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Abstract: This paper intends to contribute to the debate on gender equality and water within the Sustainable Development Goals SDGs 5 and 6. Farmers organizations are often considered key stakeholders whose participation should be fostered to achieve a good water governance in agriculture and irrigation programs. Nonetheless, many water management interventions tackle participation as an instrumental and formal process. A common assumption is that granting sufficient space for women in water management will automatically ensure a greater gender empowerment. Nevertheless, often low importance is given to assessing who really actively participates and benefits from water development projects, favoring the technical aspects. This paper addresses the articulation between gender, water management and indicators, using male, female and mixed farmer organizations as touchstones in three regions of Senegal. The authors defines a system of water gender indicators grouped into five sections. The first results show more similarities between mixed and female organizations, while the main gender inequalities are visible in the water technique and economic domains. Thanks to this study, we can see how a gender-based analysis may allow to more deeply understand some more or less "hidden" water governance mechanisms and their related implications in terms of project management and policy making.

Keywords: SDGs; gender indicators; water management; irrigation; sustainability; participation

1. Introduction

1.1. Women, Access to Agricultural Resources and Drip Irrigation Systems

In 2014, the United Nations inaugurated a new set of Sustainable Development Goals (SDGs), aiming to substitute the previous Millennium Development Goals (MDGs) as a reference for the new international development Agenda (2015–2030). In order to favor a greater inclusive and participatory process, several consultations were conducted worldwide involving multiple stakeholders. The SDGs include 17 goals, 169 targets and a preliminary proposal of 303 indicators. The 17 goals cover new topics such as climate change, economic inequality, innovation, sustainable consumption, peace and justice [1]. Nevertheless, the SDGs have been subjected to some criticisms, as the excessive importance due to the "quantification" of the development actions and the enormous number of targets and indicators to be achieved [2–4].

Our study may be integrated into the framework of two particular SDGs, SDG 5 (aimed to achieve gender equality and empower women and girls worldwide) and SGD 6 (focused on guaranteeing available and sustainable management of water for everybody). In order to cover these areas of analysis, an overview on water gender management and irrigation issues in agriculture is presented.

Women are generally the main beneficiaries of many food security projects aimed to improve the households' nutrition levels. However, despite this preference, women have difficulty being recognized as actual farmers [5]. Gender mainstreaming is feeble and low importance is given to assessing who really benefits from the projects [6] because the different gender knowledge, education, ability and potential are often not considered, favoring the technical aspects.

In particular, horticulture, more than other food crops, requires technical expertise, first concerning water management issues, considering the large amount of needed water, which is not always easily accessible. In this framework, drip irrigation systems (largely fostered by international donors) are frequently applied to irrigate home gardens aimed to providing vegetables and a most balanced diet, both for self-consumption and for additional selling purposes [7,8]. Drip irrigation (low cost, reliable, laborsaving, and easy to be technologically accepted) uses networks of pipes and tubes to direct water to the soil surface, in order to reduce the water consumption and the losses due to evaporation [9]. It was shown by researchers that drip irrigation can help farmers with saving time, improving health, food security, income, employment and control over resources [10,11].

Despite the advantages, the widespread application of drip irrigation systems presents some constraints [12–14]. Such drawbacks may be technical (e.g., the occlusion of pipes and drip trays in case of high mineralization of water), related to the management and the maintenance (high purchase, installation and repair costs) or socio-cultural.

In some cases [9], the adoption of drip irrigation systems may increase the existent social and economic inequalities, to the detriment of the smaller and disadvantaged actors. In fact, the FAO (Food and Agriculture Organization) [15] indicated that improved irrigation benefited the bigger and better organized farmers more, especially thanks to their greater capacity to count on additional capital and public support. Other researchers [16] specifically described how women and men appeared to have different incentives for investing time, labor, and capital in irrigation-related activities. In particular, especially in the Latin American context, women are generally associated with sanitation aspects, while the most "productive" uses of water (as the water for irrigation purposes) should be a peculiarity of men [17].

Similar unequal effects for women farmers could be observed even in relation to the implementation of other development interventions as hydropower projects, often translating into an increased workload for the local women, with regard to the collection of water, fodder and fuel wood (due mainly to the raising male migration), but also in a decreased access to the means of production (land, irrigation, water, etc.) [18].

In Sub-Saharan Africa, other constraints prevent a greater implementation of drip irrigation systems, such as the lack of basic infrastructure, the absence of developed markets and the cultural biases towards the active and recognized role of women in agriculture [19,20].

