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Do Governance Perceptions Affect Cooperativeness? Evidence from Small-Scale Irrigation Schemes in Northern Ghana

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Abstract: We use household survey data and results from a lab-in-the-field experiment to examine the impact of governance perceptions on the cooperativeness of water users in the maintenance of 19 small-scale irrigation schemes in northern Ghana. Cooperativeness is measured by two indicators, one indicator derived from the experiment and the other obtained from the survey. We distinguish the governance perceptions of users into six main components, and regress the two indicators on these six components. We consistently find for both indicators that cooperativeness is lower when users perceive that their water user association (WUA) is more successful in resolving conflicts. We also find that perceptions of accountability, transparency, and participation in governance jointly affect cooperativeness in a positive way, but collinearity problems refrain us from identifying which component(s) do(es) so. Type of leadership—whether or not the WUA leader was democratically elected—does not have a significant effect on cooperativeness, while having received irrigation-related training positively affects cooperativeness as measured by labor contributions to scheme maintenance. We argue that these novel insights can be of great importance for promoting sustainable management of small-scale irrigation schemes, but needs further research to examine its external validity.

Keywords: irrigation governance; water users; cooperativeness; collective maintenance; Ghana

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1. Introduction

Irrigated agriculture is advocated for improving food security, especially in developing countries in the wake of climate variability and climate change. Irrigation particularly improves agricultural performance and rural livelihoods [1–4]. Over the years, governments in developing countries have therefore invested in irrigation infrastructures. Large-scale irrigation schemes however are not only costly to build but also costly to maintain, often leaving them in a state of disrepair. This has led many development agencies to support the construction of small-scale schemes and to involve stakeholders in the planning and implementation. The idea is that inclusion of stakeholders inculcates a sense of ownership for the effective maintenance of a scheme [5,6]. Inclusiveness also reduces the burden on governments in terms of daily management and maintenance of irrigation facilities. Ostrom [7,8] emphasized the need for self-governance of common resources such as irrigation schemes. Her central point is that users of common resources can organize themselves into associations that can effectively and sustainably manage the resources. Thus, the "tragedy of the commons" is not unavoidable, and sustainability of common pool resources does not require authorities to intervene top-down [9]. These insights led to the widespread formation of Water User Associations (WUAs) for the governance of small-scale schemes in developing countries. Yet many of Africa's small-scale irrigation schemes appear to have collapsed, with researchers mostly blaming mismanagement and some weaknesses in WUA approaches [10,11].

Effective participatory governance of small-scale irrigation schemes depends on the cooperation among users in enforcing rules in the operation and maintenance of irrigation facilities. One way of assessing cooperation in self-governing user groups is the level of compliance in contributing towards the maintenance of facilities [12]. Primary contributions from users can be in kind and in cash. However, where collective action is key to achieving common goals, the tendency for some users to free-ride is inevitable. The ability of a user group to succeed in managing irrigation resources thus lies in the cooperativeness of its members, that is, their willingness to act together for a mutual interest and to demonstrate their trust in the other members through their actions. As pointed out by Cardenas et al. [13] (p. 301), "collective action in water management requires that individuals overcome their individual incentives to free-ride and be willing to cooperate in the provision dilemma".

Based on both observational data and data from behavioral experiments, the literature has identified several factors that may explain why users of a common resource may not contribute equally to a common goal [12–15]. Personal characteristics such as gender and age, for instance, seem important. The specific roles played by men and women in households may constrain their availability for communal activities differently. Young and old may also be involved differently in common matters because of their differences in experience and time horizon. Some researchers have also pointed out that individual contributions are context-based, and thus influenced by non-personal factors [16–18].

Characteristics of the common resource can also be important, including the institutional arrangements governing the resource. For instance, is the resource governed by the government or by its users, and which institutions are put in place to ensure compliance? Governance has many dimensions and, as shown by Kannan et al. [19], these dimensions may impact irrigation performance differently. Resource users' perceptions of these governance dimensions may play an important role here. As explained by Kaufmann et al. [20], perceptions matter in assessing governance because individuals base their decisions on perceived outcomes taking into consideration circumstances surrounding the decisions. This goes beyond a simple distinction between government- or user-managed resources, i.e., the perceived style of governance. The involvement of users may be larger when they observe that resources are better governed in terms of accountability of leaders, transparency in dealings, fairness/equity in resource allocation, and other governance components. Understanding how these different components can influence users' contributions can help foster the debate on sustaining small-scale irrigation resources.

This paper aims to obtain an insight into the effects of governance perceptions on the cooperativeness of water users organized in WUAs of 19 small-scale irrigation schemes in northern Ghana. The cooperativeness of a user is measured with two indicators: labor spent on maintaining the scheme and cash donations to a public fund supporting the scheme. Labor contributions were derived from a household questionnaire. Cash contributions are virtual, and were obtained from a standard lab-in-the-field experiment where participants were asked to contribute to a hypothetical public fund. While none of the schemes had such a fund (WUA membership fees are small), we consider virtual cash donations as a behavioral variable that, such as labor contributions, indicates the cooperative nature of users. Using survey data collected among 190 irrigator households and the results of the lab-in-the-field experiment for the same participants, we empirically estimate factors explaining these labor and cash contributions. In addition to user attributes and scheme characteristics, we look at the perceptions users have on the governance of their scheme, distinguishing between six components.

This study adds to the available knowledge of the commons, and the knowledge of small-scale irrigation schemes in particular, by examining what explains the contributions of users (in kind or in cash) to collective action in the maintenance of the resource with a focus on the role of governance perceptions. In particular, we examine which components of governance significantly affect users' contributions to collective action. We find that user perceptions of accountability, transparency, and participation in governance jointly promote cooperativeness in a positive way, while cooperativeness is lower when users perceive that their WUA is more successful in resolving conflicts; whether or not the WUA leader was democratically elected does not have a significant effect on cooperativeness.

Having received irrigation-related training positively affects cooperativeness as measured by labor contributions to scheme maintenance.

2. Conceptual Framework

2.1. Management of Small-Scale Irrigation Systems

The most common irrigation systems in Ghana are small-scale schemes using gravity-flow reservoirs. The size of the developed area for irrigation is the main criterion used in classifying schemes in Ghana. Sizes up to 200 ha are regarded as small-scale, between 200 ha and 1000 ha as medium-scale, and 1000 ha and above as large-scale [1]. The existence and functioning of these schemes involve many actors, including state institutions, the private sector, NGOs, and users. State institutions and NGOs generally fund the construction of the facilities and provide technical support to ensure the systems function well. After construction, it is normally the desire of funding agencies that users will use them sustainably. Sustainability in this sense refers to the ability of systems to maintain their viability by using techniques that allow for continuity [5].

