Small-scale and family farmers’ collective action in managing natural resources in Oman

The Aflaj System - Current performance and potentials for improvement
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Family farming is the predominant form of agriculture in developed and developing countries. There are over 500 million family farmers in the world, ranging from smallholders to medium-scale farmers. Family farmers are considered to be the means and the accelerators to achieve the Sustainable Development Goals. Consistently with the global agenda, the Government of Oman, with the assistance of the Food and Agriculture Organization of the United Nations (FAO), developed the “Sustainable Agriculture and Rural Development Strategy towards 2040”. The strategy emphasized the need to promote the establishment of producer organizations as a way to professionalize the agriculture sector and overcome the barriers facing small-scale and family farmers. This study documents the unique experience of Aflaj collective institutions in managing land and water among small-scale farms. Omani agriculture is characterized by 89 percent of small family farmers (farm size less than 5 acres or feddans) controlling 25 percent of the land. As of the latest agricultural census, farming in Oman is mainly a secondary activity, given the small farm size; in fact, only 1.16 percent of farmers in Oman are full-time farmers. Thirty-eight percent of groundwater in Oman is used via Falaj systems and around 3,000 Aflaj are active in the country; most of them have existed for thousands of years. The central assumption of this research is based on the idea that the performance of a Falaj relies on the social capital created within and among the organizational structures existing in the rural communities of the system. The more the rural communities have built-in social capital, the more effective is the Falaj system.

This research analyses the three dimensions of social capital as well as linkages with the organizational development of farmers’ collective action and the ways these can influence modernization of the Aflaj systems. The modernization is analysed in terms of dynamic conservation of the irrigation infrastructure, preservation of local production, conservation of local seeds and plants, environmentally sustainable use and management of natural resources, involvement in landscaping or recreation activities, increase in investment (capital and/or labour) and engagement in joint marketing or farming activities, organization of farmers in associations or informal groups, and potential for land consolidation.

Quantitative and qualitative data were collected to assess the potential of four selected Aflaj to achieve food security and ensure sustainability. A focus group discussion was organized with Falaj managers, who provided their insights on the relevance of this work in mid-October 2020. The questionnaires as well as the objectives of the study were thoroughly discussed with them. Data collection was carried out during October and November 2020 through face-to-face surveys administered by the Falaj managers or members of the farming community. It was undertaken in four sites: Misfaat Al Abryeen, Tanuf, Al-Ghantaq and Samael. Eighty questionnaires were collected.

The sampling is based on a purposive sample aiming to explore aspects of modernization of the selected Aflaj. It was predominantly guided by feasibility and possibility of data collection and personal judgement on the selection of the sites, given the confinement and numerous restrictions imposed by the government in light of the COVID-19 pandemic.

The data have been analysed using descriptive statistics and paired correlations to find relationships between variables. In a second step, predictive models explaining existing collaboration and willingness to cooperate in the future have been undertaken using regression analysis.

The study examines the ability of people who possess small farms within one Falaj to help in the modernization of the existing system and to collaborate internally, with local and central government, and with any groups or associations in the village or in the surrounding areas. It appears from the results that farm size is a positive incentive for cooperation, along with income. The larger the farm size, the higher the willingness to cooperate. The higher the income, the easier is the cooperation. This could be explained by the fact that relatively “wealthier” households are willing to take more risks to explore cooperation with other households. Households who have
relatively larger farms, and sell part of their production are more interested in cooperation than farmers who own very small farms and do not generate any cash revenue from them.

Farmers have shown a high level of trust (80 percent) in the local water institutions. This institutional trust is an indicator of the transparency of water management structures, the soundness of effective supervision of irrigation water, and fairness in the use and distribution of water resources. Falaj water distribution is governed by clear and well-established water property rights and water disputes are often resolved within the community. Most farmers (64 percent) believe there is a need for transformation of the legal status of the Falaj, specifically in relation to distribution of the water turns. The current system, based on time-sharing, is very complex, with its water turns and irrigation at night (24 hours/7 days). The absence of control of the main water flow or of storage capacity makes it necessary to undertake irrigation in the middle of the night for half of the farmers.

From a human capital perspective, the results were very encouraging, and the majority of farmers answered positively to the questions related to collective action, except for the question about willingness to consolidate land. This result is not surprising, for cultural reasons. In fact, the cultural perception is that sharing land means abandoning precious family heritage. The absence of a cadastre for agricultural land is also not conducive to land rental or consolidation for common management. The results about social trust are highly encouraging as well. The percentages of positive answers to questions related to institutional and social trust are in general much higher than negative answers, which would indicate distrust. As far as questions related to social networking, the corresponding findings are different. Farmers are more active in youth groups and social networking groups that use WhatsApp in than any other form of association or social group. The social networking is used for selling the agricultural products produced in the Aflaj. The majority of farmers are aware of both positive and negative changes to life in the Aflaj in recent years.

Consistent predictive models were built, classifying farmers into two groups: those who are effectively participating or willing to participate in any collective action within and between communities and those who are not. All the predicted variables selected are in the category of type 0/1, (Yes/No) and they are mainly related to human capital, indicating the capability or willingness of farmers to work collectively or to share machinery and tools. For this reason, logistic regression is the appropriate approach in this context. The models helped to examine how the probability of cooperating or being willing to cooperate is related to observed aspects of social capital, organizational structure, and other characteristics of the Falaj. Four models were developed that helped classify the farmers into groups, with respect to: effectively helping other farmers; willingness to consolidate land with neighbours; willingness to share machinery and tools; and willingness to create an Aflaj Association. The predictors were mainly observed characteristics about social capital, land and production assets, investment in capital and labour, and other aspects related to the organizational structure of the Aflaj. Given the small sample size available, only a few variables were significant in the models. For other variables that were not considered, we studied their associations with the predictive variables related to collective action and analysed their impact on farmers’ decisions related to collective actions. In general, paired correlations showed a high positive linkage between variables related to collective action and those related to social capital. The higher the levels of social trust, institutional trust and social networks, the more inclined farmers are to enter into a collective form of organization. Our models could be more powerful with more sampled observations and they could include more variables related to social capital.

Cooperation is already observed in Falaj communities. Some families are maintaining the common property of land and avoiding division to conserve the farm size. More effort should be deployed to encourage delegating management to one family member who would be able to make the necessary decisions to improve management and cooperation with the farming community.

Aflaj households have shown that they are actively cooperating on labour force usage through the recruitment of expatriate workers shared among two or more farmers. The modernization of Aflaj management can include

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1 Predicted variables are related to questions F1, F4, and F7 of Part F (Collective Action) and question K2 of Part K (Legal Framework). See the questionnaire in Annex 1.
the introduction and sharing of small machinery; this would reduce dependence on expatriate labour, which is seen as an obstacle by a majority of farmers, as well as reducing costs. This recommendation stems from the fact that sharing machinery is easier than sharing permanent expatriate workers, as shown by the higher rate of willingness to cooperate on machinery-sharing. The use of small machinery is observed at international level in rice field terraces in China as well as in small Japanese farms. Transferring this sort of technology will likely increase productivity, cut costs, reduce dependency on expatriate workers and favour the dynamic conservation of Aflaj.

The observed levels of trust within the communities are very high. The levels of trust are declining, however, especially among younger generations towards neighbours and community members. One important way to improve and sustain the levels of trust is to move towards formal contracts for cooperation among members of the communities. Some examples are contracts for land-sharing, for common management of farms and for sharing labour costs.

Engagement in joint marketing of crops and other farming activities has been successful in the Aflaj. Almost all farmers producing for the market showed their willingness to engage in joint purchase of inputs and joint marketing of the products. Many of these farmers are using social media as a channel for direct sale of their local products. The public authorities can further support these initiatives by connecting the different existing groups as well as to connect them to groups of urban consumers.

Eight percent of the households are currently providing services for tourists; this shows modernization of the activities by opening up the farms for recreation. In addition, 36 percent of the farmers are preserving local plants and seeds, a high enough proportion to be encouraging for sustainability and maintenance of biodiversity.

Aflaj communities can gain substantial returns by selling part of their agricultural water to other sectors of the economy. This will drive a higher use efficiency of irrigation. However, this question received low interest, with only 15.2 percent willing to sell Falaj water. In fact, the reduction of the irrigated area, due to urbanization, in some Aflaj (e.g. Al-Ghantaq) should be conducive to such a trade. Creating modes of cooperation between Aflaj water rights’ holders and urban communities to transfer water in Nizwa, for instance, could promote modernization of Aflaj and support their sustainability. Nizwa’s urban water is currently transferred from desalination plants in Barka at a very high cost.
Introduction
Family farming is the predominant form of agriculture in developed and developing countries. There are over 608 million farms in the world and more than 90 percent of these farms are family farms (Lowder, Sánchez & Bertini, 2019). They run diversified agricultural systems and preserve traditional food products and seeds, contributing to good nutrition, local development and protection of the environment. They hold unique potential for the creation of a sustainable food system.

In line with the Resolution of the UN Decade on Family Farming (UNDFF), adopted by the United Nations General Assembly in 2017, family farmers are considered the means and the accelerators to achieve the Sustainable Development Goals (FAO and IFAD, 2019). The UNDFF provides an important framework at global level that can devote special attention to family farming and to the development of an enabling social, economic and policy environment for family farmers as well as facilitating knowledge exchange among countries and regions.

Consistently with this global agenda, the Government of Oman, with the assistance of the Food and Agriculture Organization of the United Nations (FAO), developed the “Sustainable Agriculture and Rural Development Strategy towards 2040” (SARDS), along with a detailed investment plan. The strategy is based on four priorities: enhancing economic efficiency, profitability and competitiveness of agriculture and rural activities; improving environmental sustainability and resilience to natural disasters; reducing regional imbalances between rural and urban areas and promoting social inclusion; and strengthening the enabling institutional environment for agriculture, fisheries, and rural development. The SARDS emphasizes the need to promote the establishment of producer organizations as a way to professionalize the sector and overcome the barriers facing small and family farmers in the Sultanate.

This study documents the unique experience of the Aflaj, collective institutions managing water allocation among small-scale farms, and will help to illustrate the importance of family farming in the Sultanate of Oman in the collective management of natural resources. The last section of the study provides recommendations for improvements.

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2 The information on family farming has been adapted from the FAO Family Farming Knowledge Platform (FAO, 2021)
The context
The Sultanate of Oman has taken some important steps towards food security. In the World Food Index 2018, Oman ranks third in the Arab world and 29th worldwide.

The agriculture sector plays an important socio-economic role for sustainable development in the Sultanate of Oman.

Omani agriculture is characterized by 89 percent of small family farmers (farm size less than 5 feddans) who own 25 percent of the land, while 0.2 percent of farmers (farm size more than 50 feddans) own 21 percent of the land (Kotagama, 2014). Given the prevalence of small farms in Oman, farmer organizations could be a tool to assist farmers in collectively accessing inputs at lower prices and obtaining better market prices, extension services, collective storage and so forth, to ultimately increase their bargaining power and better manage their risks. Given the typical small size of the farms, the majority of farmers in Oman are part-time farmers. Farming is a secondary activity, due to the availability of better-paying jobs outside the agricultural sector. According to the Ministry of Agriculture, Fisheries and Water Resources (MAFWR) in 2018, 92,426 people in the country are economically active in the agriculture sector, representing 4.07 percent of the active population. Around 1,077 Omanis are employed full time in the agriculture sector, while the remaining 91,349 are low-skilled expatriate workers. Omanis permanently employed on farms represent only 1.16 percent of the active population.

