of the social variables characterizing the respondents the findings showed that the majority (64.5%) have moderate level of community belonging, high degree of leadership (54.2), low degree of satisfaction on extension activities (88.6%), and high level of tendency to change (66.7%).

The learning impact assessment

Knowledge and implementation

Respondents' knowledge and implementation mean scores of each item of crop–livestock package are presented in Table 5. The mean score of the respondents' knowledge about the studied package has increased from 23.41 before the attendance of the FFSs which is 39.68% of the maximum score (59) to 35.76 after the attendance which is 60.6% of the same maximum score. This indicates positive change of farmers' knowledge level by 12.35 mean score (20.9% of the total score). With respect to implementation level, the mean score of respondents' implementation of the studied package before their attendance of FFS was 20.17 (34.19% of the maximum score) which was increased to 31.89 (54.1% of the maximum score) by their attendance of learning modules of FFSs with positive change in respondents' implementation of the package recommendations by 11.72 (19.86% of the maximum score). As displayed in the same table, mean scores of each item of the studied package were raised as a reason of respondents' attendance of learning modules of FSSs.

Farmers' learning index

Results in Table 6 show the frequency and percentage distribution of respondents regarding their Learning Index (LI) of items of the integrated crop–livestock package. With regard to knowledge learning index (KLI), findings reveal that the mean score of Pearl Millet cultivation's KLI reaches 42.84% with 22 score of standard deviation. The majority of respondents (64.6%) have moderate and high KLI (33.4%+) for the same item. Regarding the implementation learning index

Table 4 Distribution of respondents by the studied variables. *Source:* the study's findings.

Variables	Mean	SD	Range		Low		Moderate		High	
			Min.	Max.	No.	%	No.	%	No.	%
Age	42.44	6.82	29	60	31	32.3	54	56.3	11	11.4
No. of family members	6*	–	5	14	43	44.8	42	43.8	11	11.4
Large animal ownership	10*	–	2	19	46	47.9	37	38.5	13	13.5
Small animal ownership	0*	–	0	12	50	52.1	36	37.5	10	10.4
Community belonging degree	12.02	3.78	0	22	10	10.4	62	64.5	24	25.0
Leadership degree	4.46	2.27	3	10	17	17.7	27	28.1	52	54.2
Satisfaction on extension work	3.14	3.31	0	22	85	88.6	11	11.4	0	00.0
Tendency to change	8.1	1.77	0	10	2	2.10	30	31.3	64	66.7

* Mode value.

Table 5 Mean scores of the respondents' knowledge and implementation of crop–livestock package before and after attendance of farmer field schools. *Source:* the study's findings.

Item	Mean score of knowledge		Mean of score implementation		Maximum score
	Before attendance	After attendance	Before attendance	After attendance	
Pearl millet cultivation	15.98	21.10	15.66	20.29	30
Silage processing	5.53	11.79	3.57	9.79	17
Feed Blocks processing	1.89	2.86	0.92	1.86	12
The total package	23.41	35.76	20.17	31.89	59

Table 6 Distribution of respondents by knowledge and implementation learning index. *Source:* the study's findings.

Item	Mean	S.D	Range		Low (0–33.3)%		Moderate (33.4–66.6)%		High (66.7–100)%	
			Min.	Max.	No.	%	No.	%	No.	%
Knowledge learning index										
Pearl millet cultivation	42.84	22.03	6.25	100	34	35.4	47	49	15	15.6
Silage processing	57.23	17.35	26.67	88.89	15	15.6	44	45.8	37	38.5
Feed Blocks processing	9.86	7.89	0.00	27.27	96	100	0	0.00	0	0.00
Total package	38.25	14.49	14.29	69.57	33	34.3	59	61.5	4	4.2
Implementation learning index										
Pearl millet cultivation	38.83	18.41	8.33	80	45	46.9	40	41.7	11	11.5
Silage processing	47.74	14.36	18.75	72.73	16	16.7	70	72.9	10	10.4
Feed Blocks processing	8.86	7.14	0.00	25	96	100	0	0.00	0	0.00
Total package	32.98	10.21	11.54	55.56	47	49	49	51	0	0.00

(ILI) of Pearl Millet cultivation, the mean ILI was 38.82% with standard deviation of 18.41. The majority of respondents (53.2%) have moderate and high ILI (33.3% +).