For common pool resources such as irrigation facilities, community ownership of facilities is vital in sustaining the systems. When communities are given a mandate to own and operate resources, they may manage the facilities by using local and communal experiences without waiting for prescribed rules. For a system to become sustainable, innovative ideas and technologies using traditional norms that are readily available are required. Gleick [21] explains that water resources that are locally innovated and managed, including small-scale dams, are more cost-effective and environmentally-friendly for local communities because of their experiences with traditional practices. The participation of local communities in irrigation governance may thus promote sustainability, because local stakeholders are often more familiar with the peculiarities of local economic, social, cultural, and environmental situations [22].

For these reasons, forming Water User Associations (WUAs), made up of local community members, has been the practice in Ghana (and many other countries) for decades. The central government of Ghana constructs and/or rehabilitates irrigation schemes through the Ghana Irrigation Development Authority (GIDA). GIDA also co-manages large and medium-scale schemes with farmers, while governance of small-scale schemes is transferred to WUAs. The WUA concept incorporates acceptable local norms and rules in governing irrigation systems so that it becomes easier for users to comply with. The most common rules of WUAs in Ghana, for instance, are compulsory participation of users in communal labor for maintenance and avoidance of upstream-farming (to minimize siltation of reservoirs). The communal labor concept is indigenous and is, thus, generally accepted for the sustenance of irrigation facilities.

Rules and regulations are required to maintain order among a group of users. This is particularly important in the management of common pool resources to avoid over-exploitation and negative externalities that pose a threat to their sustainability. Setting rules and regulations is a first step towards achieving sustainability. Sanctions serve as deterrents to other users and are also indications of unbiasedness in the management of the resources. Agrawal [23] recommends graduated sanctions, because they imply some sense of fairness as serious or frequent offenders are more severely punished.

In addition to the enforcement of rules and regulations, sustainable use critically depends on the employed type of irrigation technology and on the willingness of users to contribute to maintaining the facilities. Because the irrigation technologies used in the small-scale reservoirs in northern Ghana are quite uniform, the focus of this study is on maintenance. Here, the cooperativeness of users is reflected in the amount of labor spent on maintaining irrigation facilities and in the amount of their voluntary cash contributions through water use charges and transfers for minor utility repairs. A user's willingness to contribute is likely to be affected by both personal characteristics and characteristics of the irrigation scheme and user group. In particular, we hypothesize that the perceptions users have of the governance of their scheme influence their contributions. Our approach is schematically summarized in Figure 1 (see also Agrawal [23]).

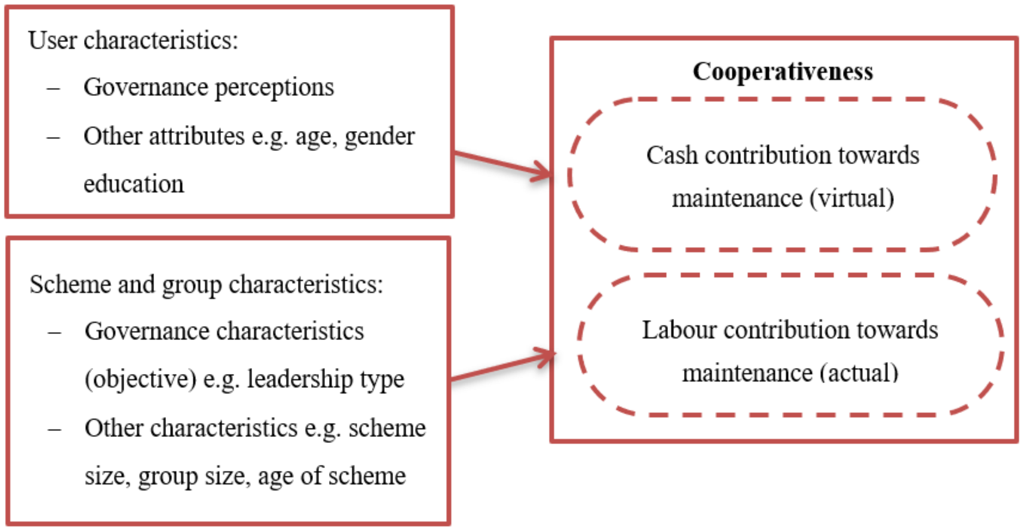

Figure 1. Factors affecting user involvement in maintenance of small-scale irrigation schemes.

In this study we examine the cooperativeness of users through their actual labor contributions to the maintenance of the scheme and their cash contributions to a hypothetical public fund supporting the scheme. The latter were obtained by running a Voluntary Contribution Mechanism (VCM) game (see Section 3.3). The two types of contributions are probably related to each other. The cash donations from the VCM game suggest evidence of the intrinsic willingness of a user to contribute to the maintenance of the scheme, and this willingness will probably also be a major driving force of a user's actual labor contribution. Moreover, as the VCM game was framed in terms of contributions towards irrigation maintenance, a user's actual labor contribution may also play a role in the hypothetical cash donations. In the next two sections we discuss the most important user characteristics and scheme and group characteristics that might influence labor and cash contributions.

2.2. User Characteristics

2.2.1. Governance Perceptions

For self-governing irrigation schemes, good governance is key to ensuring trust in users. Good governance in this sense entails using appropriate rules and regulations to guard irrigation resources. The manner in which irrigation facilities are handled by users and their leaders can have dire consequences on a user's willingness to participate. Equitable allocation of resources may for instance attract equitable contributions from users. In principle, governance can be assessed objectively [24] as well as subjectively through perceptions-based measures [25]. For the involvement of users in maintaining common property, user perceptions of governance probably are more relevant than objective criteria because users have the greatest stake in the sustainable use of their resource [26]. We elaborate the potential effects of six key governance components on user contributions to irrigation maintenance.

Participation: Issues of participation in governance may include joint decision making involving all users, women participation, and users' right of use of resources among others. A user's perception on how these issues unfold in the management of irrigation facilities can influence his/her level of contribution in maintaining irrigation facilities. When governance involves all resource users, each user may see it as a responsibility to partake in activities towards the sustenance of resources and may thus contribute towards that.

Accountability: For communal irrigation schemes, the need for leadership always arises. Leadership is required to show commitment to its responsibilities by allowing free flow of information concerning all activities [27]. Dissemination of information especially regarding expenditure and financial status of a user group can be motivating for users to contribute more for a common purpose when they feel their efforts are not wasted.

Conflict management: Common pool resources are often associated with conflicts over resource allocations, leadership, and market related disputes. Conflicts between users over maintenance and extraction of water are common in irrigation governance [28]. For users to contribute in collective action, user groups need to effectively manage conflicts to the satisfaction of all users. Disgruntled users may not contribute much in resource maintenance when they perceive biased handling of conflicts.

Transparency: Transparency is required for resources to be governed in the right way [24]. Transparency is needed at all levels of governance in ensuring proper maintenance and water extraction in irrigation [29]. Decisions regarding finances and water/land allocation require transparency to earn trust from users. When there is trust in the manner in which decisions are taken, users may cooperate in the maintenance activities for sustainable irrigation.

Equity and fairness: Disparities in resource allocation breeds tension among communal resource users. Governing irrigation resources requires land and water to be allocated equitably among all rightful users [30]. When some users feel cheated, tensions will often arise between them and those who appear to be favored, and that may stall peace in local communities. Users who perceive that inequity exists in the handling of communal resources may participate less in maintenance activities.