Faced with extreme scarcity of water in an arid environment, Omani society has developed impressive technological and social organizations to allow for sustainable use of water through the Falaj (Aflaj in plural). “The word Aflaj means a traditional water network comprising man-made underground water galleries transporting groundwater, which services a village community and an irrigation area” (Zekri and Al-Marshudi, 2008).

Through the ingenious engineering of horizontal “wells”, the Falaj system enables the extraction of groundwater for irrigation and household purposes. It is worth noting that the Falaj is more than a simple irrigation system. It also includes economic, social and management considerations. Beyond the marvel of the technical engineering, it’s important to recognize the sophisticated social organization required to manage water in an equitable and efficient way. In addition to the chronic shortage of water in the Sultanate, there is a greater need than ever to conserve this heritage and turn these challenges into opportunities that contribute to promoting rural development through social and economic innovations. Ultimately, well-functioning modern Aflaj can contribute to an efficient use of water and energy for food security and also be a mechanism for strengthening the economy in rural areas. It is clear that lifestyles have been changing with increased urbanization, population and economic growth; in addition, rural exodus and lack of institutional innovations are causing noticeable damage to the rural communities living in and around these Aflaj.
3

The conceptual framework
Most development projects and literature on irrigation focus on the creation of physical capital in the form of dams, diversion weirs, canals and other infrastructure. These projects highlight the fact that development of adequate physical capital is a key step to achieving benefits. However, physical capital is not sufficient to ensure sustainability of irrigation systems. Elinor Ostrom (1992) argues that “the rules governing how water users interact among themselves and with irrigation managers are just as important to a project’s success as are well-constructed engineering facilities”. In other words, the sustainability of irrigation systems depends on an integrated approach, taking into account the social capital considerations.

The central assumption of this research is based on the idea that the performance of a Falaj relies on the social capital created within and among the organizational structures existing in the rural communities of the Falaj system. The more the rural communities have built-in social capital, the more effective is the Falaj system. In fact, social capital interacts with the physical capital and with the organizational structures created around it, and affects the crop yields achieved and the distribution of direct and indirect costs and benefits. Human capital is also essential for the evolution of the Aflaj system. Therefore, various aspects of human capital and social capital are linked together in the development of the Aflaj system, since individual skills and abilities are needed, as well as social capital and group relations. Social trust, institutional trust and social networks are essential for group action. In addition to human capital and social capital, other aspects related to the organizational structure are also essential to achieve the common objective of Falaj development and modernization.

The “social capital” theory refers to people’s ability to work together in groups. Fukuyama defines the concept more broadly and includes “any instance in which people cooperate for common ends on the basis of shared norms and values” (Fukuyama, 2002). Social capital is an asset which allows individuals to group together to defend their interests and organize to support their collective needs. Social capital, like any physical and human capital, generates returns (Upoff, 2000; Grootaert and Van Bastelaer, 2001). It is a crucial ingredient and defines the way in which individuals organize themselves to form any type of collective action institution. Social capital is about trustworthiness, networks, and formal and informal rules or institutions. “It is an attribute of individuals and their relationships that enhances the ability to solve collective action problems” (Ostrom, 2007). Producer organizations and agricultural cooperatives are examples of organizational expressions of this social capital (Herbel and Ourabah Haddad, 2012).

This research will mainly focus on social trust, institutional trust, and social networks, as these are important social capital bonds that have been described in farmers’ participatory irrigation management literature (Cai and Zhu, 2014; Luo et al., 2017). This research will analyse these three dimensions of social capital, as well as linkages with the organizational development of farmer collective action and the ways they can influence the modernization of the Aflaj systems. The modernization is analysed in terms of: dynamic conservation of the irrigation infrastructure; preservation of local production; local seeds and plants conservation; environmentally sustainable use and management of natural resources; involvement in landscaping or recreation activities; increase in investment (capital and labour) and engagement in joint marketing or farming activities; organization of farmers in associations or informal groups; and potential for land consolidation.

Figure 1 depicts the conceptual framework of this research. According to the examined literature, “the sustainability of an irrigation project depends largely on the active participation and cooperation of individual farmers”, identified in the Figure as human capital (skills, abilities, motivation and participation of individuals) as well as on social capital or group relations, or “changes in relations between persons that facilitate action” (Ostrom, 1992).
Transformation activities such as the ones linked to agriculture involve human capital. The skill that a particular individual brings to the transformation activities he or she undertakes is a form of human capital (Ostrom, 1992). According to Ostrom, an individual farmer’s ability to increase the productivity of investments in inputs such as seeds and fertilizers and other assets is a result of human capital.

![Figure 1: Conceptual framework](image-url)

**Modernization of an Aflaj system**

- **Aflaj system**
  - Organizational development
    - Type of technology
    - Equipment
    - Irrigation infrastructure
    - Shared vision
    - Management
    - Governance
    - Leadership
    - Material & human resources
  - External environment
    - (Legal framework, Incentives, Policies)

**Modernization**
- Conservation of infrastructure
- Creation/Landscaping
- Investment capital/Labour
- Engagement in joint marketing/Farming activities
- Preservation of local plants and seeds
- Land consolidation potential
- Farmers organised (Associations/Informal groups)

Source: Sultan Qaboos University, 2020.
Social trust is one of the key components forming social capital. Coleman (1988) highlights that a group in which there is extensive trustworthiness and extensive trust among individuals is able to accomplish much more than a comparable group without these values. Individual daily life and behaviour, together with agricultural production, rely heavily on interpersonal relationships that are infused with trust. “The higher the degrees of interpersonal trust, the more frequent the interactions between farmers and other individuals in rural society...” (Han et al., 2017). People improve resource utilization efficiency (Wan and Wang, 2016; Boix and Posner, 1998), reduce transaction costs, and increase individual spontaneous social behaviour (Coleman, 1990) through interpersonal trust and cooperation. Farmers can produce more through collective action with other farmers when they trust each other.

Another component linked to social trust is the institutional trust in public institutions that are connected to community functions, such as the government and the judicial system. In the context of irrigation management, institutional trust is embedded in the transparency of water management structures of the rural community, transparency for settling water disputes, soundness of mechanisms for effectively supervising irrigation water, and fairness in the use and distribution of water resources (Xu et al., 2015). Where there is high institutional trust, farmers believe they can rely on institutions to solve problems. Moreover, high institutional trust makes it easier for the government to develop and deliver sound policies because it lowers the transaction costs associated with selling policies to farmers and securing their compliance (Cook et al., 2005).

The final component of social capital that will be examined in this study is social networks. Relationship networks bring dispersed individual members together and help them to access information and resources quickly and cheaply (Han et al., 2017). Yang et al. (2013) analysed the relationship between social networks and entrepreneurial resource acquisition. The results showed that embedding social networks to obtain social capital helps an organization acquire entrepreneurial resources and knowledge. “The larger relationship networks are, the more information about organic fertilizer they can disseminate. Farmers who receive more information are likely to contact and understand the technology correctly, making them more willing to adopt the technology than those who do not” (Yang et al., 2020). Social capital can be accumulated through networks, as they can improve production skills through cognitive enlightenment and learning, influence farmers’ behaviour, broaden farmers’ horizons and facilitate knowledge transfer (Inkpen and Tsang, 2005).

The higher the levels of social trust, institutional trust and social networks, the more inclined farmers are to enter into a collective form of organization. When members of an organization build confidence with one another, they become more inclined to engage in collective actions that can generate more trust (Fukuyama, 1995; Putnam, 1993; Nahapiet and Ghoshal, 1998). The dimensions of social capital facilitate activities among members within an organization; in turn, the problem-solving ability of the organization is improved (Nahapiet and Ghoshal, 1998). Wan and Li (2012) found a positive correlation between farmer participation in water user associations and social capital. The more social capital concerns are brought into an organization, the more effective the farmers’ collective action becomes.

Ostrom (1992) argued that both social capital and human capital are important but not sufficient, especially when the transformation activities that farmers demand have a high degree of complexity and interconnection. This is where the importance of “crafting institutions” comes into play. “Users and suppliers of irrigation systems must craft a variety of institutional arrangements to cope with the physical, economic, social and cultural features of each system. Major studies throughout the world illustrate these variations among the rules in use” (Uphoff, 1986).

Aflaj systems are common property resources that are carefully managed in Oman, from the specific perspective of irrigation. However, no innovations, adaptations or creation of collective action organizations have been carried out during the last 50 years. Hence, the issue of collective action for farm management and marketing is extremely important to foster adaptation to social and economic changes that the system needs to undertake for its growth. To achieve this objective, the farmers’ communities belonging to the Aflaj systems should base their organizational structures on organizational theories that focus on the importance of having a clear vision, built around common goals concerning farm management, and marketing based on genuine collective action. Coleman (1994) argued that if organization members have a common strategic vision and goals, this will promote integration and collective responsibility.
In order to implement this common vision, farmers around a Falaj need to come up with forms of collective action in which tasks are organized according to good management principles, a clear governance and leadership structure and enough material resources to achieve a common objective.

When the water from the Falaj is used efficiently for agricultural purposes, this resource can be very productive, allowing the harvest of a good crop. Such a result is expected to enhance the interest of the farmer community in ensuring efficient functioning of the infrastructure and eventually engaging in common business activities linked to agriculture. Thus, social capital and its three dimensions, in combination with group internal rules, functions and values, can support mutually beneficial collective actions and produce measurable improvements and modernization of the system (Uphoff and Wijaratria, 2000).
4 Definitions and research questions and objectives
For the purpose of this study, it is necessary to define some important terms from the outset.

**Aflaj** is the plural of **Falaj**, which means “split into parts” in classical Arabic. It refers to an irrigation system used in Oman, which captures mountain water and controls its movements down man-made subterranean channels.

**Collective action** describes a group of people acting together to achieve common objectives. Nobel laureate Elinor Ostrom refers to the existence, at the micro-level, of a plethora of successful community organizations that address societal needs and welfare (Ostrom, 1990; 2007).

**Institutional environment** encompasses the forces and factors affecting an organization in its environment. It consists of the “rules of the game” and the actors that influence the work of an organization and its relations.

**Performance** refers to the level of success of an organization or of a system; the dimension of performance analysed through this study is modernization of the Aflaj system.

The study examines the enabling factors (external and internal, socio-economic and institutional) influencing the modernization of Aflaj to improve food security. It shows the importance of human and social capital, which affect the development of farmer collective action and ultimately allow the Aflaj system to remain relevant to a changing context. The modernization is analysed in terms of dynamic conservation of the irrigation infrastructure, preservation of local production, seed and plant diversity, involvement in landscaping or recreation activities, increase in investment (capital and labour), engagement in joint marketing or farming activities, organization of farmers in associations or informal groups, and potential for land consolidation.

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3 An enabling institutional environment consists, for example, of transparent and sound regulatory and legal frameworks (World Bank, 2012), enabling policies (Agarwal, 2001; Penrose-Buckley, 2007; Markelova and Mwangi, 2010), a climate conducive to investment through incentives and other support services (Gijzelinck and Bussels, 2012), and spaces for policy dialogue, allowing social capital development (Coleman, 1988). In order to make markets function for the poor, well-designed institutions are key requirements (Dorward et al., 2003; Bienabe and Sautier, 2005). Institutions are understood as defining the “rules of the game” (North, 1990), such as formal rules, informal incentives and constraints (conventions, norms of behaviour, and self-imposed codes of conduct).
The general question to be addressed is:
What is the role of social capital and farmer collective action in the modernization and dynamic conservation of Aflaj systems?

