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A Model of an Agricultural Knowledge and Information System for Peasant Smallholdings: The case of Sistan and Baluchistan Province, Iran

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Abstract

The agricultural knowledge and information system (AKIS) is a necessary factor for social, economic, and agricultural development and decision-making in peasant smallholdings. Given the challenges in smallholders' access, the present study aimed to design an efficient model for AKIS for peasant smallholdings in Sistan and Baluchistan Province, Iran. The research adopted a descriptive methodology in which data were collected with a questionnaire whose validity was estimated by AVE and its reliability was determined by the CR method. The statistical population was composed of all experts and executives in the fields of agricultural research, education, and extension and the subject experts in the studied province (N=497). The sample size was determined to be 217 using Cochran's formula. The data were analyzed by SEM and using PLS and SPSS software packages. The results as to the factor loadings of the subcomponents derived from structural equation modeling show that "increasing information sources", "farm visits", "strengthening service centers", "less consistency of research findings", and "the existence of agricultural service centers" had the highest factor loadings, so they have a significant effect on the knowledge and information system model for peasant smallholdings.

Keywords:
Agricultural knowledge and information system, farm visits, peasant smallholdings, Sistan and Baluchistan Province

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INTRODUCTION

The agricultural knowledge and information system (AKIS) emphasizes social and human capital and promotes innovation by facilitating links among researchers, extension agents, and farmers. Agricultural knowledge and information are vital tools for improving the livelihood of smallholders (Mayer, 2000; Karamagi Akiiki, 2006). The present trend of agricultural development highly depends on the flow of knowledge and information among users and technologists (Verschoor, 2005). This instrument remarkably contributes to enhancing productivity, facilitating sustainability, and empowering human resources in the agricultural sector and is considered a critical resource for farmers besides land, labor, capital, and skill (Cukurl, 2013). The agricultural knowledge and innovation system is known to be highly potent for empowering economic performance and agricultural sustainability (Hermans et al., 2019). AKIS has seven key functions – consulting, knowledge development, network formation and knowledge diffusion, entrepreneurial activities, market formation, resource mobilization, establishment of legitimacy, and encounter with resistance to change (Rivera et al., 2005). The Ministry of Agriculture and Land Reclamation in Egypt (2018) defines that the three main domains of knowledge and information system include research, education (Agricultural Research Center, universities, and agricultural technical and vocational schools), and extension (Agricultural Extension Service Headquarters and the local affiliates, private sector, cooperatives, non-governmental organizations, businessmen, and economic and enterprises, farmers, agriculture firms, traders, and other contributors in the agricultural value chain), which perform the production, supply, storage, and retrieval of agricultural knowledge and information within a system known as agricultural knowledge and information system (AKIS). In the information and knowledge system applied to smallholders, traditional channels are used to a greater extent than modern channels and new communication technologies. It should be noted that farmers differ in how they access information largely depending on their conditions and abilities in collecting information, or more precisely, depending on their information-seeking behavior (Cukurl, 2013). Agricultural information should be delivered in a sound way to respond to the needs of farmers and markets, improve livelihood system, work conditions, and the lives of farmers, and transfer the latest information and knowledge on agriculture through different channels and resources, but this process requires revising information functions, as well as information-seeking behaviors and their underpinning factors among farmers (Ugwoke, 2013). The extension and research system is a key component of AKIS, so it should be supported by policy programs, agricultural knowledge and information are regarded as essential requirements of farmers (Ramos et al., 2016).

The knowledge gap between researchers and farmers in the technology research and transfer process and the researchers' ignorance of the potential capability and knowledge of technology receivers are the main reasons for the failure in technology transfer and development so that even access to the right information at the right time and through valid sources can result in the success or failure of agricultural activities (Ofuoku, 2012; Zahran et al., 2020).