Sustainable use: For every resource, sustainable use is paramount to its survival for posterity. Scarce resources such as water need to be used sustainably to preserve irrigation systems [31]. This entails abiding by rules and regulations governing the input-production-marketing chain so that resources are not over extracted or overused. Water allocation, land preparation, and every other farm activity has to follow recommended practices to enable the resonance of resources. Positive perceptions on the sustainable use of their scheme are likely to promote higher user contributions toward maintenance.

2.2.2. Other User Attributes

Age and education associate positively with cooperation in collective action [13,32]. Older users may be more involved in maintenance activities than younger ones because they tend to have more experience in irrigation activities. Knowing what benefits accrue from collective action may thus propel older users to be more committed than younger ones. Likewise, taking part in the management of irrigation resources can be better appreciated by older users. Education generally stimulates critical thinking. In small reservoirs in local communities, the use of local norms is prevalent. Users with formal education have an added advantage of being able to integrate local norms and acquired knowledge for a sustainable governance of their scheme and consequently may involve more in collective activities. Access to irrigation-related training probably also motivates users to engage more in collective management tasks [33].

The different roles of men and women in local communities may influence collective action. In rural areas in Ghana, women tend to engage more in planting, watering, harvesting, and agro-processing, while clearing of lands and soil tilling are typical male activities [34]. It is not strange though to see some women outperform men on some maintenance-related activities such as covering gullies with stones and sand, which is arduous, but that is not the norm. Thus, women's work generally requires less physical strength but may be more time consuming. For hard-core activities such as clearing weeds around irrigation facilities and desilting canals, among others, men are expected to be more involved. Since farming and for that matter irrigation is a male-dominated activity in Africa and many other places, women are likely to cooperate less in irrigation management. However, while we expect men to be at the forefront of labor contributions, we do not expect gender to be relevant in the case of cash contributions.

The plot location in an irrigation system can be important as this determines the timeliness of water accessibility [35]. For decentralized irrigation systems in Pakistan, for example, it has been found that users engage less in collective action when the resource is either abundantly available or extremely scarce [36]. However, for 48 irrigation communities in South India, whether or not a community is located at the tail end of the system was found to have no significant effect on cooperative maintenance effort [37]. In the case of small-scale irrigation, extremities in access between plot locations are small, since canals in these schemes are relatively short. In this study, plot location refers to plots along the side of an irrigation canal. Head-end plots are close to the water source, tail-end plots are at the end of the canal system.

2.3. Scheme and Group Characteristics

2.3.1. Governance Characteristics

The style of governance can influence collective action, particularly the type of leadership [26,36]. In self-governing common pool resources, the mode by which leaders are selected can either encourage or discourage user participation in resource maintenance. In groups where users are free to choose their leaders, the tendency to obey instructions from such leadership is high [38]. Leaders elected democratically often have the qualities desired by the majority for effective governance. In cases where group leaders are imposed by community heads, governments, or NGOs, users may not be enthused by the qualities of their leaders and may decide to ignore orders from them, thereby cooperating less and possibly contributing less to resource maintenance [9].

2.3.2. Other Scheme and Group Characteristics

A smaller irrigation scheme and a smaller group of users are thought to be more easily manageable with respect to organizing collective action [14,23]. Smaller schemes require fewer resources for maintenance and monitoring individual effort is easier. Moreover, because land is often limited in small schemes, users may be more committed to maintenance activities to avoid losing allocated land to other users. Contributions may be lower, however, if the size of a developed area is too small and not compliant with user demands. Smaller user groups reduce free-rider problems in collective action and are thought to function better in terms of general cooperativeness, because the social interlinkages in such groups are greater [39].

Collective action problems become larger as an irrigation scheme gets older. Older schemes require more maintenance to preserve their performance, thus demanding more cooperation from their users. On the other hand, older schemes could have more experience in solving collective maintenance issues in an acceptable way. Hence, the age of a scheme can have a negative or a positive effect on the cooperativeness of its users. Access to local markets can also have opposite effects on cooperativeness. Proximity to markets can provide better opportunities to increase the returns to irrigated produce and spread a commercial orientation among farmers [35], which can encourage users to participate in sustaining irrigation facilities. On the other hand, cooperativeness can also be undermined as proximity to markets may loosen traditional social ties that bind farmers into mutual dependencies, thereby making enforcement of collective tasks more difficult [17].

Users who depend more on a resource for their livelihood are more likely to devote time and energy in maintaining it. Dietz et al. [40] indeed considered this as one of the main conditions for collective action in common pool resources. In the maintenance of irrigation resources, users who depend less on water supply may contribute less labor and generally cooperate less in irrigation management. This might be because of having alternative income earnings opportunities or because of the specific crop grown. For instance, in the case of crops with low economic value or crops with low water demand, there are probably few incentives to cooperate in maintenance activities. However, the effect of the type of crop is not clear. If crops are grown that require a lot of water, then the stakes are in principle high, but irrigation dams can quickly run dry, which can discourage a user's participation in maintenance.

3. Methods

3.1. Study Context and Data Collection

The study was carried out in the Northern, Upper East, and Upper West Regions of Ghana. These regions are located in the north of the country. This part of the country is relatively dry and has a rainy season stretching from May to September. Annual rainfall is an average of 1000 mm and only one cropping season exists for rain fed crops. Dry season irrigation of different types is practiced by communities with water bodies to complement rain fed harvests. Irrigated crops are mainly rice and vegetables including tomatoes, onions, pepper, and leafy vegetables.

The Ghana Irrigation Development Authority (GIDA) is the main body in charge of irrigation management. In small-scale irrigation schemes, GIDA has however passed the general management responsibilities to WUAs at the community level, while the authority still gives supervisory and extension services. WUAs are made responsible for the general operation and maintenance of the facilities, the allocation of land and water, and collection of water fees [41]. Though small-scale reservoirs have several uses including irrigation, fishing, and domestic purposes, WUAs are mostly homogeneous in nature and are made up of irrigators solely.

We performed a Voluntary Contribution Mechanism (VCM) experiment in 19 small-scale irrigation schemes (using dams with canals) from November, 2014 to April, 2015 to elicit willingness of users to contribute towards irrigation maintenance. We complemented the VCM experiment with a household survey covering the last irrigation season (October 2014–April 2015). Amount of labor contributed towards resource maintenance was captured in the household questionnaire intended to measure contributions in kind by users, among other useful information needed for the study.

Various crops are irrigated in northern Ghana, but each scheme has a dominant crop for each cropping season. The main crop grown at a scheme is decided at the scheme level, and can, thus, be considered exogenous to the labor contributions of users given that maintenance requirements are also determined at the scheme level. The study considered three main crops—tomatoes, onions, and peppers. These crops have high economic value and different water requirements. Onions for instance demand less water compared to tomatoes, even though both crops have relatively similar periods of irrigation [1]. Similarly, peppers demand less watering than tomatoes, but peppers take a longer period to mature [42].