Specific questions include:

Social capital:
- What are the key social capital-related success factors for effective farmer collective action in a Falaj?
- What are the incentives for farmers to work collectively to improve the dynamic conservation of a Falaj?

Organizational development:
- What are the organizational factors linked to collective action of farmers that influence the modernization of a Falaj?
- What are the linkages between social capital dimensions and organizational development dimensions that support the dynamic conservation of Aflaj systems?
5

The research methodology/operational framework and its limitations
5.1 Data collection methods

The methodology of the study used both quantitative and qualitative methods to collect and analyse information. It included a literature review to examine the influence of the enabling factors based on social capital dimensions and their linkages to organizational development of groups of farmers around Aflaj systems as well as the collection of quantitative and qualitative data to assess the potential of a selected Falaj system to achieve food security and ensure sustainability.

5.2 Sampling

A focus group discussion was organized with seven Falaj managers who provided their insights on the relevance of this work. The questionnaire and the objectives of the study were thoroughly discussed with them. Some of the Falaj managers accepted the task of collecting the data themselves, while in other cases they supported and supervised interviewers to engage with members of farming communities carefully selected by them. Data collection was carried out through the administration of surveys by the Falaj managers or members of the farming community. Respondents were selected randomly and as many as possible households living in the area were interviewed. Data collection was undertaken in four sites: Misfaat Al Abryeen, Tanuf, Al-Ghantaq and Samael. Eighty questionnaires were collected. This is an important innovation of the study, as instead of recruiting a research team to carry out the interviews with the farmers, the Falaj managers used this opportunity to engage in discussion with the farmers and in the data collection process. Sultan Qaboos University and FAO coordinated the process and implemented a focus group discussion with the Falaj managers to kick-off the process.

The Aflaj sample can be viewed as limited and not fully representative. This limitation is due to the circumstances in which the data collection was carried out, in light of the situation triggered by COVID-19 pandemic. However, it is worth noting that the study includes Aflaj sites that are potential candidates for future registration under the GIAHS system (Globally Important Agricultural Heritage Systems) and featuring different levels of modernization.

Falaj Tanuf has been selected for the in-depth case study to assess the capabilities of the farmer groups collaborating around the Falaj in encompassing value chain services (input provision, labour provision, collective farm management, marketing). The four Aflaj are similar in size and number of farmers.
5.3 Methodology limitations

A series of limitations can be listed in this study for the primary data collection instruments used and for the contingent situation linked to the COVID-19 pandemic, which delayed and restricted the possibilities of field work.

The sampling is not a fully representative sample, but a purposive sample aiming to explore aspects of modernization and efficiency of the selected Aflaj. It was predominantly guided by feasibility and possibility of data collection and personal judgement in the selection of the sites, given the confinement and numerous restrictions imposed by government due to the COVID-19 pandemic.

Furthermore, the restrictions regarding the interaction between interviewees and interviewers could also have affected the reliability of the survey instrument and the capacity of capturing with accuracy the information provided by the respondents.

Finally, it was not possible to carry out focus group discussions with the farmers directly, because of the COVID-related restrictions, and this has limited the possibility of cross-checking and identifying relevant common themes through group discussions and exchanges. However, as previously indicated, one focus group discussion was made possible with the managers of the Aflaj.

5.4 Statistical analysis

Initially, the data have been analysed using descriptive statistics and paired correlations to find relationships between variables. In a second step, predictive models explaining existing collaboration and anticipated willingness to cooperate in the future have been undertaken using regression analysis.

Logistic regression is the appropriate approach that can be used in this context, when the dependent variable is of type 0/1. It helps to explain farmers’ ability or willingness to collaborate or to take any action within the community inside the Falaj. The logistic model helps to classify farmers into two groups – who does and who does not currently collaborate or share labour/machinery effectively or might in the future – by estimating the probability of belonging to the first group (dependent variable equals 1). A cutoff value of 0.5 is usually used to classify the farmer in one or the other of the groups. That farmer belongs to the group of farmers not collaborating if the probability is below the cutoff and otherwise belongs to the group of those who are collaborating.

To build the model, we first identified all candidate variables, and then classified these into dependent and independent variables. The majority of the variables obtained from the study are categorical and especially of type 0/1. Very few numerical variables were obtained and the majority of them were related to land and production systems. Some of the variables include farm size, water rights, crops area, or number of trees and animals. It is important to note that logistic regression models do not necessarily assume a direct linear relationship between the dependent and independent variables. However, this model assumes a linear relationship between the logit function and the independent variables. Therefore, a strong linear relationship between the predictor and any independent variable does not mean that the variable should be included in the model.

We identified two types of dependent variables and all of them are of type 0/1, with “yes” coded 1 and “no” coded 0. Farmers were asked to answer “yes” or “no” to the following questions: “Are you getting help from other farmers in agricultural activities?”, “Are you willing to consolidate your land and use it as a single farm with your neighbours to reach a critical size?”, “Are you willing to create an Aflaj Association?”. We classified the dependent variables in two classes: variables about effective collaboration and labour-sharing and variables about willingness to collaborate in the future. Then we identified all other explanatory variables that may have a significant impact on the dependent variables. We examined the association of all possible explanatory variables with the identified dependent variables in order to find the best combination for the model. Since all the dependent variables are of type 0/1, we used contingency table and hypothesis tests to identify the different types of association between these variables and the explanatory variables by pairs.
Given that we have a small sample size, our model could not include many independent variables to avoid any overfitting problem. In addition, the degrees of freedom, calculated by the difference between the sample size and the number of independent variables, represent the effective sample size and should be reasonable enough to allow a good estimation model. It is also important to mention that the sample size is reduced by some missing responses to some questions by the interviewees. Another aspect that may affect the validity of the model is the multi-collinearity that may exist between some explanatory variables. With correlated predictors, the standard error of the estimate of the regression coefficient can be inflated. Excluding a non-significant variable from the model can affect the significance of other parameters. This means that the variables collectively have predictive power, but individually their significance may not be determined accurately. For this reason, we are more concerned about the best fit than the non-significance of some variables. In addition to the limited number of observations, some answers were missing for some variables, which meant that the estimation of the model would be conducted with fewer observations. Instead of relying on significance tests and associated p-values, an alternative approach is to judge the variable’s true contribution to the model by examining the goodness-of-fit measure, known as deviance. For logistic regression, the test of significance of the predictors has a number of serious limitations. It is based on normality assumption and it relies on large samples and performs rather poorly for small samples. The change in deviance is preferred to determine the model of “best” fit. Essentially, this technique aims at finding the most parsimonious model to fit the data. The p-value calculated for our model to assess the global significance is based on the change in deviance.

In the selection of our model, the best choice of explanatory variables was based on pre-specified criteria and the best combination among all possible models was selected. In general, the stepwise selection technique was used to reduce the complexity of the model without compromising its accuracy. Note that, all things being equal, the simpler model was always chosen and considered as the final model returned by the stepwise regression. Because of the small sample size of the observations, this technique was not used automatically. All possible combinations with the selected explanatory variables were explored and the model retained gave the best fit, based on the following criteria:

Akaike information criterion (AIC) is considered equivalent to the coefficient of determination of the linear regression model. AIC penalizes the increasing number of variables in the model. It helps to avoid overfitting and is calculated based on the prediction error. The smaller the AIC, the better the model compared to other models.

P-value of global significance of the model is calculated using the change in deviance, as explained earlier. The lower the p-value, the greater the statistical significance of the explanatory variables and their effects.

Accuracy describes the overall predicted accuracy of the model. It is the proportion of negative and positive (0 and 1) correctly predicted.

Precision, also known as sensitivity, indicates the proportion of positive values out of all the correctly predicted values. It is useful when positive cases are the target, meaning in our case the farmers who are effectively collaborating or willing to collaborate.

Given the small sample size available, only a few variables could be involved in the model. For variables that were not considered, we studied their associations with the predicted variables related to collective action and analysed their impact on farmers’ decisions related to collective action.
Findings
6.1 Descriptive statistics and paired correlations

Characteristics of the sample: age considerations and relations to the agricultural activities in the Aflaj

The heads of households in the sample are 100 percent male; this is explained by gender roles in traditional rural Omani society. Figure 2 shows the age of the household heads by percentage. The majority of the household heads are 41-50 and 51-60 years old, with these two brackets representing 60.8 percent of households. The household heads aged over 60 years old represent ten times the number of household heads under 30 years old, with the former representing 13.9 percent and the latter representing 1.3 percent. Given the life expectancy of 78 years in Oman, the population of farmers over 60 years old is still active and largely consists of retirees from the public sector. In fact, the current population of farmers is formed essentially of part-time farmers whose main jobs are in the public sector or by retirees from the public sector, particularly the defense sector. Sixty-two percent of Omanis retire at the early age of 57 years, many of whom return to work in a second career to complement their pensions (Al Shaibany, 2010).

When the interviewees were asked about “Youth in Agriculture and the Falaj” (question M1; see questionnaire), the response was that most young people think that agriculture is too hard a job and as many as 43.4 percent of those interviewed wish to move away from the Falaj. The facts that a large share of the youth is not interested in working in the agriculture sector and that only 1.3 percent of active farmers are under 30 years old could have a positive impact in the long run, as more land will be available for fewer farmers, resulting in larger farm sizes and gains through economies of scale. The lack of interest from the youth could be a risk for the future sustainability and modernization of the Aflaj. However, the influx of relatively young retirees, who are characterized by a relatively high standard of living and who appreciate living in the Aflaj and in rural areas, could be seen as an excellent driver that will potentially support investments in the dynamic conservation of the Aflaj. The numbers also show that some young farmers are currently active in the Aflaj and will ensure the sustainability of the systems in place. With the concentration of land in a few hands, chances will be higher for young people to be interested in farming as an economic activity in the future. Furthermore, several young farmers are currently pursuing farming as a secondary activity and this will likely continue, as it provides a secondary and complementary source of income. We are far from the scenario of deserted villages caused by a massive migration to cities.
Another important external factor driving youth leaving the Falaj is job opportunities offered in other economic sectors, which are better paid than jobs in the farming sector. Among the interviewees, only 9.2 percent said that the income from farming contributes 20-40 percent of their total income. This is a small proportion of farmers. The great majority (90.8 percent) said that the income from the farms contributes 20 percent or less of their total income. None of the interviewees depends totally on farming for income. Eighty percent of the farms are not market-oriented and the major share of the production is destined for family consumption. The production and self-consumption of agricultural products by farmer households is often not considered as a source of income, leading to an underestimated contribution of the farms to total income. Overall, these results show that returns from farming are not sufficiently high (in cash returns) and not a single household depends totally on agricultural activity to earn a living. On the other hand, Figure 3 shows that households whose income contribution percentage from farming is higher do own smaller farms. This result clearly shows that small land size is not per se an obstacle to sustaining agricultural production and food security, as long as farming constitutes a part-time or secondary source of income. Thus, despite the small size of the farms and the principal activity being outside the agriculture sector, a number of Omanis living in Aflaj continue to develop agricultural activities on their inherited farms to generate a complementary source of income and food for the family.