Ashrafi et al. (2010) enumerate the characteristics of a peasant farming system as the wastage of resources, human resources, and inputs in small farming units along with a multiplicity of land parcels compared to large farming units. Farmers are mostly illiterate or poorly literate and do not enjoy modern knowledge and technology. Their production method is generally traditional, habitual, and experiential and is not usually based on a coherent annual plan and budget. They rarely innovate, do not use basic resources optimally, and cause water and soil pollution and degradation due to not caring for improved

agronomic methods and the ignorance of or inattention to the conservation of water and soil resources. Although these units have a relatively high land economic return, their productivity of production factors is in total at a low level (Herrero et al., 2010). Two outstanding features of peasant smallholding systems are farmers' illiteracy or low literacy and their deprivation of modern technology and knowledge. Farmers in this system often have no good access to agricultural information and knowledge about crop production, post-harvest, and processing, as well as markets and opportunities, they usually lack business cooperation, collective action, storage and transportation facilities, market information, and capital for investment, and they are weak in the market (Mukhwana et al., 2005).

In addition to these facts, agriculture productivity is declining in Sistan and Baluchistan province, markets and emerging market opportunities are still out of the farmers' access, and the agricultural sector of the province is facing unprecedented challenges (Agricultural Jihad Organization, 2019). In 2018, this province accounted for only about 2 percent of the total added value of the agricultural sector of Iran including crop farming, animal farming, and forestry (Ramazankhah et al., 2016). Given the growing demand for crops, the need for more efficient use of the scarce resources in this province is an undeniable fact. In addition to supplying the demand of society as the main goal, the optimal use of agricultural resources can increase the income of farmers for whom agricultural activity is a lifestyle in addition to economic activity. The challenges of the agricultural sector in this province include, but not limited to, farmers' poor access to information sources, the low rate of rainfall in the province and the deficiency of water resources, the lack of grounds for extensive cooperation and public investment in agricultural production activities, and the lack of proper agricultural marketing establishments resulting in the involvement of brokers and middlemen in crop markets (Anonymous, 2017).

The data show that for every 708 agricultural operators in the province, only one extension staff is engaged in services. There are 37 centers of Agricultural Jihad Organization in this province, while according to the extension divisions, there are 138 production areas and the responsibility of each production area is with only one expert. In addition, extension activities heavily depend on government funding. The shortage of manpower-themed products, the lack of agricultural jihad centers in areas prone to agricultural activities, old age and low level of agricultural exploitation, the use of extension factors in non-extension (executive) activities, and low motivational factors for educational, extension and research forces are among the problems and challenges of the province's agricultural knowledge and information system (Agricultural Statistics of Sistan and Baluchistan Province, 2014).

In most parts of Iran, e.g., Sistan and Baluchistan Province, AKIS is suffering from a shortage of facilities and human resources and a multiplicity of smallholders, which causes a lack of coherence and good access for farmers. So, this research was conducted to design a proper AKIS model for smallholdings. A review of the literature shows that some research has addressed the actors, components, and elements of information and knowledge systems. Some others have discussed the relations and interactions of elements and actors, and yet some have focused on procedures and methods used to provide consultation services for each farming system (Table 1).

METHODOLOGY

The research adopted a descriptive method. Data were collected with a questionnaire whose validity was determined by average variance extracted (AVE) and its reliability was estimated by the composite reliability (CR) method. The statistical population was composed of all experts and managers in the

Table 1

The Results of Previous Studies on the Enablers and Key Factors of Agricultural Knowledge and Information System (AKIS)