Especially in sub-Saharan Africa, women are often excluded by improved horticulture projects, and they continue to suffer from insecure livelihoods and lack of income-generating activities [21]. Inadequate water access for productive purposes is one of the factors that increases the social, economic and environmental vulnerability and poverty of women and their households [22,23]. In the 1990s, some studies focusing on water access [24,25] shared the "unverified premise that women's uses of water mainly occur in the domestic or nonmarket sphere, in implicit opposition to men's uses of water, which are believed to be mainly productive and market oriented" [26]. Despite this assumption, some most recent analyses [27–29] have started to contest this dichotomy, highlighting the necessity to make more visible the link between women, irrigation and water innovation processes in agriculture. At the same time, other studies related to the specific field of drip irrigation underlined a general gender blindness in such projects, mainly oriented towards technical issues [6,30].

As underlined also by Van Houweling et al. [31], technical water questions may not be separated from the issues related to the land property and the resources and inputs access. Some researchers [21,32,33] highlighted the same level of productivity between women and men active in agriculture, despite the different input access levels [34]. In practice, there would be no

differences between different genders in terms of productivity and agricultural revenues, when women farmers can count on an equal access to resources and sell their crops in the same way as men [35].

The same assumption is valid also in relation to the fair and unequal access and management of technology [36] and technical training [37] even in agricultural contexts. The study of Haile et al. [38] highlighted the relative ease of using of drip irrigation systems that would be particularly suitable for women, provided with proper training. This latter point represents a relatively unexplored issue within the data gathering process, to be taken into consideration for the elaboration of efficient and all-inclusive monitoring and evaluation indicators [39].

1.2. Farmer Organizations and Gender Exclusion Mechanisms

In many interventions, a communitarian management of the irrigation perimeters is required and promoted by the international donors [12]. One of the main adduced motivations is that, by decentralizing to local institutions the management of water resources, the whole community will benefit, and this will lead to a sustainable use of the resources over time [40]. However, the orientation methods towards entrepreneurial models (rather implied within the drip irrigation projects) may undermine the existent relationship within the local farming systems, as those belonging to the traditional farmer organizations (FOs) [41].

For these reasons, an important dimension, taken into consideration by this study, is related to the link between the farmer organizations (FOs) and the implementation of drip irrigation systems.

FOs are organizations created by the producers to render services to the members of the organizations. We can distinguish four main types of functions, and relative forms of organizations: (1) representing and defending the interests of the producers (as the "Unions"); (2) having economic and technical function (generally cooperatives or professional associations); (3) improving natural resource management (as the water user associations—WUAs—irrigation schemes or associations of forestry operators); (4) fulfilling a social development function (as informal or formal village associations or local development associations) [42]. We can also distinguish other types of FOs on the basis of their gender components—for instance: men, women and mixed organizations. These types of FOs should provide the same type of services to their members; nonetheless, the effective power owned by women organizations and women within mixed organizations appears weaker compared with the male members. As largely stressed by Bina Agarwal [43,44], when women perform substantial decision-making roles within the management committees of FOs, positive effects in terms of sustainable management, use and conservation of commons resources (as water) are frequently observed. Other researchers observed that, when women farmers have a greater access and participation in water issues (especially within irrigation institutions), their performance and revenues, as well as the general household livelihoods, increase [45]. However, at the same time, gender is a critical factor leading to further exclusion mechanisms within the internal decision-making processes of farmer organizations [46].

The women exclusion can be observed looking at some particular type of grassroots organizations such as the water user associations (WUAs). WUAs are intermediate organizations based on the principles of the "Community-based Management (CBM)", diffused in several areas of southern countries. WUAs are strongly connected with the structural adjustment policies, promoting the increasing privatization of water and irrigation processes. These policies had a significant impact on the irrigation sector in southern countries and often result in the transfer of the operations to Water User Associations [15]. Even in the WUAs, a sporadic representation of women is often observed [47]. This exclusion is usually due to the WUAs selection criteria, often allocated to the "formal rights holders" and based on the education level, on the social status and on the power relations within the local communities (which, in practice, exclude women) [48].

1.3. Water Gender Indicators

One the main problems encountered in analyzing gender and water issues in agricultural contexts is the wide lack of available and uniform gender-disaggregated data, often highlighted by practitioners and academics [49,50]—a deficit that may negatively influence the calculation and application of SMART (specific, measurable, achievable, relevant and time-bound) water gender indicators. However, even in the case of a larger availability of statistical information, data must be contextualized and critically detailed in order to adequately define the whole complexity behind gender relations and water management.