Source: Sultan Qaboos University, 2020.
Table 1 shows the land size of the farms. On average the farm size is 5,603 m² or 1.3 feddans (acres), while 25 percent of households own less than 1,000 m². There is a large variation in farm sizes, ranging in this case from 160 m² to 21,000 m² (5 feddans). The existence of very small farms (160 m²) is an indicator of the attachment to land and ownership in the Falaj. According to the group discussion with the Aflaj managers, selling inherited land in the Falaj is still seen as a shame or disgrace in the community. The creation of mechanisms that would allow retaining land ownership, while maintaining the activity and productivity of that land is of paramount importance for the conservation of Aflaj and food security.
Farm size and income as drivers for collaboration between farmers

What is striking is that those households that own relatively larger farms and have higher incomes, earned outside the agricultural sector, have a strong willingness to collaborate and cooperate with their neighbours and the farmer community. The collaboration here is defined as mutual aid among farmers, measured as a response to question F1: “Do you help other farmers in agricultural activities?” This is shown in Figure 4, where the average farm size is slightly higher for farmers involved in mutual aid, with 6 100 m² versus 5 285 m² for those not involved in mutual aid. The difference in the median is higher, with 4 200 m² versus 2 750 m² for those not involved in mutual aid. It appears from the results that farm size is a positive incentive for cooperation, as well as income level. It seems that the owners of larger farms are also more oriented to cooperate. The higher the income, the more likely is the cooperation. This could be explained by the fact that “wealthier” households are willing to take more risks to explore cooperation. Results also showed that farmers who are collaborating are generating a higher return per feddan. In fact, farmers involved in cooperation gained 2 239 OMR/feddan versus 861 OMR/feddan for those who are not collaborating.

![Figure 4](image-url)

**Figure 4**

Farm sizes owned by households who are collaborating versus not collaborating within the farming community

*Source: Sultan Qaboos University, 2020.*
Resource sharing and collaboration among farmers

The majority of farms (53.8 percent) are owned by a family and not individually owned. This is already a positive sign of cooperation among family members avoiding the division of land. On the other hand, family ownership makes it difficult to further cooperate with neighbours, as the decision lies not with one single person but involves several family members. The average farm size owned by a family is 6,535 m², which is larger than the farms individually owned, with an average of 4,407 m². Encouraging family ownership is positive for keeping a reasonable farm size that allows sustainability of the agricultural activity.

Although some very small farms exist that are rented, the rental of farms is not frequent in Aflaj systems; only 3.7 percent of farmers are renting land. Renting land is a form of cooperation which allows bringing the farm to an economical size by cutting costs of labour and machinery.

Households in Aflaj systems are very attached to their land, as revealed by the survey, and want to avoid disputes and opposition from family members when making decisions. The lack of mobility of land ownership is a constraint to cooperation and could be addressed by establishing clear property rights, through registration in a cadastre and clear contracts between parties willing to cooperate.

Figure 5

Farm size by type of ownership in m²

Source: Sultan Qaboos University, 2020.
The modernization is analysed in terms of dynamic conservation, for which land consolidation or aggregation is a component. Regarding the willingness to strengthen cooperation in the future, a high proportion of farmers showed an interest in consolidating/aggregating land with family members (63.6 percent). Land consolidation with neighbours received little approval from households, however, with only 23.4 percent willing to enter into such an action. This can be explained by the lack of guidelines and absence of support for common management of land. Most households said that they are not willing to consolidate land with neighbours, in order to avoid disputes and retain their freedom of decision-making. This attitude has nothing to do with social trust, as will be explained later, because a majority of households trust their neighbours. Cooperation through land consolidation or aggregation will always result in higher productivity and higher returns when accompanied by the proper investments, as shown from the results described above on returns from farming.

Challenges to collaboration among farmers

One more obstacle to household cooperation is houses built inside the farm. Households who have built their houses inside the farm represent 18 percent of the total interviewees. For this category of households the farm is essentially a fenced garden, which excludes the possibility of sharing labour, machinery or land consolidation, regardless of its size. The fenced garden is considered part of the house and traditionally no foreigners are allowed in. The proportion of farmers who have houses inside the Falaj and who also own land for housing outside the Falaj is 13.3 percent. The sustainability of Aflaj as productive land and beautiful landscape requires the avoidance of further house-building inside the farms. One example of an Aflaj system that is affected by the presence of houses is Al-Ghantaq Falaj, where most of the farms have been fenced, along with the houses built in them. Such a circumstance prevents the use of the Falaj for recreation activities for both households and visitors.

The availability of low-cost expatriate workers does not encourage cooperation among farmers by sharing fixed labour costs. Results of the survey showed that the proportion of households who hired permanent workers during the past three years is very high, representing 77 percent of the respondents. The average monthly cash salary is 85 OMR (US$ 221). The workers are offered free accommodation and food, bringing the real labour cost to around US$ 400/month. Only 10.1 percent of the households do not hire permanent or occasional labour. The average farm size owned by households not employing expatriate labour is 1 967 m². To encourage farmers' cooperation on labour-sharing, the implementation of regulations on hiring expatriate workers should be tightened and authorizations to employ expatriate workers should be linked to sharing the labour force, by law or by increasing the farm size eligible for hiring permanent expatriate workers. Despite the fact that 77 percent of the respondents rely on permanent expatriate workers, 67 percent affirmed that they are sharing permanent labour for farming. This is due to the existing labour laws and to the small size of the farms. Households do not resort to permanent expatriate workers if they cannot pay them from the farm's returns and this encourages them to share costs. Currently, households may hire an expatriate worker but agree informally with one or more neighbours to share the costs and the labour force. This cooperation is reflected by 67 percent of the households and is quite important; it should be strengthened via more formal contracts to avoid disputes and to ease the recruitment process. The willingness to share permanent labour is strong, as 69.3 percent of the respondents indicated they are ready to do so. This rate is higher than the current rate of permanent labour force-sharing. The highest level of willingness is shown for sharing machinery, with 77 percent of the respondents willing to participate in such an action in the future. It is evident that sharing machinery is easier than sharing permanent expatriate workers. Expatriate workers live within the community and the employer has the obligation to provide housing and to ensure health services and food. Hence the higher rate of willingness to cooperate on machinery-sharing. This is also a positive sign, as introducing new small machinery will be highly accepted by households.

Positive signs of cooperation are evident, as 51.3 percent households affirmed that they are already helping each other through mutual aid, mainly in pruning, harvesting, consulting and advising, maintenance and sharing permanent workers.
Strong levels of social trust and willingness of farmers to share resources

The results of the survey showed that overall the level of trust is high, with 70 percent of the respondents, on average, saying they “trust” or “totally trust” their families, friends, neighbours and community members. Only 7 percent of the respondents have little trust and just 2 percent totally distrust the neighbours or farmers in the community, as shown in Figure 6. The results clearly show that the social environment of group relations, reflected through trust, is producing an enabling and conducive environment for cooperation among farmers. In other words, the current relationships within the families and among the households are very good and do not constitute any barrier against cooperation. Even though the level of trust is very high, however, it has not been sufficient to engender or trigger modernization and introduction of innovation. The dynamic modernization of Aflaj might thus need some external support for bringing in new ideas to be discussed by the households.

Source: Sultan Qaboos University, 2020.
When farmers were asked about the level of trust among community members decreasing or increasing during the last ten years, disaggregated by age, the results clearly showed that this dimension of social capital is slowly fading. The level of decreased trust is higher than the level of increased trust for all age categories during the last ten years, as shown in Table 2. Most of the respondents over age 30 showed some decreased level of trust in family members, neighbours and farmers. Younger households expressed a sharp decrease in level of trust in neighbours and farmers. However, given the limited observation of household heads under 30, this result should be taken with a lot of caution and cannot be generalized. The absence of formal contracts among farmers and lack of written rules and regulations on cooperation issues could be one reason for such a decline in the level of trust among community members. One Falaj manager (Al-Ghantaq) even mentioned the experience of a small group of farmers who came together for the common management of one farm and collectively invested US$ 30 000 to jointly produce vegetables. The arrangement functioned well for two years but then the owner of the land withdrew from the agreement due to the absence of a formal contract. However, all the participants recovered their capital investment as well as their profits, which is an indicator of the existence of basic levels of trust within the farming community in this Falaj.

In general, the majority of farmers have a high level of trust in relatives, friends, neighbours and other farmers. The level of trust is higher for groups of farmers who are effectively sharing labour than for those who are not. For example, for trust in relatives the percentages are 94 percent for the first group versus only 76 percent for the second group. For trust in neighbours, the percentages are 67 percent versus 60 percent, respectively, and for trust in other farmers, it is 70 percent versus 56 percent, respectively, for the two groups.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Changes in the level of trust, among community members, during the last 10 years</th>
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<tbody>
<tr>
<td></td>
<td>Same level of trust</td>
</tr>
<tr>
<td>Under 30</td>
<td>0</td>
</tr>
<tr>
<td>31-40</td>
<td>63.2</td>
</tr>
<tr>
<td>41-50</td>
<td>63.3</td>
</tr>
<tr>
<td>51-60</td>
<td>66.6</td>
</tr>
<tr>
<td>60+</td>
<td>81.2</td>
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</tbody>
</table>

**Strong institutional trust in local Aflaj-related leadership**

For relationships with institutions, the level of trust is different from the levels of trust with social groups. If we consider the two groups of farmers – those who are sharing labour and those who are not – the level of trust is high in traditional village leaders (74 percent and 68 percent, respectively), in Falaj leaders (64 percent and 62 percent, respectively), in the Falaj treasurer (70 percent and 68 percent, respectively), and in religious leaders (49 percent and 54 percent, respectively). The level of trust in other groups is low. With regard to level of trust in government officials, for the two groups of farmers who are or not sharing labour, the percentages are 43 percent and 37 percent, respectively, for central government officials, 47 percent and 39 percent, respectively, for local government officials, and 32 percent and 32 percent, respectively, for extension workers. We can conclude here that this area needs to be looked into by the Aflaj leadership.

In general, the decision-making process has no effect on the level of collective action of farmers for modernization of the farms. In the two groups of farmers – those who are or are not sharing labour – the percentages of those considering decision-making inclusive are quite similar (69 percent and 67 percent, respectively) and represent the majority for both groups. However, farmers who are sharing labour think more positively about the local leadership than those who are not (56 percent versus 45 percent, respectively).
Informal social relations among farmers: a driver to consolidate formal collaboration among farmers using technologies of communication and social media

If we examine the degree of activity of the farmers within social networks, we find that in general they are not very active in social groups, except in youth or WhatsApp groups. For example, 18 percent of those belonging to the group of farmers who are sharing labour and only 6 percent from the other group are active in the village group. An established tradition in Oman is the existence of informal credit groups, in which a group of households share their savings in a rotational way; the savings goes first to one household and then to another in the next month or next year and so on according to the agreement. The percentage of farmers active in savings groups is about 8 percent. Households participating in informal credit groups or savings groups usually have very high trust in each other. The existence of this sort of group facilitates investments in farm modernization. For youth groups, being active or not has no effect on decisions regarding sharing labour or not. The percentages are divided equally between youth groups of farmers sharing labour or not.

The organizational factors linked to collective action of farmers are reflected in Table 3 below. All the organizations in Aflaj are informal, except the farmers’ associations. Youth groups represent the highest number of households involved, to which 51.4 percent of the respondents belong. Thirty-eight percent of the households are active in a “water management group”, the organization most specifically rooted in the Aflaj. The activities in this group are related to the maintenance and cleaning of the Aflaj. Social media is also quite present among members of the farming community, with 34.8 percent connected through WhatsApp. The groups are connected through social media, where members participate by exchanging advice and experiences and participating in the decision-making process (given that face-to-face meetings are not allowed due to COVID-19). The adoption of social media is encouraging as it is enhancing the exchange of information and advice within the community. Some households are also using it to advertise and market their niche products, such as local wheat and fruit. The relatively high use of social media, connecting the community members, cements the group relations and facilitates interactions, discussion of ideas and even decision-making, allowing a larger number of households to participate and be included in the decision-making process. The adoption of social media groups addressing the Aflaj issues is increasingly relevant, given the mobility restrictions due to the COVID-19 pandemic.