AKIS enablers and key factors	References
Pluralist extension system, research centers, private companies, Agricultural Service Center, cooperatives, educational and extension programs	Izadi and Yaghoubi Farani (2017)
Information and communication sources and channels, interpersonal information resources, family members and local officials; multimedia information sources, television and radio programs; educational electronic media, movies, and CDs; and printed information resources, scientific books, newsletters, and research reports of organizations, access to information and communication resources and channels, level of communication skills, level of information needs, level of trust in sources and Information and communication channels	Dinpanah and Amoei (2012), Feli Nahavand et al. (2016), Khanmohammadi & Rezaei (2018), Goli et al. (2013)
Technical knowledge of extension agents, human factors, gaining farmers' trust and participation, the spirit of participation and teamwork, free supply of agricultural services and combining indigenous knowledge with modern agricultural knowledge, education, farming experience, agricultural work experience, technical knowledge, research and extension relationship	Dinpanah and Amoei (2012), Salmanvandi and Ebrahimpour (2013), Adib and Rousta (2012), Norouzi and Malekmohammadi (2018)
Farmers' localcommunication channels, real needs, information sources, written sources, farmers' own communication channel, investment in agricultural research, agricultural education and extension, information sources, access to information, newspapers, and then magazines and radio	Zahran et al. (2020), Khatoon Abadi (2011), Khaksar Astaneh and Karbasi (2005), Haque et al. (2016), Pounds (1985), Kumar et al. (2014)
Extension classes, access to information, farmers' age, farmers' experience, local institutions, information satisfaction and information appropriateness, information satisfaction, information seeking behavior, access to information, agricultural information and knowledge, consulting, educational, and extension	Asadi et al. (2009), Moghadas Farimaniet al. (2008)
Extent of informal relationship among agricultural information subsystems, extent of relationship of agricultural information with other information systems, extent of the control of agricultural system over the environment	Ahmadvand and Karami (2007)
Organizing and strengthening agricultural research, agricultural knowledge and information, communication of agricultural research and extension, communication links with research, insufficient number of subject specialists, participation of senior researchers in in-service training of extension staff, extension organization, research and extension staff	Sharifzadeh et al. (2008), Norouzi and Malekmohammadi (2018)
Agricultural research, state-run research institutes and centers, research infrastructure, agricultural knowledge and information system, information network among researchers, extension agents, and farmers, lack of joint planning between research and extension, willingness to participate in teamwork between researchers and extension agents, communication mechanisms between research and extension	Ranaei et al. (2018), Alipour et al. (2006)
Participation in production organizations, improving the educational level of extension staff for better interaction with researchers and creating more coordination between researchers and extension agents, farmers, non-interference of extension in demand, production, transfer, and application of technologies, the level of participation of extension staff in collaborative activities with farmers, the extent of employees' tendency to cooperate with researchers, positive tendencies of extension staff towards partnership with researchers, participation of extension experts	Falsafi and Hosseini (2018),Mohammadzadeh and Sedighi (2002),Hosseini and Eskandari (2008)
Confident farmers, knowledge farmers, knowledge-buying farmers, experienced farmers; group farmers, educated farmers, innovation, market orientation, learning, research and extension services	Jostein and Egil (2017), Ramos-Sandoval (2017)
Farmers'union (GAPs), main sources of agricultural information, pesticide/fertilizer agencies, poor internet facilities, poor searching and computer skills	Abdolrahman et al. (2016), Vera et al. (2015)
Relationships between farmers and extension agents, extension agents, lack of access to serious technologies	Sani et al. (2015)
Agricultural innovation and knowledge systems, NGOs and access to credit, use of mobile phones	Abebe et al. (2013)
Government extension, NGOs, agricultural companies, the main source of information for smallholders, mainly local factors including neighbors, family members, markets, and farmers' social organizations, traders and input retailers, foreign workers,and research institutes	Karbo and Bruce (1997), Ramirez (1997)