A simple random approach using a lottery method was used to sample respondents from a list of WUA members. Fifteen (15) respondents were sampled from each of the 19 WUAs, giving a total of 285 participants for the VCM experiment. Ten (10) of the game participants were randomly selected in each WUA for the household interviews. The depth of the household questionnaire needed a large amount of time to complete, so we had to limit the number of respondents. For each scheme, one of the three crops considered dominant in the scheme was chosen. A crop is dominant when it is grown by most farmers compared to other crops. Only growers of the dominant crop took part in the sampling process. Non-growers of these crops were however allowed to take part in focus group discussions. The group discussions helped us understand the governance structure at the community level, and to explain some of the empirical estimates obtained from the survey data.

To ensure that our game satisfied the rationality constraint, we organized the games in the dry season (when farmers had finished their rainy season activities). We also carried out the VCM game at the irrigation site (when farmers were busy in their fields) to motivate all farmers to take part. When farmers see their colleagues involved, they may also have the interest in participating. Further, farmers have numerous challenges, and given the opportunity to win a little cash in the games, they took the games seriously.

3.2. Estimating Governance Perceptions

We incorporated 46 indicators of irrigation governance in the household questionnaire, segregated into six components of governance (see Appendix A). These indicators were selected from a preliminary desk top study and were validated by key stakeholders. The indicators were put in the form of positive statements. Respondents were asked to indicate their opinions on a scale from 1 indicating "strongly disagree" to 5 meaning "strongly agree". Likert-type items grouped into survey scales is recommended in cases where a single survey item is insufficient in capturing a construct [43,44]. Parametric analysis is possible using mean or total scores if the scale passes the Cronbach alpha test of internal consistency [44]. The rule of thumb is to accept Cronbach alpha greater than or equal to 0.7, which implies that the indicators in the scale are inter-correlated and sufficiently measure the underlying latent trait. Cronbach alpha values exceeding 0.90 are considered problematic, for this may suggest that some indicators are redundant [45]. Table 1 indicates that our survey scale passes the test, so we use the mean score from the rankings as proxy for a user's governance perceptions.

Table 1. Cronbach alpha test of irrigation governance components scales.

Irrigation Governance Component	Number of Components	Average Interim Covariance	Scale Reliability Coefficient (α)
Participation	5	0.3757	0.78
Accountability	5	0.6177	0.85
Conflict management	4	0.1763	0.71
Transparency	14	0.3688	0.88
Fairness and equity	7	0.2682	0.71
Sustainable use	11	0.2589	0.72
Overall governance	6	0.2398	0.87

3.3. Estimating Voluntary Cash Transfers through a VCM Game

A standard Voluntary Contribution Mechanism (VCM) game was framed in the context of irrigation management, asking participants to make contributions to a (hypothetical) public fund for the maintenance of their irrigation facility. The benefits of the fund were explained to participants. The idea was that the fund could be used to hire technical assistance for repairs of facilities beyond their capacity whenever GIDA failed to attend to their calls. Participants were randomly placed in anonymous groups of five, with each person not knowing which group others belonged to, and played for a total of 10 rounds. Three groups were formed, and they were all made to sit far apart from each other, so that they could not observe their neighbors' decisions.

In each round of play, participants were given 25 tokens as their endowments, and were asked to decide how many tokens they would invest in a private account for their own benefit and in a public account towards the maintenance of their dam. A token invested in a private account yielded the participant a token without interest. Earnings from the public account however depended on what other members of the group would contribute. The total of the contributions by a group to the public account was multiplied by 2 and then divided equally among all group members at the end of each round. The earnings of participant i (E_i) at each round were therefore given by

$$E_i = 25 - C_i + 0.4 \sum_{j=1}^{5} C_j \quad (1)$$

where C_i is i's contribution to the public account, and the summation is taken over all members of the group.

The only information given to participants in each round was the total contribution by their group to the public account and the amount each group member received from the public fund. A group was not informed of the total contributions by the other two groups.

Real payments were made to incentivize participants to take the experiment seriously and make choices as they would have made in real situations. These payments were based on a random draw from the ten rounds. Each group member was paid according to his or her choice made in this round of play. Cash payments were 30 pesewas per token (an average of USD 0.10 at the time of the experiment).

We follow common practice by measuring the variable "cash contribution" by the average contribution of a user to the hypothetical public fund over the ten rounds of play [46,47]. In a standard repeated number of VCM games, contributions normally start at a high level and gradually decrease. Though stakes are high in the beginning, they carry no further repercussions and therefore may be weak indicators of cooperativeness. For finite games, contributions in the last round can be predictable and may also be weak estimates of cooperativeness. The essence of repetition is to control for reciprocity. Since reciprocal behavior affects collective action, it is expected that cooperation unravels overtime in finitely repeated games [48]. Therefore, an average of the repeated contributions is a better measure for the variable "cash contribution" than relying on the first or last round of play.

The participants did not play the game with their own money but with money provided by the game organizers. This might have led them to spend the money more recklessly than they would their own, implying an overestimation of their cooperativeness—the so-called house money effect (see, e.g., [49,50]). If this potential effect is similar for all participants, the mean level will be affected but not the variation of the average contributions. Since only the latter matters for our regression analysis (the levelling effect is captured by the constant), this would not pose a problem. However, if the house money effect would differ among participants, our regression results could be misinterpreted. For instance, there is evidence that house money effects occur especially among participants who are more risk averse [51] and that women are more risk averse than men [52]. Then a lower average contribution by women (other things equal) would not necessarily imply less pro-social preferences than men, but could also result from a lower risk tolerance. Unfortunately, we lack data on risk preferences among the participants to control for this possibility.

3.4. Empirical Approach

The variable "labor contribution" is measured by the number of days a plot owner took part in maintenance activities in the previous year. Some users did not take part in such activities themselves but were represented by members of their household, which we also counted as contribution by the user. As explained above, the variable "cash contribution" is measured by the average contribution of a user over the ten rounds of play.

We hypothesize that labor contributions and cash contributions towards the collective maintenance of the irrigation scheme depend on user characteristics (governance perceptions and other attributes of the user) and scheme/group characteristics. This gives the following regression equation:

$$M_{ij} = f\left(G_{ij,}\ U_{ij},\ S_j\right) + e_{ij} \quad (2)$$

where

M_{ij} = household labor contribution or cash contribution by user i of scheme j;
G_{ij} = governance perception of user i of scheme j;
U_{ij} = other attributes of user i of scheme j;
S_j = scheme and group characteristics of scheme j;
e_{ij} = error term.

We assume that governance perceptions affect users' cooperativeness in a similar way across all 19 perimeters. Several scheme and group characteristics are included to control for the large diversity of the perimeters in the sample. Other explanatory variables in the model control for the observed heterogeneity among users. Table 2 summarizes the definitions of the variables used in the empirical models, and their measurements. A Tobit model is used for the regression on cash contributions, since observations are censored. OLS is used for the regression on labor contributions.

Table 2. Definition of variables.