Table 3

<table>
<thead>
<tr>
<th>Percentage of households belonging to groups/associations active in Aflaj</th>
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<tbody>
<tr>
<td>Agriculture groups/farmers’ associations</td>
</tr>
<tr>
<td>Water management groups</td>
</tr>
<tr>
<td>Village groups</td>
</tr>
<tr>
<td>Religious or spiritual groups</td>
</tr>
<tr>
<td>Youth groups</td>
</tr>
<tr>
<td>Savings groups</td>
</tr>
<tr>
<td>WhatsApp or other social media groups</td>
</tr>
<tr>
<td>Other groups</td>
</tr>
</tbody>
</table>

Source: Sultan Qaboos University, 2020.

A majority of farmers (69 percent) consider that the decision-making process is inclusive, with some households asking for more involvement. The fact that decision-making is already perceived as inclusive, without any efforts deployed from the public institutions, is indicative of an enabling environment for further collaboration.
Small-scale and family farmers’ collective action in managing natural resources in Oman

The Aflaj System - Current performance and potentials for improvement

There is a strong association between the opinions of the farmers on leadership and trust in social groups. Farmers who have a strong opinion on leadership have a high level of trust in their relatives (86 percent). Other percentages of trust in friends, neighbours, and other farmers are 76 percent, 71 percent, and 76 percent, respectively. In general, the level of trust in family, neighbours and other farmers is slightly higher for those who think positively about the actual leadership (68 percent to 71 percent). Farmers who think positively about the local leadership have high levels of trust in traditional village leaders, Falaj managers, and Falaj treasurers, with percentages of 79 percent, 82 percent and 81 percent, respectively. This shows a high level of trust in the local water institution. This institutional trust is proof of the transparency of water management structures, the soundness of mechanisms for effective supervision of irrigation water, and fairness in the use and distribution of water resources. Aflaj water distribution is governed by clear and well-established water property rights.

However, the farmers’ trust in local and central government representatives, as well as in extension workers and religious leaders is lower, ranging only from 41 to 56 percent. This can be explained by the fact that households are more in touch with and in need of Falaj leadership than with local or national organizations. Indeed, the survey results show that only 20.5 percent of the farmers have had interactions with local/central institutions during the last three years. Furthermore, the Falaj leaders are nominated and elected by the households living in the community, which produces a higher level of trust, while other leaders are nominated by the central government.

Regarding the irrigation system, most farmers (64 percent) believe that there is a need for transformation of the legal status of the Falaj, specifically in relation to the irrigation system and distribution of the water turns. The current system, based on time-sharing, is very complex, with its water turns and irrigation at night (24 hours/7 days). The absence of either control of the main water flow or storage capacity obliges half of the farmers to undertake irrigation in the middle of the night.

Aflaj infrastructure maintenance is self-funded by the returns from water sale and is thus independent in most cases from the need for support from public institutions. Currently, each Falaj has its own management committee, and there is very little cooperation among Aflaj. Households were asked if there is any interest in creating an association of Aflaj at the regional level to share resources, knowledge and experience in Aflaj maintenance (question K2). The proportion of farmers who are willing to create a Aflaj association is 59 percent. The role of Aflaj associations is to bring together Aflaj of the same Wilayat, and start collaboration and cooperation among the different Aflaj. The high percentage of positive responses to the question is a good indication that farmers are willing to cooperate beyond their community. A WhatsApp group has already been created for this purpose and gathers the Falaj managers of Wilayat Nizwa, according to the manager of Falaj Al-Ghantaq, who initiated the group. The next step consists of finding ways to formalize the idea and bring it to reality. It is expected that an Aflaj Association would reduce the burden/cost of Falaj maintenance by buying and sharing modern equipment, as well as mobilizing trained and skilled farmers.

If we examine the Aflaj with current level of collective action of the farmers, we can observe that, in general, the majority of farmers believe in the need to transform the legal status of the Falaj, regardless of whether they are sharing labour (66 percent) or not (64 percent). Labour sharing is considered here as an indicator of ongoing collective action. For the creation of an Aflaj Association, however, considerations are different, since 72 percent of the farmers who are sharing labour responded positively, while only 46 percent of those who are not sharing labour responded positively.

Eighty-two percent of the farmers think that important positive changes have affected the community and household life in the Falaj during the last 5-10 years. The majority explained that the positive changes consisted essentially of renewed interest in the agriculture sector and the preservation of the Aflaj. Households are coming back, after retirement, to work, live and improve community life. Many of these farmers are aware of the Falaj maintenance requirements and details. Many households are introducing new crops. This result reflects that households see these changes as positive for the sustainability and dynamic conservation of Aflaj.

On the other hand, 64 percent of farmers think that important negative changes have affected the community and household lives during the last 5-10 years. These negative changes consist essentially of the heavy dependence on expatriate workers, insufficient maintenance of Aflaj, and water flow problems. The results of the survey show that both positive and negative impacts have occurred during the last 5-10 years. It appears that the overall
renewed interest in rural life is a good driver for the modernization and sustainability of Aflaj. Aflaj are expected to be overseen by a few middle-aged farmers, with the help of machinery, and potentially bring new sources of revenue from the field of recreation. Households are also identifying expatriate labour as a burden that should be addressed.

Other interesting aspects revealed in the survey are that 8 percent of the households are currently providing services for tourists, which shows modernization of the activities by opening up the farms for recreation, and that 36 percent of the farmers are preserving local plants and seeds in a high enough proportion to encourage sustainability and maintenance of biodiversity.

The engagement in joint marketing of crops and other farming activities is a performance indicator of success of an organization. Given the main purpose of production being for family consumption (84 percent), households who expressed interest in becoming part of a group for joint purchase of inputs (22.3 percent) and joint marketing of products (25.9 percent) represent only one-quarter of the total respondents. Twenty-two percent expressed a willingness to develop a joint label for local production. Farmers aged between 30 and 60 expressed their willingness to develop a joint label equally; there was less willingness from farmers aged 60 and above and none from those under 30. Though these numbers seem low, they actually reflect a high willingness to join efforts to develop marketing activities by those households who are supplying products to the market. Given the limited size of their farms, the remaining majority of households do not produce agricultural goods to sell in the market. In other words, all households for which production supplies the market are interested in joining efforts to improve the marketing of the products and services produced in the Falaj.

Only 8 percent of the farmers are interested in cooperating to add value to the local products. This result is consistent with the percentage of households producing for the market, which is 8.5 percent. In other words, almost all farmers who are currently marketing their products are interested in joining efforts to add value to the local products. Finally, the transfer of agricultural water from the Falaj to other sectors of the economy received lower interest, with only 15.2 percent willing to sell Falaj water. This could be explained by the fact that the Falaj flow has already declined according to the respondents, due to climate change reflected in lower rainfall as well as higher temperatures.

### 6.2 Predictive models: Logistic regression

The models developed in this section have a predictive aspect, explaining the cooperative and collective action of small farmers. The choice of these models, as well as the different variables considered, is based on the descriptive analysis of the survey conducted for the study. A wide variety of information was collected, taking into consideration factors that can have an impact on the improvement and modernization of the Aflaj. Factors are classified in terms of social, human, economic, institutional and any other external or internal aspects.

We identified four dependent variables for four models that can be used and estimated with the data set.

- **Model 1** is based on current cooperation. The dependent variable is “Farmers who are or are not currently helping others in agricultural activities within the community”. This question received 51.3 percent positive responses.

- **Models 2-4** are based on farmers’ willingness to cooperate in the future. The objective is to measure the farmers’ interest in dynamic modernization of the Aflaj and introduce changes that will improve the efficiency of resource use. The dependent variables considered, respectively, are “willing or not to consolidate land with neighbours”, which received 64 percent positive responses; “willing or not to share machinery and tools”, which received 77 percent positive responses; and “willing or not to create a Aflaj association”, which received 59 percent positive responses.

If we examine in detail the common characteristics and aspects of farmers who answered the question about willingness to share machinery and tools for farming, we find that the majority of those who answered “yes” also think that they are involved in the decision-making process (68 percent). In addition, 53 percent of them have a
strong opinion on actual leadership. However, 42 percent of them are preserving local plants and seeds. This is a positive aspect in the conservation of the Falaj if we see that only 18 percent of those who answered “no” are preserving local seeds and plants. The majority of farmers who answered “yes” are ready to consolidate land with family members for future work (74 percent), while only 33 percent among those who answered “no” are ready. Farmers in this group also indicated an interest in being organized through groups or associations. Two-thirds of them are willing to create Aflaj Associations. Regarding social trust, the majority of farmers who are willing to share machinery and tools also have trust in relatives, friends, neighbours and other farmers. In general, 67 to 88 percent describe having trust or total trust. This confirms the positive relationship between collective action and social trust. In terms of institutional trust, it is clear that farmers think that few services are provided, since the level of trust in local and central government is low. Among farmers who answered “yes” to the question of sharing machinery and tools, only 44 percent and 48 percent have trust or total trust in institutions, respectively. However, their levels of trust in the Falaj treasurer and manager are higher. For social networking, few types of groups are active in the Falaj. In general, very few farmers adhere to social groups, except for WhatsApp, youth or water management groups. However, if we compare farmers from the two groups – those who are willing to share machinery and tools and those who are not – we find that the percentage of those who are active in social networking is higher in the first group. This is an indication that a positive relationship exists between any collective action and the system of groups and social networking. Results show the importance of human and social capital, which help in developing the collective action of the farmers and consequently their ability and motivation to improve the Falaj system.

Tables 4-7 summarize the results for the four models. Some models are more accurate than others, but given the small size of the data set, we can consider all of them good enough to predict the behaviour of the farmers in the Falaj in terms of collaboration and the willingness to share labour and other resources.

### Table 4

**Model 1**

<table>
<thead>
<tr>
<th>Dependent variable: Farmers who are currently helping each other or not in agricultural activities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Explanatory variables:</strong></td>
</tr>
<tr>
<td>- Land size</td>
</tr>
<tr>
<td>- Number of water rights</td>
</tr>
<tr>
<td>- Size of land for housing outside the Falaj</td>
</tr>
<tr>
<td>- Type of ownership of land for housing outside the Falaj</td>
</tr>
<tr>
<td>- Active or not in water management group</td>
</tr>
<tr>
<td>- Decision-making process inclusive or not</td>
</tr>
<tr>
<td><strong>AIC:</strong> 38.37</td>
</tr>
<tr>
<td><strong>P-value for global significance:</strong> 0.041</td>
</tr>
<tr>
<td><strong>Accuracy:</strong> 0.75</td>
</tr>
<tr>
<td><strong>Precision:</strong> 0.76</td>
</tr>
</tbody>
</table>

In Model 1, the variable of land size has a positive relationship with the dependent variable. Farmers who are currently helping each other have larger farms (6 100 m² vs 5 285 m²) than farmers who are not helping. For the second explanatory variable, representing water rights, it is the opposite; farmers who are helping each other have fewer water rights, on average. Farmers who are helping each other have their land for housing outside the Falaj. The proportion of individual ownership of the land for housing outside the Falaj is higher in the category of farmers who are helping each other. For social networking, those who are helping each other are less active in water management groups, but more involved in the decision-making process.
Table 5

Model 2

Dependent variable: Farmers who are willing or not to consolidate land with neighbours

Explanatory variables:
- Number of water rights
- Size of land for housing outside the Falaj
- Type of ownership of land for housing outside the Falaj
- Active or not in water management group

AIC: 41.97
P-value for global significance: 0.1547
Accuracy: 0.78
Precision: 0.25

Source: Sultan Qaboos University, 2020.