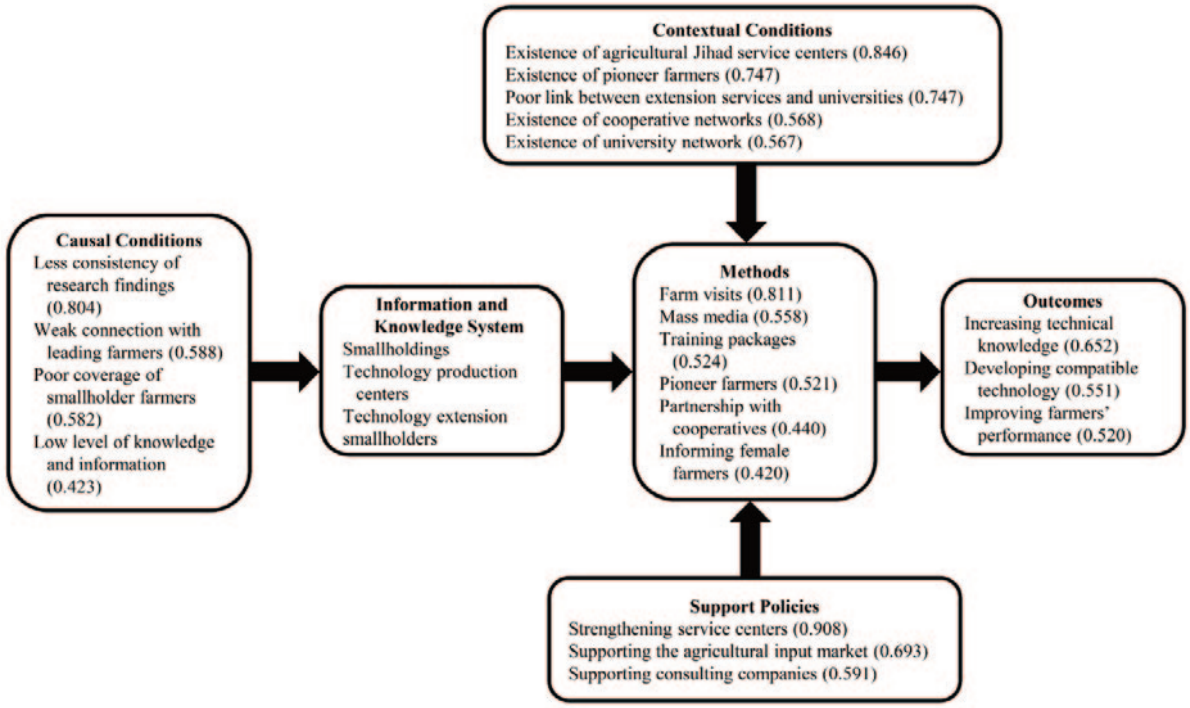

Figure 1. The Conceptual Model of the Knowledge And Information System for Smallholdings In Sistan and Baluchistan Province

fields of agricultural research, education, and extension, as well as the relevant experts in Sistan and Baluchistan province. The sample size was determined by Cochran's formula to be 217 and the sampling method was simple randomization. Data were analyzed by the structural equation method using the PLS and SPSS software packages. The proposed model was validated by confirmatory factor analysis (CFA) within the framework of SEM. The face and construct validity of the questionnaire was determined by the convergent validity method used in the framework of CFA. The construct validity was calculated by AVE for which the values of >0.5 have been reported by different researchers to be appropriate. The construct validity index, or AVE, had values greater than 0.5, reflecting the suitable validity of the studied constructs, a self-design structure questionnaire was employed as the primary data collection instrument. The fit index was used to check the final fit of the model. The goodness-of-fit (GOF) can be estimated by calculating the geometric average of communality and R^2 as follows:

$$GOF = \sqrt{average(communalities) \times R^2}$$

RESULTS AND DISCUSSION

The participants were, on average, 40.46 years old, with the oldest and youngest being 65 and 24, respectively. Most respondents were male. The highest frequency of educational level was related to a "bachelor's degree" reported by 104 participants (47.9%) and the lowest was related to a "Ph.D." as 38 participants (17.5%). Among the educational majors, the highest frequency was for "agronomy" 151 (69.6%) and the lowest was for the "technical-engineering" majors (5.5%) (Table 2).

The components studied in the research included causal conditions, smallholding AKIS extension methods, smallholding AKIS support policies, smallholding AKIS contextual conditions, smallholding AKIS outcomes, and smallholding AKIS, these factors were extracted using theoretical studies. Figures 2

Table 2

The Statistical Distribution of Demographic And Professional Characteristics of The Respondents (n = 217)