Hence, the difficulty to measure these dynamics and elaborate some gender sensitive indicators arises. Indicators are common tools for the lifetime because they summarize large amounts of data and give precise information on the investigated topic. Gender indicators are even more critical because they require an accurate data gathering process disaggregated by sex. Moreover, they also capture many different aspects of women's and men's lives and reflect many gender issues. Some studies were carried out on water and gender indicators in agriculture [30,51,52].

One of the most remarkable attempts is represented by the work of Barbara Van Koppen, who proposed the Gender Performance Indicator for Irrigation (GPII). The GPII identifies intra-household divisions of farm labor and decision-making and access to land and water, and determines whether the decision-makers of a household's irrigated plots are women or men. The GPII further analyses the participation of women farm decision-makers within Water User Associations and their participation in leadership [30]. This latter point allows for stressing other important issues in the study of water and gender nexus: the possibility to become a member of such water associations is often connected to titles of land and water (generally owned by men). Since control over water resources and relative decisions generally results in political power, often rural women lack decision-making and voices within irrigation and water management organizations, contributing to rendering their active role in agriculture once again more invisible [17].

Another valuable attempt is represented by the Socio-economic and Gender Analysis (SEAGA) methodology, based on the analysis of socio-economic patterns and the participatory identification of the different gender needs at a rural level. The SEAGA was developed by the Food and Agriculture Organization (FAO), in partnership with the International Labor Organization (ILO), the World Bank (WB) and the United Nations Development Program (UNDP) in 1999. In particular, the SEAGA tool includes a Guide on Irrigation, aimed to include a more gender-oriented and participatory planning within the irrigation systems. An in depth space was dedicated to the women exclusion by the construction and the maintenance operations [15], however without providing specific gender indicators.

The water gender indicators proposed in this study differ from the previous attempts: in this case, we underlined more the technical component (irrigation systems, type of used technology and fertilization system) applied to the specific context of horticulture. Furthermore, in this research, we did not focus on the households, but we considered three types of FOs (female, male and mixed) not only dedicated to irrigation purposes (as the GPII).

1.4. Research Questions

This work tries to partially answer the following question: is it possible to summarize and clearly show the whole described complexity through a simple system of indicators, directed to assessing and describing the gender (in) equalities in the water access, use and management in agriculture?

To achieve this goal, some fundamental sub-indicators referred to three types of farmer organizations (male, female, mixed) are proposed and analyzed, in order to facilitate their overall interpretation and application. The research background is a horticultural program carried out in some rural settings of three Senegalese regions. Since a joint management of drip irrigation systems is often fostered, it is interesting to analyze the correlations between this entrepreneurial model, the social capital (represented by the selected local FOs) and the gender implications. Other analyses

have shown both the controversial [20,41,53] and the positive [54,55] effects of drip irrigation among small farmers in general, but without analyzing in depth the possible gender implications of such interventions among different types of FOs. Actually, even what may happen at the FO scale may positively or negatively affect the rural intervention. The overall idea behind the choice to compare three types of FOs (female, male and mixed) has been influenced by the conviction that selecting only women (and women organizations) as the only beneficiaries of such development programs doesn't mean achieving the actual success and sustainability [43,44]. The micro-reality of the field is complex and multiple. For instance, looking at the context of the study, previous surveys clearly showed how, in the case of mixed FOs, generally women occupy only one position of responsibility on the total of six, which are generally accounted within such type of FOs [13].

In this work, some indicators are studied, in order to analyze the possible (social, economic, gender, . . .) inequalities engendered by drip irrigation systems. The elaborated indicators may have several purposes. First, they can highlight the existent gender inequalities (in terms of access and management of resources first water and decision-power) between the different types of selected FOs. Second, they may allow the involved stakeholders both to better picture the initial situation in which the program is inserted and to better adapt the following future actions, in order to ensure a real, effective and sustainable participation of women within such water and agricultural programs.

The paper will be organized as follows. First, a synthetic description of the study area is provided. Afterwards, the specific methodology and the relative system of water gender indicators divided in five categories (social, plot, water, water technique, economic) are illustrated. Data for this study come from semi-structured questionnaires, submitted to a large sample (144 respondents) of local farmer organizations' representatives (women, men and mixed—both women and men) in three regions of Senegal (Thies, Fatick and Diourbel). Therefore, the final results of the research are presented and critically discussed. Hereafter, the paper discussion is focused around the lack of gender-disaggregated data observed during the data gathering process, the possible ways to manage this type of problem and the implications of this gap in terms of Monitoring and Evaluation (M&E) and operationalization of the gender mainstreaming in practice.