Variable	Definition
Dependent variables	
Labor contribution	Number of days a user household took part in maintenance activities in the past season
Cash contribution	Average contribution in the VCM experiment on irrigation management over the ten rounds of play
User characteristics	
Governance perceptions (unweighted averages; 1-to-5 Likert scale)	
Participation	Average of 5 participation indicators
Accountability	Average of 5 accountability indicators
Conflict management	Average of 4 conflict management indicators
Transparency	Average of 14 transparency indicators
Equity and fairness	Average of 7 equity and fairness indicators
Sustainable use	Average of 11 sustainable use indicators
Overall governance perception	(Unweighted) average of all six governance components
Other user attributes	
Age	Age of user in years
Gender	A dummy that takes a value of 1 if the user is male
Educational level	Number of years of formal education
Household labor force	Number of people in the household that are 15 years or older
Training	A dummy that takes a value of 1 if user has attended any irrigation-related training or workshop
Head-end plot	A dummy that takes a value of 1 if plot location is at head-end
Tail-end plot	A dummy that takes a value of 1 if plot location is at tail-end
Scheme and group characteristics	
Leadership type	A dummy that takes a value of 1 if the chairman of the group was elected
Scheme size	Developed irrigable area of a scheme in acres
Group size	Number of users in a WUA
Age of scheme	The number of years a scheme has existed
Local market	A dummy that takes a value of 1 if there is a market in the community (a proxy for proximity to markets)
Absence	Mean number of days users stayed away from the community in a WUA in the last irrigation season
Tomatoes	A dummy that takes a value of 1 if main crop is tomatoes, and zero otherwise
Onions	A dummy that takes a value of 1 if main crop is onions, and zero otherwise

4. Results and Discussion

4.1. Summary Statistics

In Table 3 we present summary statistics of the variables for the 190 survey respondents. Labor contributions towards maintenance activities per user vary from 2 to 11 days per irrigation season with a mean of 5.2 days. The coefficient of variation equals 0.34, indicating a substantial variation in labor contributions among users. The mean cash contribution to the hypothetical public fund, derived from the VCM experiment, is 8.63 tokens, with minimum and maximum contributions of 2.5 and 20.6 tokens. The coefficient of variation equals 0.45, indicating that the variation in cash transfers exceeds that of the labor contributions. A possible explanation lies in the fact that participation in maintenance is visible to other users while contributions in the game are not and that social pressures, motivated by equity considerations, reduce the variability of labor contributions. There may also be other explanations, such as participants having greater appetite for risk when it came to the game. Further research on differences in contributions in a game setting with actual contributions is needed to provide more insight into the underlying factors.

Table 3. Summary statistics of the variables used in the empirical analysis (n = 190).

Variable	Mean	Std. Dev.	Min.	Max.	Coefficient of Variation
Dependent variables					
Labor contribution	5.18	1.764	2	11	0.341
Cash contribution	8.63	3.847	2.5	20.6	0.446
User characteristics					
Governance perceptions					
Participation	3.98	0.692	1.8	5	0.174
Accountability	3.63	0.852	1.2	5	0.235
Conflict management	4.13	0.499	1	5	0.121
Transparency	3.71	0.652	1.6	5	0.176
Equity and fairness	3.57	0.597	1.86	5	0.167
Sustainable use	3.29	0.598	1.91	4.73	0.182
Overall governance perception	3.72	0.522	2.1	4.79	0.140
Other user attributes					
Age (years)	40.1	12.0	16	70	
Gender	0.61	0.49	0	1	
Education (years)	3.70	4.90	0	16	
Household labor force	9.30	3.52	3	18	
Training	0.69	0.46	0	1	
Head-end plot	0.30	0.46	0	1	
Tail-end plot	0.32	0.47	0	1	
Scheme and group characteristics					
Leadership type	0.68	0.466	0	1	
Scheme size	35.2	21.7	6	84	
Group size	81.2	42.8	30	200	
Age of scheme	44.1	15.2	10	57	
Local market	0.37	0.485	0	1	
Absence (days)	2.18	2.07	0	6.6	
Tomatoes	0.58	0.495	0	1	
Onions	0.21	0.409	0	1	

The average contributions from all three groups in the VCM experiment (Figure 2) are consistent with results from other experimental games, where average contributions start at a high percentage of endowments and decline with repetition [46,47]. The decline in contribution is probably a result of inequity aversion when contributors realize others are not cooperating [53]. Figure 3 plots the cash and labor contribution variables. As expected, it shows a positive relationship: users who tend to contribute more in cash also tend to contribute more in kind towards collective action.

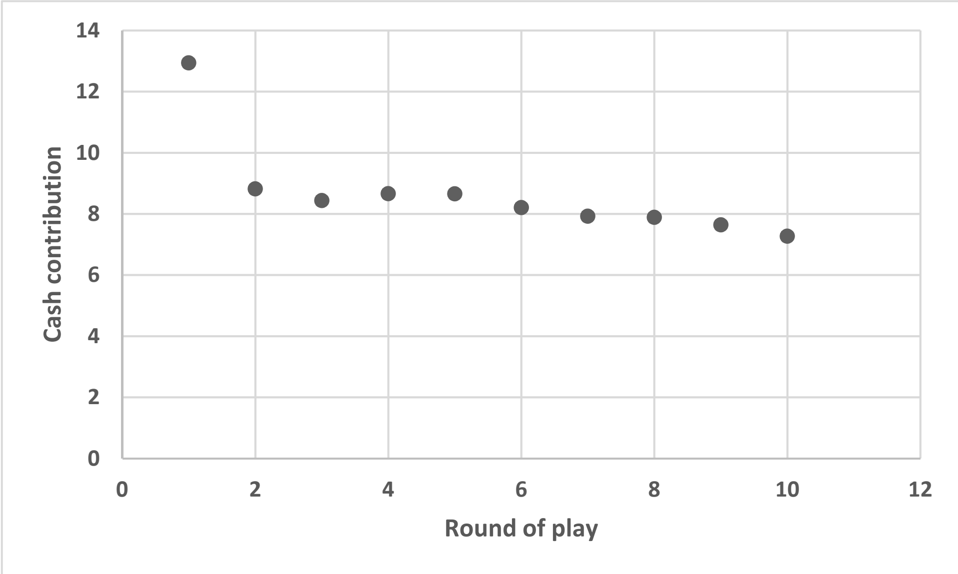

Figure 2. Average contributions (in tokens) per round from the VCM experiment.