Characteristics	Category	Frequency	Percentage	Cumulative percentage
Age (years) Mean = 40.46	20-30	41	18.9	18.9
	31-40	55	25.3	44.2
	41-50	85	39.2	83.4
	51-60	36	16.6	100
Gendern	Male	171	78.8	Mode = male
	Female	46	21.2	
Educational level Mode = B.Sc.	B.Sc.	104	47.9	47.9
	M.Sc.	75	34.6	82.5
	Ph.D.	38	17.5	100
Majorn Mode = human science	Agronomy	151	69.6	-
	Basic science	23	10.6	-
	Human science	26	12	-
	Technical-engineering	12	5.5	-
	Others	5	2.3	-
Organizational positionn Mode = expert	Expert	143	65.9	-
	Expert-in-charge	23	10.6	-
	Manager	21	9.7	-
	Faculty member	30	13.8	-
Job experience (years) Mean = 15.9	1-5	12	5.5	5.5
	6-10	40	18.4	24.0
	11-15	70	32.3	56.2
	16-20	35	16.1	72.4
	21-25	37	17.1	89.4
	26-30	23	10.6	100

and 3 display the initial measurement models of the research that were drawn in the Pls environment and include all latent variables of the research and the reflective measurement model in two modes of the estimation of standard coefficients and coefficient significance. The confirmed components are smallholding AKIS extension methods with a factor loading of 0.541, smallholding AKIS support policies with a factor loading of 0.705, smallholding AKIS contextual conditions with a factor loading of 0.585, causal conditions and mechanisms of smallholding AKIS with a factor loading of 0.587, smallholding AKIS outcomes with a factor loading of 0.457, and finally, smallholding AKIS with a factor loading of 0.606 (Figure 2).

The result as the support policies is consistent with Salmanvandi and Ebrahimpour (2013), Falsafi and Hosseini (2018), and Rees et al. (2000). Similarly, Byerlee et al. (2006) and Govindaraju (2010) emphasized the need for supporting AKIS centers. Sharifzadeh et al. (2014) assert the potential of smallholding AKIS and investment in this system, which agrees with our findings. Roling and Engel (1991), Asadi et al. (2009) and Shabanali Fami et al. (2012) collaborate our results as to the support policies. Our finding regarding the contextual conditions is consistent with the reports of Gholami et al. (2018), Inanlou et al. (2018), Zali (2016) and Bahraini and Shadnam (2007). Also, numerous research studies have already emphasized our results for the causal conditions (e.g., Enayatirad et al., 2010; Yaron, 1992; Dahama & Bhatnagar, 1997; Qgunwale & Laogun, 1998; Singh & Sahay, 1995; Tollefson, 1995; Rezvanfar &

Zare, 2008; Mohammadzadeh et al., 2015; Sabor et al., 2011; Malek Mohamadi, 2004; Fami et al., 2008; Aghasizadeh, 2003; Hoseyni & Sharifzadeh, 2006).

The reason for the greater effectiveness of protectionist policies in this study is probably due to the lack of necessary support in recent years for small farmers. Also, smallholders seem to expect more support. Also, due to the lack of a powerful information and transmission network, the background conditions have been effective. Due to the fragmentation and dispersion of micro-peasant farmers' lands and the incompatibility of the promotion system and the methods used, the component of information transfer methods has also been effective.

The reliability of each item reflects the amount of factor loading of each observed variable and is used to show the extent to which the measurement indices (the observed variables) are acceptable for the measurement of the latent variables. Its minimum acceptable value is 0.3, and factor loadings of 0.4 indicate a moderate level of significance. In CFAs, factor loadings of >0.5 reflect a strong significance level and a close correlation between the observed variables and the target factor. Table 3 presents the factor loadings of each independent variable.

SEM (partial least squares) was used to study the effect of independent and dependent variables and confirm the whole research model (Table 4).

The first hypothesis claims that contextual factors are influential on smallholding AKIS. The statistical analysis (Figures 2 and 3) shows that the path coefficient between these two variables is 0.517. Since the significance value between the two variables is 5.106, which is greater than 1.96, the first hypothesis is supported. The results as to the other hypotheses are presented in Table 5.