2. Materials and Methods

Senegal has a long trajectory of development of farmer organizations at the rural level. Since the decolonization (occurred in 1960), the Senegalese State has directly promoted the FO development for the modernization of the rural world, starting from informal spontaneous groups (as the informal female groups for joint savings and credits schemes—called *tontines*) to more structured cooperatives, as the Women's Promotion Groups (*Groupements de Promotion Féminine*—GPF, since 1968) and the Regional Rural Development Societies. In the early 1980s, following the structural adjustment reforms and the progressive disengagement of the central State, new endogenous associations, directly embedded within the villages (such as the *Groupements d'Intérêt Economique* —GIE), federations (national corporatist unions,) and federations of federations (such as the *Conseil National de Concertation et de Coopération des Ruraux*—CNCR) started to appear [42].

2.1. Research Context

Data were collected in the framework of a drip irrigation horticultural project started in 2013 and carried out in three regions of Senegal: Thies, Fatick and Diourbel (Figure 1). According to the latest national households poverty survey, two of them (Thies and Diourbel together with the Dakar region), accounted for almost half (48.6%) of the total population of Senegal and contributed more than 35% to the whole poverty rate of the country [56].

The project was aimed to improve the overall life, food security and production conditions of local small farmer organizations (women, men and mixed organizations) providing them with a more efficient irrigation method for the cultivated plots. The project presented since the beginning a gender sensitive lens since the main intended beneficiaries were women farmers. One component of

the project was developed in these central regions of Senegal (part of the so-called *Bassin Arachidier* and it was primarily focused on the improvement of the local horticultural production, for the final selection of 70 horticultural perimeters (each of them ranging from 5 to 10 hectares for a total of around 400 hectares) among the initial 144. A gender analysis of such horticultural component thus seemed the most interesting since, in Senegal, this sector (generally intended to export operations) mostly involves women even if especially as farm hands [57]. The project intended to apply a "communal system" of the cultivated land (in which the implication of farmer organizations is strongly fostered, as already mentioned before), using a common water source to irrigate all the plots of the horticultural perimeter. In practice, the whole perimeter was divided into individual plots, with several management committees (mainly composed of men) entitled to take decisions about the perimeter management.

Figure 1. The three studied regions.

Thiès, Diourbel and Fatick are regions next to the capital Dakar, provided with a quite efficient road system. The climate is semi-arid and the agriculture production is limited only to some products as mil (*Panicum Miliaceum* L.), sorghum (*Sorghum vulgare* L.), bean (*Vigna unguiculata* L.) and peanut (*Arachis hypogaea* L.). In these areas, the reduction of the peanut prices (during the 1980s–1990s, also due to the devaluation of the West African CFA franc and the Central African CFA franc—CFA Franc), the climatic uncertainty and the soil degradation caused the decrease of incomes and the impoverishment of the rural population, producing a large emigration to Dakar and abroad [58,59]. In particular, two of the three considered regions (Fatick and Thiès) appear geographically and economically more advantaged (with access to the sea), while the third (Diourbel) is more inland, drought-stricken and not provided with an efficient road network.

The main sources of up-to date information related to these regions were deduced from the regional reports made by the National Statistic Agency of Senegal (*Agence Nationale de la Statistique et de la Démographie*—ANSD). However, such available gender disaggregated data were not completely uniform and harmonized, providing diverse types of information (for instance only limited to education, health or agriculture issues) for each analyzed region.

In these three regions, the heads of the agricultural households are mainly male, compared with a proportion of women varying between 13% and 15% (the same average than at the national level) [56].

The region of Thiès is an important centre of agricultural production due to its potential in water and soil characteristics. In 2009, the regional population was about 13% of the Senegalese population, with an equal distribution between women and men [60].

The population of the Fatick region, is young (as in the whole Senegal, where more than 50% of the population is under twenty years), while the sex ratio amounted to 98 men per 100 women [61].

In the Diourbel region, on the whole health situation, the 89% of the children recorded a good nutritional status compared to 65% in 2008, while, considering the prenatal consultations, around 45% of the pregnant women benefited from consultations [62].