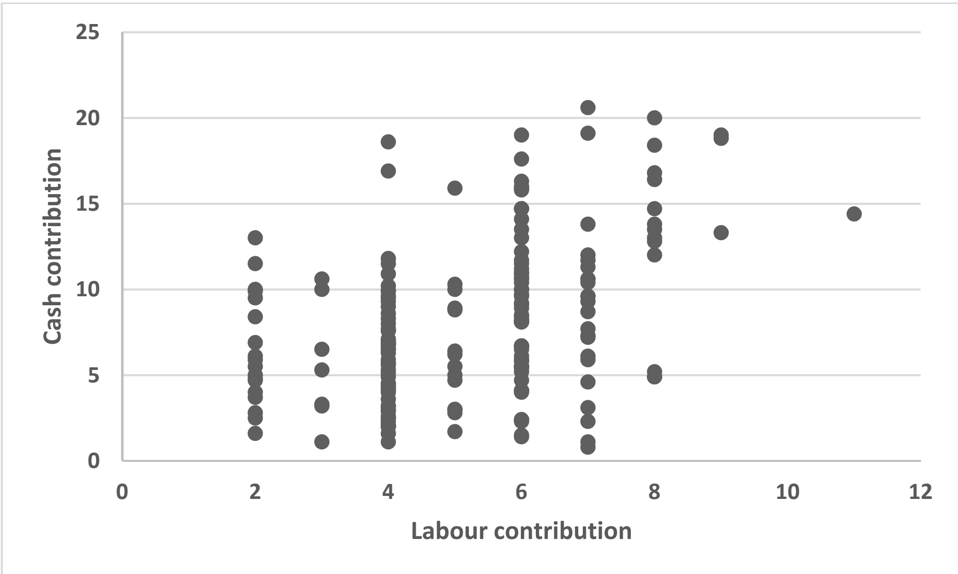

Figure 3. Scatter plot of cash contributions (in tokens; average over ten rounds of play) and labor contributions (in days), 190 respondents.

Continuing with Table 3, the mean of overall governance perceptions is 3.72, with minimum and maximum ratings of 2.1 and 4.79. This implies that the overall perception of users about irrigation governance is fairly good (i.e., larger than 3.0) in northern Ghana. Its standard deviation (0.52) is 14% of the mean, which is relatively low compared to most of the individual governance components. This suggests that there is more agreement in the overall rating of irrigation governance than in its components. Among the latter, accountability perceptions have the highest variation (23% of the mean), while conflict management perceptions have the lowest variation (12% of mean). So there appears to be more agreement on conflict management than on the other components, with accountability having the most varied opinions. Conflict management also has the highest mean score (4.13), while perceptions about sustainable use have the lowest mean score (3.29).

Users are mostly middle-aged with a mean of 40 years, and with a minimum and maximum age of 16 and 70 years, respectively. The representation of gender in our sample is fairly balanced: about 60% of the respondents are men and 40% are women. Though some users do not have any formal education, others have up to 16 years of formal education. The mean education is 3 years, indicating that most users have low levels of formal education. The size of household labor force ranges from 3 to 18, with a mean of 9 persons. Households in northern Ghana are mostly extended in nature and are thus mostly large, as shown here. The distribution of respondents over plot locations is fairly uniform, with 30% of the respondents having head-end plots, 32% having tail-end plots, and 38% being located in the middle. It should be noted that in the communal labor approach, all users are supposed to voluntarily avail themselves for maintenance works whenever the need arises without reference to the number of plots one has or the location of the plots.

The results also indicate a wide variation in scheme size. The schemes range from a minimum of 6 to a maximum of 84 acres of developed areas with a mean size of 35 acres (14 hectares). The oldest scheme is about 57 years old and the youngest is about 10 years old. The mean age of schemes is 44 years, which indicates that most of the schemes are relatively old. The average number of days users have stayed out of the community (absence) in a WUA is about 2 days per season, and the maximum absence is 6.6 days.

4.2. Regression Results

4.2.1. Governance Perceptions

Regression results are presented in Table 4. Columns (1) and (3) show the results when overall governance perception is included as an explanatory variable, while columns (2) and (4) present the results for the six components of governance that we distinguish in this study.

The results indicate that overall governance perception has a significant positive effect on labor contributions, but not on the cash contributions obtained through the experimental game. A possible explanation is that labor contributions can be observed by other users of a scheme whereas cash contributions in the game are anonymous. Further research is needed to examine the role of visibility when comparing contributions to a public good in an anonymous game setting with actual contributions. When we distinguish between the specific components of governance perceptions, an interesting consistent pattern emerges: Accountability has a significant positive effect on cash as well as labor contributions, while conflict management has a significant negative effect on cooperativeness in cash; the other four governance components that we distinguish are not significantly related to either of the two cooperative measures. A one unit increase in the perceptions of accountability (on a 1–5 scale) increases a user's expected cash contribution by 1.245 tokens (ca. USD 0.1245), on an average of 8.633 tokens (ca. USD 0.8633), and the average labor contribution by 0.506 days per season, on an average of 5.179 days. On the other hand, a unit increase in a user's perception of conflict management decreases expected cash contributions by 1.533 and average labor contributions by 0.306.

The unexpected result for users' perceptions of conflict management may to some extent be caused by the relatively high score (4.13) and limited variation (0.50) in farmers' perceptions of conflict management (Table 2). If the relationship would really be negative, it seems to suggest that users' satisfaction with the rules and regulations put in place to avert conflicts contribute to freeriding and other anti-social behavior by users. Free riding may be a result of selfish desires, where users take the opportunity to free-ride in their contributions when they observe a congenial environment in their WUA with good management of conflicts. Users who perceive conflict management to be good, thus cooperate less when they expect that the conflicts that this may cause will probably be well handled. More research is needed to test whether, and under which conditions, successful conflict management might contribute to freeriding.

Table 4. Regression results for cash contribution (Tobit) and labor contribution (OLS).

Explanatory Variables	Dependent Variables			
	Cash Contribution [VCM Game]		Labor Contribution [Irrigation Maintenance]	
	(1)	(2)	(3)	(4)
User characteristics				
Governance perceptions				
Participation		0.379		0.076
		[0.847]		[0.344]
Accountability		1.245 *		0.506 *
		[0.708]		[0.285]
Conflict management		−1.533 ***		−0.306 *
		[0.588]		[0.178]
Transparency		0.223		0.517
		[0.441]		[0.332]
Equity and fairness		0.561		0.146
		[0.508]		[0.309]
Sustainable use		0.729		0.289
		[0.460]		[0.257]
Overall governance perception	0.502		1.290 ***	
	[0.612]		[0.231]	
Other user characteristics				
Age	0.242 ***	0.235 ***	0.059 ***	0.057 ***
	[0.026]	[0.026]	[0.009]	[0.008]
Gender	0.467	0.553	0.454 **	0.434 **
	[0.420]	[0.410]	[0.160]	[0.160]
Education	0.096 **	0.086 *	0.020	0.024
	[0.043]	[0.045]	[0.019]	[0.021]
Household labor force	−0.001	0.024	0.058 **	0.064 **
	[0.055]	[0.050]	[0.026]	[0.023]
Training	0.988	0.948	0.816 **	0.735 **
	[1.004]	[0.891]	[0.308]	[0.317]
Head-end plot	0.237	0.449 *	0.139	0.237
	[0.297]	[0.262]	[0.210]	[0.201]
Tail-end plot	0.050	0.188	0.428 *	0.486 **
	[0.412]	[0.396]	[0.223]	[0.209]
Scheme and group characteristics				
Leadership type	−0.542	−0.909	0.384	0.266
	[0.796]	[0.553]	[0.258]	[0.238]
Scheme size	−0.027	−0.022	−0.017 ***	−0.016 ***
	[0.024]	[0.022]	[0.004]	[0.003]
Group size	0.009	0.003	−0.000	−0.001
	[0.016]	[0.014]	[0.002]	[0.002]
Age of scheme	−0.022	−0.014	−0.010 *	−0.012 *
	[0.026]	[0.025]	[0.006]	[0.006]
Local market	1.388	1.414 *	1.078 ***	1.220 ***
	[0.934]	[0.825]	[0.169]	[0.169]
Absence	0.159	0.091	−0.046 *	−0.054 *
	[0.187]	[0.157]	[0.025]	[0.027]
Tomatoes	0.728	0.281	0.352	0.270
	[1.041]	[0.987]	[0.287]	[0.324]
Onions	0.818	0.011	0.036	−0.001
	[0.901]	[1.050]	[0.322]	[0.355]
Constant	−2.377	−3.956	−3.057 **	−2.158
	[1.783]	[7.542]	[1.333]	[1.973]
Observations	190	190	190	190
(Pseudo) R-squared	0.157	0.172	0.504	0.519