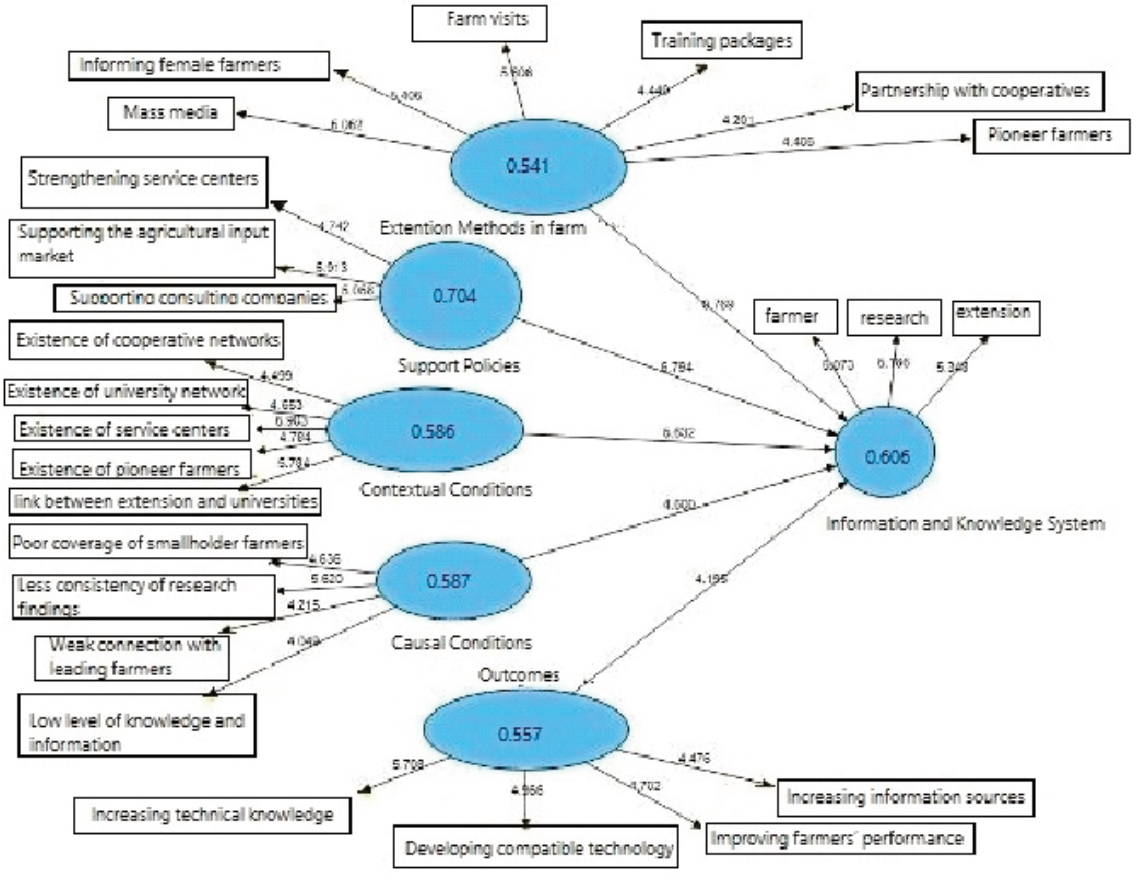

Figure 2. The Measurement of the Final Model and the Results As to the Hypotheses in the Standard Mode