For Model 2, farmers who are willing to consolidate land own fewer water rights than those who are not. Farmers who are not willing to consolidate land have a higher proportion of individual ownership of the land for housing outside the Falaj and also a higher proportion of individuals who are active in water management groups.

Table 6

Model 3

Dependent variable: Farmers who are willing or not to share machinery and tools

Explanatory variables:
- Land size
- Number of water rights
- Size of land for housing outside the Falaj
- Good relationships or not with groups in the neighbourhood

AIC: 29.60
P-value for global significance: 0.014
Accuracy: 0.73
Precision: 0.83

Source: Sultan Qaboos University, 2020.

In Model 3, farmers who are willing to share machinery and tools have greater land sizes by approximately 2200 m², and greater land size for housing outside the Falaj than those who are not willing to share machinery. However, they have fewer water rights (approximately two Athar less). In social networking, farmers willing to share machinery have a higher proportion of individuals who have good relations with groups in the neighbourhood.
Small-scale and family farmers’ collective action in managing natural resources in Oman

The Aflaj System - Current performance and potentials for improvement

Table 7

Model 4

<table>
<thead>
<tr>
<th>Dependent variable: Farmers who are willing or not to create a Falaj Aflaj association</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Explanatory variables:</strong></td>
</tr>
<tr>
<td>- Number of water rights</td>
</tr>
<tr>
<td>- Size of land for housing outside the Falaj</td>
</tr>
<tr>
<td>- Type of ownership of land for housing outside the Falaj</td>
</tr>
<tr>
<td>- Believe or not in the need for transformation of legal status of the Falaj</td>
</tr>
<tr>
<td><strong>AIC:</strong> 39.71</td>
</tr>
<tr>
<td><strong>P-value for global significance:</strong> 0.003</td>
</tr>
<tr>
<td><strong>Accuracy:</strong> 0.79</td>
</tr>
<tr>
<td><strong>Precision:</strong> 0.91</td>
</tr>
</tbody>
</table>

In Model 4, farmers who are willing to create an Aflaj Association have more water rights and larger land sizes for housing outside the Falaj than those who are not. They also have a higher proportion of individual ownership of land for housing outside the Falaj. Farmers belonging to the same group have a higher proportion of individuals who think that there is a need for transformation of legal status of the Falaj.

Model 4 is very accurate and the global significance of the variables is high at any level. The degree of precision is very high and we were able to identify farmers who are willing to create an Aflaj Association at 91 percent precision.

Model 2 may have a limitation in terms of global significance and precision, but it should be mentioned that it is the best possible fit obtained given the low number of observations (81). In addition, the variable indicating willingness to consolidate land is very important in the study since we are interested in small-scale farms and consolidation is very important in physical and social capital and can present a good opportunity for many farmers to improve the productivity of their farms.

The land size of the farm, the number of water rights, and housing inside the Falaj, as well as the type of ownership, are determining factors for many decisions taken by the farmer to collaborate or to consolidate effort in labour and management with groups in the Falaj. We initially expected that the models obtained with such a small sample could be weak. To our surprise, the models are good and accurate enough to classify any farmer individually in different groups, based on the observation of the explanatory variables, or to predict the proportion of farmers that belong to the same group and have the same characteristics, based on the explanatory variables. With additional sample observations, some models can be improved and likely other variables related to social and institutional trust can become part of the models. When we examined the correlation between variables related to any collective action and other variables of the study, we found that, in general, variables related to social capital are positively correlated to variables about collective action. This means that farmers having common characteristics in terms of social trust, institutional trust or group networking are more likely to have positive responses to the questions related to working collectively, consolidating land or sharing labour and machinery. With positive correlations, we can conclude that enhanced social capital results in improved human capital and high collaboration and better collective action, which can influence the modernization and improvement of the Aflaj systems.

Source: Sultan Qaboos University, 2020.
For the actual proposed models, only the variable about social networking was relevant and had a significant effect on the predicted outcomes. For variables related to social and institutional trust, the model selection step shows non-additional significance of these variables to the proposed models. This may be explained by the fact that significance tests are unreliable in small samples. In addition, we observed that responses generally show similar levels of trust in different groups of dependent variables. The responses are very similar and do not show large changes between groups (low variability).

It is unexpected to see this category of variables excluded from our models, since intuitively, they should have a certain impact on the decisions of the farmers in collective and social action. There is probably a need to include more sample observations in order to see variables from social and institutional trust considered in the predictive models.
Discussion
The modernization of the Aflaj depends on the ability of the farmers to collaborate within the community. It will depend on their ability and motivation to take advantage of both human capital and social capital. A good level of social capital is mainly measured by social and institutional levels of trust, as well as social networking. Many small farmers have abandoned some crops because of low profitability of their farms, which have been reduced in many cases to small parcels. The government of Oman is encouraging investment in the modernization of the Aflaj and their irrigation systems with the condition of conserving and protecting their social and historical aspects. By 2018 some 11 Aflaj went through modernization, covering an area of 197 feddans. Some 500 farmers benefitted from these projects which made it possible to approximately double the irrigated area (MAFWR, 2019; personal communication). The central assumption of this research is based on the idea that the performance of a Falaj relies on the social capital created within and among the organizational structures existing in the rural communities of the system. The more the rural communities have built-in social capital, the more effective is the Falaj system. In fact, social capital interacts with physical capital and with the organizational structures created around it, affecting the productivity and sustainability of the system, including the amount of irrigated land, the amount of water provided for productive use, the crop yields achieved and the distribution of direct and indirect costs. The consolidation of both social and human capital can play a dominant role in the improvement of the Falaj system.

The study examines the ability of people possessing small farms within one Falaj to contribute collectively to the modernization of the existing system and to collaborate internally, with local and central governments, and with any groups or associations in the village or in the surrounding areas. It appears from the results that larger farm size is a positive incentive for cooperation, along with income. Farmers who are actually collaborating on the use of labour and machinery have relatively larger farm sizes. In addition, the higher the income, the easier is the cooperation. This could be explained by the fact that “wealthier” households are willing to take more risks to explore ways to collaborate. Results showed that farmers who are currently cooperating with their peers are generating a higher return per feddan. In fact, farmers involved in cooperation gained 2 239 OMR/feddan versus 861 OMR/feddan for those who are not collaborating.

Apart from the questions related to land and production systems, interviewed farmers were asked questions that were mainly focused on aspects of human capital and the ability to act collectively, and social capital with its three dimensions – social trust, institutional trust and social networking. Other questions focused on topics such as organizational structure and legal frameworks. Results about the ability and motivation of farmers to take collective action were very encouraging. The majority of farmers provided positive responses to the questions regarding willingness to share labour, machinery and tools, except for the question about willingness to consolidate land. Land consolidation/aggregation with neighbours received only 23.5 percent of positive responses. This result is not surprising, since many farmers are more conservative about the idea of sharing land with other households, which leads them to reject common management of the land with people other than their relatives. Because of cultural considerations, sharing/aggregating land is perceived as a form of abandoning a precious family heritage. This aligns with the high level of trust in relatives compared to other communities.

There is still a strong attachment to land ownership. In addition, the absence of a cadastre for agricultural land, clearly showing the borders and the ownership of the properties, is not conducive for land rental or consolidation for common management. According to Falaj Tanuf’s manager, only some of the lands within the Falaj are registered in the cadastre. Nevertheless, the results also highlighted the interesting fact that around 54 percent of the land is still owned by a family and not individually owned. This shows that more than half of the households are conserving land for farming and avoiding further subdivision. This serves as a good indicator of level of cooperation among family members. Furthermore, the proportion of farmers who are willing in the future to consolidate/aggregate land with other family members and use it as a single farm to reach a critical size is 63.6 percent, which is higher than the current level of cooperation among family members.
The results about strong social trust are highly encouraging. The percentages of positive answers to questions related to institutional and social trust are in general much higher than those indicating distrust. Seventy percent of the respondents, on average, “trust” and “totally trust” their families, friends, neighbours and community members. Only 7 percent of the respondents have little trust and just 2 percent totally distrust their neighbours or other farmers in the community. The current social environment is considered to be enabling and conducive for cooperation among farmers. However, care should be taken, as the results clearly showed that this dimension of social capital is slowly fading. The level of decreased trust is higher than the level of increased trust for all age categories during the last ten years.

For questions regarding social networking, results are different. Farmers are more active in youth and WhatsApp groups than other forms of associations or social groups. The majority are aware of positive or negative changes to life in the Falaj.

Our analysis shows positive relationships between variables related to collective action and variables related to social capital. This finding shows the importance of both social capital and collective action in the development of Aflaj systems. Social and institutional trust indicate stronger relationships than social networking, except for some specific groups such as youth groups or the groups using WhatsApp, which do represent an important factor. According to the majority of farmers, transformation and improvement of the legal framework and the creation of associations in the Falaj can help in developing the social capital and consequently can be an incentive for the farmers to work collectively.
8

Recommendations
The survey results show clearly that small land size is not per se an obstacle to cooperation among farmers or for sustaining agricultural production and food security, given that farming is taken as part-time or secondary source of income, which is the case for all Aflaj considered in this study.

The high level of social trust is reflected in the current level of cooperation observed among households in the Aflaj communities that are sharing land, labour and machinery. Several families maintain the land as common property and avoid its division to conserve the farm size and sustain the production. The cooperation of family members reflected in common ownership of land is positive for keeping a reasonable farmland size that allows sustainability of the agricultural activity and productivity. Around 68 percent of households expressed their willingness and interest to consolidate/aggregate family land in the future, while only 23 percent are willing to cooperate with their neighbours.

Efforts should be deployed to delegate management to one family member, who should be able to make the necessary decisions to improve management and likely start cooperation with the farming community.

Another path towards cooperation is encouraging owners of small plots to rent them through well-prepared contracts that define the property and protect it. Providing a variety of management contracts for these farms, to formalize cooperation within a family and ease cooperation within the community, is an important step towards better cooperation in the future.

Encouraging farmers and facilitating the registration of their properties in the cadastre would certainly help in land aggregation and consolidation. Such action would likely encourage the rental of land and consolidation of the common management of farmland, which is expected to result in the enhancement of food security, as more agricultural products will be available in the market.

It has been observed that 18 percent of households have built their houses inside a Falaj, effectively turning the farm into a fenced garden. This prevents any possibility of common farm management. In fact, the surveys highlighted that in Falaj Al Ghantaq, for example, most of the farms have been fenced with houses built inside. Such a transformation prevents the use of the Falaj for recreation activities for visitors and does not allow sustainability of agricultural production and food security. Cooperation among farmers in such types of fenced gardens will be almost impossible.

The Omani government has long ago developed land for housing outside the Falaj in order to protect the agricultural land from urban invasion. Overall, this strategy has been fruitful as only a minority of farmers built houses inside the Aflaj. A tighter implementation of the regulations, such as totally prohibiting building new houses inside the Aflaj, is recommended. In parallel, public authorities could encourage the extension of the urban areas around Aflaj to satisfy the demand of housing plots. The modernization of management of the farms includes protection of agricultural land inside the Aflaj, reserving it exclusively for agricultural activities. The lack of urban land outside the Aflaj should be resolved by offering alternatives to households. This is very important, to avoid those in younger generations building their houses inside the Falaj. It is also recommended, whenever possible, for the government to develop policies to expand the availability of agricultural lands in areas bordering Aflaj. This has already been observed in Aflaj where the irrigation system has been transformed to a drip and sprinkler irrigation system; the saving of water allowed for almost doubling the irrigated land.
Aflaj households have shown that they are actively cooperating on labour force usage through the recruitment of expatriate workers working in two or more farms. This cooperation is driven by the cost of labour as well as the existing labour laws regarding the recruitment of expatriate workers. The level of trust among farmers is also an important factor for such cooperation.