Notes: *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$; robust standard errors are in parentheses.

We did not find significant effects for the other four governance components. High correlations among different governance components may play a role in this respect. As shown in Table 5, correlation coefficients among the six components range from 0.27 to 0.80. High correlations between explanatory variables tend to inflate the standard errors of the coefficient estimates, thereby decreasing the likelihood that the null hypothesis of no effect of the explanatory variables (i.e., governance components in our case) on the dependent variable (i.e., cooperativeness) will be rejected. The high correlations among some of the governance components are a specific feature of the data set that we used for this study. Unfortunately, it is not possible to solve this problem with the current data set.

Table 5. Correlation matrix of governance components.

	Participation	Accountability	Conflict Management	Transparency	Fairness and Equity	Sustainable Use
Participation	1					
Accountability	0.7534	1				
Conflict management	0.5245	0.6063	1			
Transparency	0.7120	0.8003	0.5807	1		
Fairness and equity	0.4811	0.4778	0.4261	0.6365	1	
Sustainable use	0.2921	0.2748	0.3477	0.4106	0.5783	1

We calculated Variance Inflation Factors (VIFs) for each explanatory variable to obtain more insight into the severity of multicollinearity (see Appendix B). The square root of a variable's VIF shows how much the standard error increases as compared to if that variable had zero correlation with the other explanatory variables in the model. As a rule of thumb, a VIF value of 10 or higher is commonly regarded as a sign of severe multicollinearity. The mean VIF equals 2.55, suggesting that multicollinearity is not a major problem. VIF values exceeding 5.0 are observed for three governance components, namely accountability, transparency, and participation. Although these values are less than 10, they indicate that we should be cautious with drawing conclusions for these three components. The VIF of conflict management, however, has a value of 2.32. This value suggests that there is no serious multicollinearity problem for that specific component.

In addition, we ran regressions with conflict management as the only governance perception component in the model, with conflict management and accountability as the only two components, and with conflict management and the three strongly correlated government components in the model. All control variables, (user attributes and scheme/group characteristics) were also included. Conflict management was found to have a consistent significantly negative effect on cooperativeness as measured through cash contributions. This finding confirms that (multi)collinearity among governance components plays no role in the negative effect of conflict management on cash contributions. It thereby strengthens one of the main findings of the empirical analysis. In the case of labor contributions, the results suggest that the inherent tendency to free ride when conflicts are properly managed only show up when other factors (including other governance aspects) are properly controlled in the regressions. For the three strongly correlated governance components, the results show that care should indeed be taken in drawing strong conclusions. In the regression for labor contributions, transparency instead of accountability has a strongly significant positive effect when conflict management is the only other included governance component. The data set does not allow us to identify which of these three components, if not two or all three of them, significantly affect cooperativeness.

4.2.2. Control Variables

In contrast to the results obtained for governance perceptions, which are fairly consistent for (hypothetical) cash contributions and (actual) labor contributions, the results obtained for the control variables vary considerably between the two user commitment measures that we examine in this study. The only exception is the age of the respondent, which was found to have a significant positive effect (as expected) on both measures. This finding supports the premise that older users in WUAs cooperate more due to their longer experience in irrigation and accrued insights into the benefits of collective action [32] (p. 587). In addition to the age, the level of education of the respondent was also found to exert a strongly significant positive effect on the intrinsic motivation towards contributing to collective action, as measured by the hypothetical cash contributions. This finding provides support for the assertion that education stimulates critical thinking and scrutiny in distinguishing right from wrong for continuity. The only other user characteristic that was found to have a significant effect on cash contributions obtained through the VCM game was plot location in the equation with perceptions of components of governance. In that specific regression it was found that users with head-end plots tend to cooperate more than users with plots elsewhere in the scheme. This finding is opposite to our a priori expectations (see Section 2.3), and may, in fact, point to the presence of reverse causality (if a user's cooperativeness affected a user's plot location in the past).

User characteristics are found to play a more prominent role in labor contributions to maintenance, i.e., in public good contributions that can also be observed by the other users of the resource. Education was found to have a non-significant effect, while gender, household labor force size, training, and tail-end plot location were all found to exert significantly positive effects on the actual labor contribution to maintenance of the irrigation scheme (columns 3 and 4 in Table 4). Male users contribute about 0.434 labor days (2.604 h) per season more than female users. Irrigated farming in Ghana is male dominated, so women may be less likely to cooperate in maintaining them. Further, irrigation maintenance activities are laborious and involve desilting of canals and re-embankment of dam walls among others, which may explain why men contribute more labor than women. Households with a larger labor force tend to provide more labor to the common good, which is consistent with findings in Wang et al. [54]. One additional person in the labor force increases labor contribution by about 0.384 working hours (0.064 days). Larger households can more easily trade responsibilities among their members, and, thus, are more able to take part in communal activities whenever the need arises, hence affecting maintenance positively. Users who have had the opportunity to attend irrigation-related trainings or demonstrations contribute about 0.735 labor days extra to maintenance of the scheme. This finding is consistent with a case study in South Africa [33]. Our focus group discussions revealed that some NGOs, particularly World Vision and the Association of Church Development Program (ACDEP), organize sensitization workshops on livelihoods activities including irrigation, for which some users have been privileged to take part. This, they said, gives them insights into how to improve irrigation. Irrigation-related training is thus crucial in real cooperation towards irrigation maintenance. Tail-end users contribute about 0.486 days more labor towards maintenance than users located in other parts of the scheme. This finding is similar with Nagrah et al. [36] who found that, in Pakistan, watercourse communities located at the tail reaches of irrigation systems contributed more labor to maintenance than communities located elsewhere. Our focus group discussions disclosed that tail-enders sometimes voluntarily desilt blocked canals and laterals outside communal work days, so as to access water to their plots, thus making their labor contribution significantly higher than users in preferred locations.