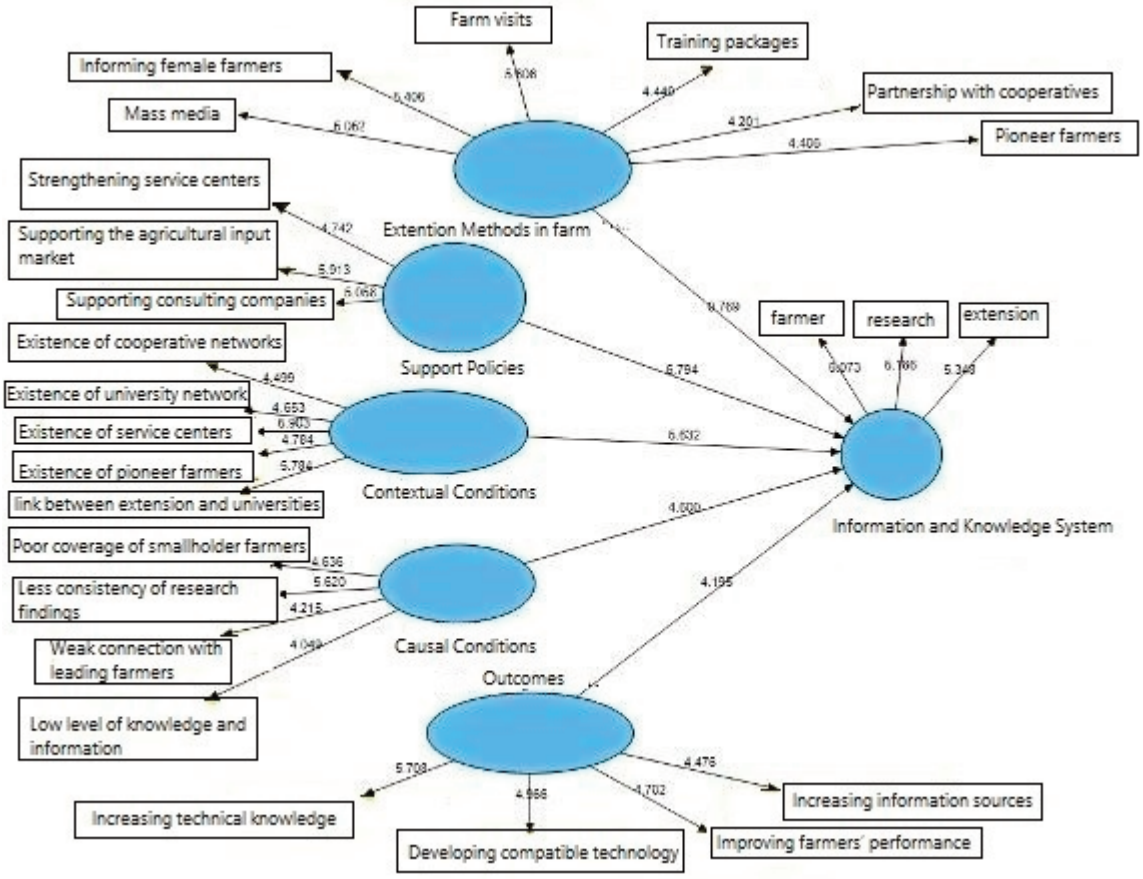

Figure 3. The Measurement of the Final Model and the Results As to The Hypotheses in the Significant Mode

Table 3

The Factor Loadings of the Modified Subcomponents of the Agricultural Knowledge and Information System for Peasant Smallholdings

Factors	Observed variables	Factor loadings
Contextual conditions	Existence of agricultural Jihad service centers	0.846
	Existence of pioneer farmers	0.747
	Poor link between extension services and universities	0.747
	Existence of cooperative networks	0.568
	Existence of university network	0.567
Causal conditions	Less consistency of research findings	0.804
	Weak connection with leading farmers	0.588
	Poor coverage of smallholder farmers	0.582
	Low level of knowledge and information	0.423
Intervening conditions	Strengthening service centers	0.908
	Supporting the agricultural input market	0.693
	Supporting consulting companies	0.591
Extension variables	Farm visits	0.811
	Mass media	0.558
	Training packages	0.524
	Pioneer farmers	0.521
	Partnership with cooperatives	0.440
	Informing female farmers	0.420
Outcome variables	Increasing information resources	0.815
	Increasing technical knowledge	0.652
	Developing compatible technology	0.551
	Improving farmers' performance	0.520