A large proportion of households mentioned the negative impact of expatriate workers during the last ten years, from 2010-2020. According to the farmers, expatriate workers lack the agricultural skills to manage the farms. This has impacts on farmland, crops and water management, especially when they work for households who are not resident in the area. One option for reducing the dependence on expatriate workers and cutting costs of labour within the Falaj community is the introduction of small machinery for ploughing, planting and pruning which can be shared by all the farmers in the Falaj.

The modernization of Aflaj management can include the introduction and sharing of small machinery. This will reduce the dependence on expatriate labour, as well as cutting costs. This recommendation stems from the fact that sharing machinery is easier than sharing permanent expatriate workers, as shown by the higher rate of willingness to cooperate on “machinery sharing”. The use of small machinery is observed at international level in the small rice field terraces in China, as well as in small Japanese farms. Transferring this sort of technology will likely increase productivity, cut costs and reduce the dependency on expatriate workers. Training of farmers on the use and maintenance of this sort of machinery will be needed. Farmers have shown an existing high level of cooperation on machinery sharing. Sharing resources implies an existing strong social capital that can be further cemented and enhanced with introduction of low-cost small machinery.

The observed levels of trust within the communities studied here are quite high. However, levels of trust are declining, especially among the younger generations. Most farmers rely on informal contracts, as mentioned in the group discussion. Thus, evolving from informal contracts to simple formal contracts would protect the rights of all involved households and strengthen the group social relations. This in turn will encourage higher levels of cooperation.

Engagement in joint marketing of crops and other farming activities is successful in the Aflaj. Almost all farmers producing for the market showed their willingness to participate in joint purchase of inputs and joint marketing of products. Many of these farmers are using social media as a channel to sell their local products. More than 50 percent of households are using social media; this is an indicator that existing organizational “informal groups” have a say in cooperation and should be targeted to strengthen the collective action of farmers in order to support the modernization of the Aflaj. The public authorities can further support these initiatives by encouraging a broader connection of the producers to urban consumers.

Improving the maintenance of the Aflaj could also be achieved through the facilitation of formally establishing an Aflaj Association. The role of the Association will be essentially to introduce modern technology for the maintenance of the underground channels, share experience and share skilled farmers who have experience in the maintenance of Aflaj.

Aflaj communities can gain substantial returns by selling part of their agricultural water to other sectors of the economy. Once farmers find a market for their water, this will drive a higher use efficiency of irrigation. This question received a low interest in the survey, with only 15.2 percent willing to sell Falaj water. In fact, reduction of the irrigated area, due to urbanization, in some Aflaj (e.g. Al-Ghantaq) should be conducive to such a trade, as indicated by the Falaj manager. Returns from water sales could be used to improve Falaj maintenance.
Case study: Falaj Tanuf
Falaj Tanuf is located in the Wilayat of Nizwa, as shown in Figure 7. (The Falaj and the dam are shown.) Falaj Tanuf was selected because the aquifer system is a karst aquifer, allowing the installation of a flow controller gate so water can be detained behind the gate (Al-Abri, 2016).

Source: Sultan Qaboos University, 2020.
According to the Agricultural Census 2013-14 (MAFWR, 2014), there are 179 farms in Tanuf using the Falaj as a source of irrigation. A large variety of crops are grown, including vegetables, fruits and annual crops such as fodder. Table 8 shows the top 15 crops covering the largest areas and the highest numbers of trees. As shown in this Table, palm groves cover 216,281 m² which is 50.6 percent of the irrigated area. Different types of forage crops, such as corn, alfalfa and sorghum, represent 37 percent of the cropped area.

<table>
<thead>
<tr>
<th>Crop/Tree</th>
<th>Area (m²)</th>
<th>Number of trees</th>
<th>Percent of total area of Falaj</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palm groves</td>
<td>216,281</td>
<td>4,827</td>
<td>50.61</td>
</tr>
<tr>
<td>Corn</td>
<td>88,465</td>
<td>-</td>
<td>20.70</td>
</tr>
<tr>
<td>Panicum miliaceum (millet)</td>
<td>36,174</td>
<td>-</td>
<td>8.46</td>
</tr>
<tr>
<td>Alfalfa clover</td>
<td>25,576</td>
<td>-</td>
<td>5.98</td>
</tr>
<tr>
<td>Sorghum</td>
<td>10,943</td>
<td>-</td>
<td>2.56</td>
</tr>
<tr>
<td>Wheat</td>
<td>9,486</td>
<td>-</td>
<td>2.22</td>
</tr>
<tr>
<td>Sugar cane</td>
<td>6,039</td>
<td>-</td>
<td>1.41</td>
</tr>
<tr>
<td>Onion</td>
<td>5,715</td>
<td>-</td>
<td>1.34</td>
</tr>
<tr>
<td>Garlic</td>
<td>5,001</td>
<td>-</td>
<td>1.17</td>
</tr>
<tr>
<td>Sweet lemon (Quince) trees</td>
<td>4,205</td>
<td>145</td>
<td>0.98</td>
</tr>
<tr>
<td>Barley</td>
<td>3,945</td>
<td>-</td>
<td>0.92</td>
</tr>
<tr>
<td>Lemon trees</td>
<td>3,807</td>
<td>141</td>
<td>0.89</td>
</tr>
<tr>
<td>Chickpeas</td>
<td>3,117</td>
<td>-</td>
<td>0.73</td>
</tr>
<tr>
<td>Other forage crops</td>
<td>1,810</td>
<td>-</td>
<td>0.42</td>
</tr>
<tr>
<td>Fig trees</td>
<td>1,365</td>
<td>39</td>
<td>0.32</td>
</tr>
<tr>
<td>Other crops/trees</td>
<td>5,430</td>
<td>-</td>
<td>0.81</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>427,359</strong></td>
<td><strong>100.00</strong></td>
<td></td>
</tr>
</tbody>
</table>

Source: Sultan Qaboos University, 2020.

There are 179 farms using Falaj Tanuf for irrigation. Some 109 Omani and 141 expatriate workers are reported as working in these farms. The minimum size of farms in Tanuf area is 67 m². The average farm size is 1,721 m² and the maximum size is 13,017 m².

The majority of the households (two-thirds of the total) are composed of people 41 years old or older and only one-third are aged 31-40 years. Those with members 41-50 years old represent half of the population of farmers in the Falaj.

To the question: “Youth in the Agriculture and the Falaj”, 35.1 percent of the interviewees think that most young people do not want to move out from the Falaj, despite hard working conditions, and wish to improve their livelihoods and living conditions within their Falaj. However, 10.8 percent of the responses indicated that younger generations think that agriculture is too hard and many wish to move out from the Falaj. The results for Tanuf are contrary to those of other Aflaj. But it should be noted that the category of young people under 30 years old represents 0 percent in Tanuf; hence, the results should be taken with caution.
Table 9 shows the size of the farmland. On average the farm size is 3,364 m² or 0.8 feddans (feddans) while 25 percent of the households own less than 850 m². There is a large variation in farm size, ranging in this case from 400 m² to 10,000 m² (3.4 feddans).

Farmers who own relatively larger farms and have a high income, gained from outside the agriculture sector, are more inclined to collaborate and cooperate with their neighbours and farmers’ community. The collaboration considered here is the mutual aid among farmers, measured by the response to the question F1: “Do you help other farmers in agricultural activities?” The median farm size for farmers involved in mutual aid is higher, at 3,400 m² versus 2,000 m² for those not involved in mutual aid. It appears from these results that farm size is a positive incentive for cooperation as well as income. The higher the income, the easier is the cooperation. This could be explained by the fact that “wealthier” households are willing to take more risks to explore cooperation.

The majority of farms (61.1 percent) are owned by a family and are not individually owned. This already is a positive sign of cooperation among family members, which avoids the division of land. On the other hand, family ownership makes it difficult to further cooperate with neighbours, as the decision is not made by one single person but involves several family members. The average farm size owned by a family is 2,950 m² and is lower than the farms individually owned with an average size of 3,400 m². The numbers here show that some land consolidation has taken place, most likely through sales from family members. Only 5 percent of the farms are rented.

As for willingness to strengthen cooperation in the future, a high proportion of farmers (72.2 percent) showed an interest in consolidating land with family members. Land consolidation with neighbours received little approval from households, with only 22.2 percent willing to enter in such an action. Most households said that they are not willing to consolidate land with neighbours, in order to avoid disputes and retain their freedom of decision-making.

One more obstacle to household cooperation is houses built inside the farm. Households who have built their houses inside the farm represent a high proportion (38.9 percent) of the total interviewees. For this category of households the farm is effectively a fenced garden, totally excluding the possibility of sharing labour, machinery or land consolidation, regardless of its size. The fenced garden is considered part of the house and traditionally no foreigners are allowed in. Among those who hold housing inside the Falaj, 75 percent are sharing the ownership of the farm with family. The proportion of farmers who have houses inside the Falaj and also own land for housing outside the Falaj is 27.8 percent.
A GIS analysis has been carried out for Falaj Tanuf and results have shown that 28 percent of the Falaj area is fenced and hence could not be considered in a future plan of common farm management.
Results of the survey showed that the proportion of households who hired permanent workers during the past three years is very high, representing 77.8 percent of the respondents. Some farmers prefer hiring occasionally when needed; they represent 27.8 percent. Only 22.2 percent of the households do not hire permanent or occasional workers. The average farm size owned by the households not employing expatriate workers is 850 m². Those farmers are not allowed to recruit expatriate labour, given the national regulations and they also cannot afford to pay the salary of an expatriate worker, as the farm’s production will not cover the costs. Those who do employ workers have an average land size of 3 922 m². Although 77.8 percent of the respondents rely on permanent expatriate workers, 50 percent also affirm that they are sharing the permanent labour for farming.

The level of willingness to share permanent labour is 88.9 percent. This rate of willingness is higher than the current permanent labour force sharing. Willingness to share machinery was indicated by 72.2 percent of the respondents. This is also a positive sign, as introducing new small machinery will be highly accepted by households.

Positive signs of cooperation are evident, as 50 percent of households affirmed that they are already helping each other through mutual aid – mainly in pruning, harvesting, consulting and advising, maintaining and sharing permanent workers.

The results of the survey showed that, overall, the level of trust is quite high. On average, 77.8 percent have “trust” and “total trust” in families, 55.5 percent in friends, and 44.4 percent in neighbours and community members. The results show clearly that the group-relation social environment is enabling and conducive for cooperation among farmers. In other words, the current relationships within the families and among the households are very strong and do not constitute any barrier to cooperation.

When farmers were asked about whether the level of trust among community members had been decreasing or increasing during the last ten years, a high percentage indicated they had the same level of trust in relatives and other farmers – 61.1 percent and 66.7 percent, respectively. However, half of the respondents declared a decreasing level of trust in neighbours. For questions related to institutional trust, the majority of respondents see themselves as having a neutral perspective regarding all institutions except for the traditional village leader and Falaj treasurer, in whom they have more trust – 61.1 percent and 44.5 percent, respectively.