Specific scheme and group characteristics were also found to affect, in particular, actual labor contributions to maintenance, while they hardly affected the more intrinsically motivated donations in cash to the common pool resource. Availability of local markets was found to have a significant positive effect, whereas scheme size, age of the scheme, and absence from the community all had significant negative effects. Users in communities with a local market contribute on average 1.22 more labor days towards maintenance as compared with communities without a local market. Market proximity brings commercialization, which is an incentive for effective irrigation [35]. In fact, presence of a local market is the only scheme and group characteristic that was also found to significantly affect cash contributions in one of its regressions. The estimated coefficient for scheme size equals −0.016 (column (4) in Table 4). This implies that labor contributions are on average 0.35 days (on a mean value of 5.18 days) smaller when the scheme size is 21.7 acres (=standard deviation; see Table 3) larger. The negative effect of scheme size on labor contributions towards maintenance that we found is consistent with a case study in the Philippines conducted by Fujiie et al. [14]. Large schemes provide users access to abundant resources (other factors being equal), and are difficult to manage in terms of effective monitoring of individual contributions to maintenance. The significant negative effect found for the age of a scheme suggests that the amount of work that is needed to maintain a scheme negatively affects the willingness of users to contribute. Dependence on the resource was measured in our study through the absence of users, i.e., the mean number of days users stayed away from the community. It was found to be negatively related, thereby providing support for the proposition that users who depend less on irrigation for their living contribute less to its maintenance.

Finally, leadership type, group size, and main crop grown in the scheme were found to be insignificant in explaining both hypothetical and actual contributions to the resource. For leadership type, it implies that perceptions of the quality of governance of the resource is what matters for user cooperativeness, not whether the leader was elected or not. The finding for group size contradicts previous findings by, for example, Fujiie et al. [14] that smaller user groups are easier to manage in terms of organization for collective action. The results for the main crops grown in the schemes suggest that differences in irrigation water requirements or economic values of these do not seem to play a role in motivating users to contribute to the maintenance of the schemes in northern Ghana.

5. Conclusions

Although we apply two fundamentally different methods for measuring cooperativeness, the main findings for the 190 water users in northern Ghana we examined are similar in terms of governance dimensions: Users contribute less to the common good if they find that their WUA is better able to resolve conflicts in a way that is satisfactory for everyone; they contribute more if they can hold their WUA leaders accountable for performing their responsibilities, but this positive effect may also reflect other highly correlated governance components. The finding that leadership type does not play a significant role, while controlling for differences in governance perceptions, suggests that perceptions of the quality of governance of the resource matter for user cooperativeness, not whether the WUA leader was elected or not. Finally, we found that irrigation-related training positively affects cooperativeness as measured by labor contributions to scheme maintenance. Our results evidenced that users will contribute more for common purposes when they can testify of accountable leadership, particularly where leaders are open in disseminating information to members of the group regarding resource allocations, finance, and other relevant matters. Perhaps transparent and accountable leadership builds trust in members and is it the increased trust that induces more social participation—future research could shed a light on this.

An interesting novel insight is the strong evidence we found that user perceptions of adequate conflict management have a negative effect on contributions to the common good. One potential explanation that could be tested is that users are more likely to free-ride in their social contributions when they perceive a friendlier environment in their group where conflicts are better handled. We are not aware of any studies finding a similar result. Since our result is based on a case study for 19 WUAs in northern Ghana, it needs to be checked for robustness in comparable research performed for other common pool resources and in other parts of the world.

The study is limited for not capturing the effect of risk given that risk levels of farmers are likely to influence their level of cooperativeness and adherence to governance structure. Future studies may explore the role of risk preferences and perceptions.

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Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki. The field data collection was done in 2014, at which time the University for Development Studies (UDS) in Tamale, Ghana had no Institutional Review Board (IRB). Prior to the establishment of the IRB in 2019, it was agreed that experienced supervisors very familiar with the culture and norms of research areas should ensure that fieldwork was carried out following the rules of the Declaration of Helsinki. This rule was strictly adhered to in the field research for this publication.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are openly available in DANS-EASY at https://doi.org/10.17026/dans-xkv-3fkb.

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Appendix A

Table A1. Summary of Irrigation Governance Components and Their Variables.

Participation	Accountability	Conflict Management	Transparency	Equity and Fairness	Sustainable Use
Participation of eligible users in the use and management of facility (right of use)	Access to information by users	Satisfaction of conflicting parties in land- and water-related conflicts	Existence of an organizational structure	Well-defined users	Suitability of soil for irrigation
Participation in decision making involving all users (joint decisions)	Dissemination of expenditure and financial standing of WUA	Handling of tensions in leadership	Transparency in the election of leaders (existence of democracy in group)	Adequacy of irrigable land (compared to number of users)	Management of facility (effective?)
Recognition of users by higher authority (e.g., participation in best farmer awards)	Leaders' commitment to duties	Price- and market-related conflict resolutions	Application of rules and regulations (Rule of Law)	Equitable access to water	Availability of water over the years
Participation by gender (women involvement in irrigation management)	Confidence of users in leaders	Use of graduated sanctions	Adequacy of group meetings	Adequacy and fairness of water charge	Sufficiency of water for irrigation in the current year
Participation of all users in maintenance	Management of finances		Openness of group members at meetings	Available market for irrigated produce	Availability of water in coming year
			Cooperation of individual users in collective action (members' commitments)	Equitable access to land	Water quality
			Openness of leaders in respect to transactions concerning the group	Equity in handling user concerns	Output from irrigation
			Reliability of leaders		Trust in WUA for the general management of facility
			Information flow among members of WUA		Support from assembly and district officials

Table A1. *Cont.*

Participation	Accountability	Conflict Management	Transparency	Equity and Fairness	Sustainable Use
			Transparency in water discharge (e.g., timeliness)		Ready market/ good prices for irrigated products
			Spate of corruption		Good maintenance of facility
			Awareness of group members on financial matters		
			WUAs' activeness (dormant group or active)		
			Monitoring and control of water discharge (is it transparent and are users cooperating?)		

Appendix B

Table A2. VIFs of Explanatory Variables in Regression.

Variable	VIF	1/VIF
Accountability	5.49	0.182231
Transparency	5.32	0.187806
Participation	5.21	0.191837
Group size	3.70	0.270427
Scheme size	3.46	0.288866
Fairness and equity	3.10	0.322409
Onion	2.97	0.336322
Tomatoes	2.72	0.367951
Sustainable management	2.50	0.399336
Training	2.38	0.419618
Conflict management	2.32	0.431391
Leadership type	2.05	0.488330
Age of scheme	1.85	0.541595
Local market	1.60	0.626320
Head-end plot	1.38	0.725875
Tail-end plot	1.35	0.740046
Age	1.28	0.783182
Absence	1.27	0.790457
Gender	1.20	0.830451
Edu	1.19	0.841961
Household labor force	1.15	0.868040
Mean VIF	2.55	

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