Table 4
The General Criteria of the Model's Quality

Research components	Composite reliability	R^2	Composite reliability	Cronbach's alpha	Communality	AVE	Communality indexQ^2 = 1-SSE/SSO
Smallholding AKIS	0.774	0.438	0.802	1.000	1.000	1.000	0.288
Smallholding AKIS extension methods	0.851	0.375	0.931	0.758	0.742	0.823	0.437
Smallholding AKIS support policies	0.855	0.643	0.903	0.829	0.854	0.805	0.166
Smallholding AKIS contextual conditions	0.924	0.584	0.851	0.910	0.951	0.782	0.331
Smallholding AKIS outcomes	0.795	0.491	0.911	0.822	0.789	0.841	0.167
Causal conditions	0.857	0.524	0.912	0.726	0.874	0.766	0.178

Table 5
A Summary of the Results of Hypotheses Testing

Hypothesis	Pathcoefficient	*p*-value	Result
Contextual factors influence smallholding agricultural knowledge and information system.	0.571	5.106	Confirmed
Causal factors influence smallholding agricultural knowledge and information system.	0.524	4.658	Confirmed
Extension factors influence smallholding agricultural knowledge and information system.	0.344	6.021	Confirmed
Support factors influence smallholding agricultural knowledge and information system.	0.440	4.365	Confirmed
Outcome factors influence smallholding agricultural knowledge and information system.	0.521	4.751	Confirmed

Overall, the contextual conditions, outcome conditions, methods, intervening policies, and causal conditions accounted for 43.8 percent of the variance in AKIS. The remaining 56.2 percent was related to the effect of other factors. Among the subcomponents in each category, smallholding AKIS is most strongly affected by the existence of agricultural Jihad service centers with a factor loading of 0.864 among the subcomponents of the contextual conditions, less consistency of research findings with a factor loading of 0.804 among the causal subcomponents, strengthening service centers with a factor loading of 0.908 among the support subcomponents (intervening conditions), farm visits with a factor loading of 0.811 among the subcomponents of the extension methods, and increasing information resources with a factor loading of 0.815 among the outcome subcomponents. Connection and cooperation with production foundations and interaction with pioneer and experienced farmers are also influential on smallholding AKIS.

CONCLUSIONS

To develop a model of AKIS for smallholdings, the constructs affecting this system were identified by a qualitative approach. The research objective was achieved by using field data analysis and least squares methods as the main approach of SEM. The final model developed in this research is composed of six primary components including smallholding

AKIS, contextual conditions of AKIS, AKIS methods, causal conditions, AKIS reasons and applications, the outcomes of AKIS adoption, and support conditions and policies. This model has 25 subcomponents – five for contextual conditions, three for the AKIS component, six for AKIS methods, four for AKIS outcomes, four for AKIS reasons and applications, and three for AKIS support policies. The factor loadings of the variables are presented in the final model.

In conclusion, it can be asserted that the model presented in this research for smallholding AKIS was developed by organizing the results of previous studies in the context of the presented conceptual framework and it was tested by data collected by a quantitative field study from experts and managers in the specialized, research, education, and extension fields. This model is compatible with the conditions and attributes of AKIS for smallholdings and can be used to inform policymakers and officials for the development of agricultural systems. It can also act as a framework to guide agricultural extension, education, and research agents in managing macro plans of agricultural knowledge and information development in smallholdings. The framework can contribute to stimulating innovation and increasing coordination among national and regional players.

Smallholders need specific educational, information, and marketing needs in light of their socioeconomic conditions. The agencies that are responsible for generating and distributing information required by smallholders should consider their real needs. When designing and implementing plans for information dissemination among smallholders, it should be remembered that these plans should be based on smallholders' real needs besides attention to comprehensiveness and all different dimensions.

- The field and establishment of agricultural jihad service centers should be done in such a way that it is available to small peasant farmers and systematic support to small peasant farmers in order to reach the information resources they need should be done in such a way that agricultural service centers and agricultural jihad staff play a more prominent role.

- It is recommended to use the capacities and capabilities of extension, research, and cooperative institutions and the development of extension and phytosanitary consulting companies with the priority of agricultural graduates and handing over some functions of agricultural research to them.

- Supportive policies include the adoption of appropriate policies in the field of agricultural insurance, low-interest bank facilities, guaranteed purchase of agricultural products, and contract agriculture.

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