The organizational factors linked to collective action of farmers are reflected in Table 10 below. All the organizations in Aflaj are informal, except the farmers’ associations. Youth groups, to which 73.3 percent of the respondents belong, rank highest in group participation, and 46.7 percent are active in the water management group. The activities in this latter group are related to the maintenance and cleaning of the Aflaj. Social media is also present among the farming community, with 50 percent connected through WhatsApp. Groups connect through social media to exchange advice and experiences and to participate in decision-making processes.
Only 27.8 percent of the farmers consider that the decision-making process is inclusive.

As for the modernization of the irrigation system, most farmers (83.3 percent) believe that there is a need for the transformation of the legal status of the Falaj, specifically in relation to the irrigation system. The proportion of farmers who are willing to create a Falaj association is 44.4 percent.

Sixty-seven percent of farmers think that important negative changes have affected the community and the households, while a large majority (93.8 percent) also think that positive changes have benefited the community during the last 5-10 years. Interesting findings are that 11.2 percent of the households are currently providing services for tourists or selling products in the local market, which shows modernization of the activities by opening up the farms for recreation, and 55.6 percent of the farmers are preserving local plants and seeds, a high enough proportion to be encouraging for sustainability and maintenance of biodiversity.

Given that the main purpose of production is for family consumption, the households who expressed interest in joining groups for joint purchase of inputs (13.8 percent) and joint marketing of products (34.5 percent) together represent half of the total respondents. All households who produce more than the family uses are interested in joining efforts for better marketing of the products and services produced in the Falaj. Only 7 percent of the farmers are interested in cooperating to add value to the local products. The transfer of agricultural water from the Falaj to other sectors of the economy also received limited interest, with only 24.1 percent being willing to sell Falaj water.

### Table 10

<table>
<thead>
<tr>
<th>Group</th>
<th>Percent participating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture groups/farmers’ associations</td>
<td>0</td>
</tr>
<tr>
<td>Water management groups</td>
<td>46.7</td>
</tr>
<tr>
<td>Village groups</td>
<td>6.7</td>
</tr>
<tr>
<td>Religious or spiritual groups</td>
<td>6.7</td>
</tr>
<tr>
<td>Youth groups</td>
<td>73.3</td>
</tr>
<tr>
<td>Savings groups</td>
<td>7.1</td>
</tr>
<tr>
<td>WhatsApp or other social media groups</td>
<td>50</td>
</tr>
</tbody>
</table>

*Source: Sultan Qaboos University, 2020.*
Reference


Dear participant,

The research, which falls under an FAO project in collaboration with Sultan Qaboos University and the Ministry of Agriculture, Fisheries and Water Resources, examines the enabling factors (both external and internal, socio-economic and institutional), influencing the modernization of Aflaj to improve food security.

It will show the importance of human and social capital, which affect the development of farmers’ collective action and ultimately contribute to the modernization of the Aflaj and their sustainability.

Today we would like to ask you questions about your household, community and life in the Falaj. All the information you give will be strictly confidential. Your name or any information you disclose will not be given to anyone outside the project. Your cooperation is greatly appreciated as it will help us to understand better the life and work in the Falaj and the aspirations of the community for its modernization.

All information that you provide in the questionnaire will be treated as strictly confidential.

For further information, please contact:

Slim Zekri,
Sultan Qaboos University
slim@squ.edu.om
Mobile: +968 92309149

Nora Ourabah Haddad
FAO Oman
nora.ourabahhaddad@fao.org

Questionnaire No: ..................
Part A: identification data

A1. Name of interviewer: ............................................................................................................................................

A2. Name of interviewee: ............................................................................................................................................

A3. Contact number: .................................................................................................................................................

Part B: unit of analysis

B1. Name of Falaj: .....................................................................................................................................................

Part C: household profile

C1. Gender of the household head

☐ Male    ☐ Female

C2. Age of the household head

☐ Under 30    ☐ 31-40    ☐ 41-50    ☐ 51-60    ☐ Over 60

C3. Main job ..............................................................................................................................................................

C4. Monthly family income (OMR)

☐ Less than 600    ☐ 600-1000    ☐ 1000-1500    ☐ 1500-2000    ☐ 2000+

C5. Proportion of income from agriculture

☐ 0-20%    ☐ 20-40%    ☐ 40-50%    ☐ More than 50%
**Questionnaire** target group: farmers in the Aflaj

**Part D: land and production assets**

D1. Land size

☐ individually owned  ☐ family owned  ☐ rented

D1.1 How many water rights do you own? (Athar = 30 mn water share) in minutes

D2. House within the Falaj?

☐ Yes  ☐ No

D2.1. If yes

☐ individually owned  ☐ family owned

D3. Do you own land for housing outside the Falaj?

☐ Yes  ☐ No

D3.1. If yes

Size

☐ individually owned  ☐ family owned

D4. During the past 3 years have you worked on the farm, taking care of farm-related work?

☐ Yes  ☐ No

D5. During the past 3 years, have you hired any permanent worker to work on your own farm?

☐ Yes  ☐ No

D6. If yes, what is the average monthly salary you provide for the permanent worker?

D7. What are the main tasks the permanent employee is in charge of?
D8. During the past 3 years, have you hired occasional workers to work on your own farm on a regular basis?
- Yes
- No

D9. What are the main tasks undertaken by the occasional workers?
- Pruning
- Harvesting
- Palm tree tasks
- Marketing tasks

D10. During the past 3 years, what was the major use of the land?
- Cultivation for family consumption
- Cultivation for selling in the market or to tourists
- Recreational activities for family as a garden
- Tourism: renting the farm for local or foreign visitors
- Other reason(s)

D11. Who irrigates your farm?
**Part E: production system**

E1. What types of products are cultivated?

<table>
<thead>
<tr>
<th>Product Type</th>
<th>Number</th>
<th>Area (m²)</th>
<th>Area for forage crop (m²)</th>
<th>Please specify types</th>
<th>Please specify Areas (m²)</th>
<th>Please specify types</th>
<th>Please specify</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date palms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fodder</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit trees</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vegetables</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please specify types

E2. What type of livestock do you raise?

<table>
<thead>
<tr>
<th>Livestock Type</th>
<th>Number</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cows</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sheep/Goats</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chickens</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please specify

E3. Are you preserving local plants and seeds?

- [ ] Yes
- [ ] No

Please specify which ones, as well as the types of activities that you perform to preserve them
Part F: collective action

F1. Do you help other farmers in agricultural activities?

☐ Yes ☐ No

What are the activities for which support is provided?

F2. Are you getting help from other farmers in agricultural activities?

☐ Yes ☐ No

What are the activities for which you are getting support?

F3. Are you willing to consolidate your land and use it as a single farm with your family members to reach a critical size?

☐ Yes ☐ No

Why?

F4. Are you willing to consolidate your land and use it as a single farm with your neighbours to reach a critical size?

☐ Yes ☐ No

Why?

F5. Are you sharing permanent labour for farming?

☐ Yes ☐ No

Why?
Questionnaire target group: farmers in the Aflaj

F6. Are you willing to share permanent labour for farming within the Falaj community?
   □ Yes  □ No

Why?  

F7. Are you willing to share machinery and tools for farming?
   □ Yes  □ No

Why?  

F8. Do you contribute to the maintenance or conservation of irrigation infrastructure of the Falaj?
   □ Yes  □ No

Why?  

F9. How much do you pay annually for maintenance or conservation of irrigation infrastructure of the Falaj?

Nothing. Why not?

F10. Are you willing to be part of groups or associations to engage in (tick all that apply):
   □ Joint purchase of inputs
   □ Joint marketing of products
   □ Joint marketing of water for uses other than agricultural purposes
   □ Joint value addition
   □ Developing a joint label for local production
   □ Any other service you deem of importance
Small-scale and family farmers’ collective action in managing natural resources in Oman

The Aflaj System - Current performance and potentials for improvement

F11. Are you already doing any of the activities mentioned in questions F1-F5?

☐ Yes  ☐ No

Please specify which one(s)? ........................................................................................................................................

F12. In the past 12 months, have you participated in any voluntary common activity to do some work for the benefit of the community/ Falaj?

☐ Yes  ☐ No

Part G: group relations social trust

G1. Do you have trust in

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Relatives?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Friends?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neighbours?</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Farmers of your community?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

G2. How do you evaluate the level of trust in the family and in the neighbourhood over the last 10 years?

<table>
<thead>
<tr>
<th>Level of trust over the last 10 years</th>
<th>1. Same level of trust</th>
<th>2. Increased level of trust</th>
<th>3. Decreased level of trust</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neighbourhood</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Among individual farmers</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Questionnaire** target group: farmers in the Aflaj

---

**Part H: group relations institutional trust**

H1. Do you have trust in?

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Local government officials?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central government officials (MAF, MRMWR officials)?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traditional village leader?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Falaj manager?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Falaj treasurer?</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Extension workers?</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Religious leaders?</td>
<td></td>
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</tr>
</tbody>
</table>

H2. Are there restrictions or corrective measures for not abiding by the rules for water use in the Falaj?

- Yes
- No

Please specify

---

H3. Do you have any interactions with local/central institutions?

- Yes
- No

Please specify
Part I: group relations social networks

I1. Are there active groups in the Falaj?

<table>
<thead>
<tr>
<th>Type of group</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture group / association</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water management group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Village group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Religious or spiritual group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Youth group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Savings group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WhatsApp group or any other social media group (specify the type)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other (specify the type)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I2. Do you belong to formal or informal groups or associations?

☑ Yes     ☐ No

Please specify

I3. In your opinion, what are the two most important groups existing in the Falaj?

Group 1

Group 2

I4. How often do people meet in these groups?

Group 1

Group 2
I5. How can you acquire membership in these groups?

☐ Required to join
☐ Invited
☐ Voluntary choice
☐ Other

I6. What do you think are the benefits of joining these groups?

I7. Are there good relationships with other groups in the neighbourhood?

☐ Yes ☐ No

Please specify

I8. Thinking about life in the Falaj, in the last 5-10 years, were there any important changes that affected, positively or negatively, the community and the households?

**Positively:**

☐ Yes ☐ No

Please specify

**Negatively:**

☐ Yes ☐ No

Please specify
Part J: Falaj organizational structure

J1. In your opinion, how is the local leadership?
- Strong
- Passive
- Weak
- Please specify

J2. Is the decision-making process inclusive?
- Yes
- No
- Please specify

Part K: legal framework

K1. Do you think there is a need for transformation of the legal status of the Falaj?
- Yes
- No
- Please elaborate further

K2. Are you willing to create a Falaj association?
- Yes
- No
- Please elaborate further
Questionnaire target group: farmers in the Aflaj

Part L: environmental sustainability

L1. What type of pesticides are you using?

- Organic
- Synthetic

Please give an idea of frequency and quantity

L2. What is your perception on the Falaj flow of water? Has it changed in the last 5 years?

L3. How would you rate the pollution level in the Falaj (negative impacts on the environment)?

- 1. Very worrying
- 2. Worrying
- 3. Neutral
- 4. Not worrying
- 5. Not worrying at all

L4. What kind of effects of climate change do you see in the Falaj?
Part M: youth in agriculture and the Falaj

M1. Young people see no future in agriculture and in the Falaj and are eager to emigrate.

- Most young people think that agriculture is too hard and many wish to move out of the Falaj.
- Most young people do not want to move out of the Falaj, despite hard working conditions, and wish to improve their livelihoods and living conditions within their Falaj.
- Most young people are satisfied with working conditions and do not want to move out.
- Young people see their future in agriculture and are eager to continue and improve the activity of their parents.

Any suggestions to improve the existing system of Aflaj: Please give as much detail as you can.

WE HIGHLY APPRECIATE YOUR COOPERATION AND TIME