Considering Silage processing recommendations, the mean score was decreased from 57.23% for KLI to 47.74% for ILI with standard deviation of 17.35 and 14.36 respectively. The majority of respondents (84.3%) have more than 33.3% of KLI; this percentage was increased for ILI to reach about 83.3% of them. Also the mean scores of KLI and ILI concerning Feed Blocks processing were decreased from 9.86% to 8.86% with standard deviation of 7.89 and 7.14 respectively. All of respondents have low level of learning index for both knowledge and implementation of Feed Blocks recommendations.

With regard to the total score of the studied package, the mean scores reached about 38.25 for KLI and decreased to 32.98 for ILI, with standard deviation of 14.49 and 10.21 respectively. Considerable proportion of the respondents (61.55) has moderate level of KLI. On the other hand more than one third (34.3%) of respondents have low level of KLI and the remaining 4.2% had high level of KLI. Referring to ILI, the majority of respondents (51%) have also moderate level of total package ILI, and the remaining 49% were located in low level while no one has high level of ILI.

Variables affecting farmers' learning index

In order to determine factors affecting respondents' knowledge and implementation learning index, Chi-Square test was used as shown in Table 7. Findings in Table 7 show that respondents' KLI of Pearl Millet cultivation was significantly related to the number of family members (Chi-Square = 11.95) and large animal ownership (Chi-Square = 10.62). Results also show that respondents' KLI concerning Silage processing was significantly related to large animal ownership

Table 7 Chi-Square values of the studied independent variables with knowledge and implementation learning index for the studied crop–livestock package. *Source:* the study's findings.

Studies variables	Knowledge learning index (KLI)				Implementation learning index (ILI)			
	Pearl millet	Silage	Feed Blocks	Total package	Pearl millet	Silage	Feed Blocks	Total package
Age	7.888	5.848	4.109	5.145	3.579	4.436	3.078	5.692
No. of family members	11.950*	3.782	5.107	6.894	4.543	2.873	5.493	4.732
Large animal ownership	10.624*	12.750*	12.533*	16.130**	6.995	11.495*	14.325**	9.238*
Small animal ownership	2.290	6.314	4.272	5.925	2.090	6.134	5.210	5.079
Belonging degree	4.520	1.735	3.432	1.671	11.817**	1.418	3.459	2.789
Leadership degree	6.415	7.927	11.648*	10.419*	5.014	76.31	12.328*	10.425*
Satisfaction on extension work	7.246	3.656	2.874	5.432	6.291	3.396	3.190	5.046
Tendency to change	4.482	15.588**	4.461	8.792	4.136	13.296**	5.656	5.256

* Significant at 0.05 level.
** Significant at 0.01 level.

(Chi-Square = 12.75) at 0.05 level of probability. Findings also show that large animal ownership and leadership degree affect respondents' KLI concerning Feed Blocks processing at 0.05 level of probability. Regarding the factors affecting the respondents' KLI regarding the total crop–livestock package, results show that there were statistically significant relationships with large animal ownership and leadership degree with Chi-Square values of 16.13 and 10.42 at 0.01 and 0.05 levels of probability respectively.

With regard to factors affecting respondents' ILI, results show that there are seven variables related to the studied items of ILI. There were significant relationships between large animal ownership and respondents' ILI concerning Silage processing (Chi-Square = 11.49), Feed Blocks processing (Chi-Square = 14.32), and the total studied package (Chi-Square = 9.24). Respondents' community belonging degree affects their ILI concerning Pearl Millet cultivation (Chi-Square = 11.82) at 0.01 level of probability. The respondents' leadership degree was significantly related to their ILI concerning Feed Blocks processing (Chi-Square = 12.33), and the total studied package (Chi-Square = 10.42). Finally, respondents' ILI concerning Silage processing was significantly affected by their tendency to change (Chi-Square = 13.29) at 0.01 level of probability

Conclusion

According to the revealed results, it could be noticed the project approach of extension can help in overcoming the shrinking of public extension approach. Participatory extension efforts such as farmer field schools are more likely to help small farmer. The overall mean scores of farmers' learning are positively changed by their attendance of FFS which indicate the learning impact of such participatory extension efforts.

It appears that the majority of respondents are located in the moderate category of learning index (33.34–66.66%) which indicated how much effective the FFS was as an adult education method. So, public extension could implement such method to gain its advantages especially in important and strategic new entered crops or innovations. This study highlighted the factors affecting farmers' learning index, number of family members, large animal ownership, leadership degree, and tendency to change, and belonging to community should be considered in the application of the participatory extension efforts.

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