A widespread water access deficit is present in the Fatick region, where only 9.5% of the population has a tap in the house (the national average at rural level is 18.3%) instead of the 38% of the other two regions. At the same time, another problem of water safety clearly appears in this region with 33.8% of unprotected wells (traditional open wells, where the risk of both water contamination—due to insects, animals excreta, dust, and people insecurity, e.g., children that may fall inside, is very high), against a national average of 25% [56].

Fatick is the more rural region (86% of the total population), whereas Diourbel is more urban-oriented (64% of the total population lives in the cities). In contrast, in the Thiès region, there is a more uniform distribution of the population between rural and urban areas (44.2%), but the region appears to be one of the main urbanized areas of the country [56]. On the basis of the main consulted statistical sources, the Diourbel region appears to be the most vulnerable by reasons of its deep deficiencies in terms of gender empowerment, especially with regard to access to education, agricultural inputs, socio-political representation and financial resources [63].

One of the main outcomes emerging from the study is the difficulty to find comparable gender disaggregated data at regional and local levels, especially those regarding the most economic issues referring to the agricultural activities and to the water use for productive purposes. Conversely, a good level of regional information on health, education and social issues disaggregated by gender can be observed.

2.2. Sample Description

A survey with a semi-structured questionnaire was conducted to interview 144 farmers organizations (of three types: women, men and mixed), each of them active in the horticultural sector. The questionnaires were conducted in 2015 and they were addressed to the representatives (generally the person in chief, e.g., the president or the general secretary) of each FO. The sample was selected on the basis of the following criteria:

- A significant presence of women farmers;
- The presence of existing potential horticultural perimeters;
- The presence of local sources of water (suitable for horticulture activities) still active or to be rehabilitated;
- The presence of grassroots organizations already active in the area.

The three different types of FOs were not distinguished on the basis of their purpose and legal status (as economic, informal, cultural or village association). The informal associations represented around 25% of the total, while most of the selected FOs were Groups of Economic Interest GIE (40% of the total). This last feature can be well incorporated within the general approach followed by the drip irrigation interventions more oriented to the entrepreneurial management of the perimeters.

Most of the FOs (around the 50% of the total) were created in the 2000s, while one third in the 1990s and the remaining organizations during the 1970s and 1980s.

Interviews were carried out by researchers and technicians, with the presence of local facilitators.

The questionnaire was divided into three different sections (Table 1):

- Water sources;
- Horticultural perimeters;
- Grassroots organizations.

The first section (water sources) was aimed to identify type and status of the present water sources, mainly for agricultural purposes. The second part was intended to make an overview of the geographical position and the general characteristics of each agricultural perimeter. Finally, the third was designed to better understand the type of the farmer organizations active at local level, as well as their main activities and their level of internal governance.

Table 1. The collected data.

Questionnaire Section	Data and Unit	Type of Variable and Ranges
Water source	Type of source	nominal
	Type of pump	nominal
	Pump conditions	ordinal (broken = 0; functional = 1)
	Presence of reservoir	dummy (yes or not)
	Type of reservoir	nominal
	Quality of the water (for irrigation)	ordinal (not adequate = 0; adequate = 1)
	Water use (for domestic use or irrigation)	nominal
Horticultural perimeter	Plot distance from the village (meters)	continuous
	Size of the perimeter (hectares)	continuous
	Method of irrigation	nominal
	Perimeter status	ordinal (inactive = 0; active = 1)
	Average plots size	continuous
Grassroots organizations	Group legal status	nominal
	Group establishing (year)	discrete
	Sex of the Leader	dichotomy (man/woman)
	Group type	nominal (men's, women's or mixed)
	Number of men	discrete
	Number of women	discrete
	Gender of the secretary of water use association (if existing)	dichotomy (man/woman)
	Types of cultivated products	nominal
	Selling of products	dummy (yes/not)
	Purchase of inputs like fertilizer	dummy (yes/not)
	Joint cultivation of the perimeter	dummy (yes/not)
	Plots distribution (individual or group)	nominal
	Advantages of the membership	nominal

2.3. The Water Gender Indicators

On the basis of the main findings and constraints previously described in relation to water, gender and rural development issues, five macro-categories of indicators (social, plot, water, water technique, economic) have been proposed in order to critically analyze the results coming from the 144 questionnaires. Each macro-category included a set of sub-indicators (Table 2). In order to achieve a broader interpretation of the gender implications, these indicators were based on the necessity and the will to jointly include the multiple dimensions, more or less hidden, behind the water management issues [64,65].

Table 2. The categories of indicators and their sub-components.

Category	Sub-Components and Relative Codes		
Social	Age Class (AC)	First Education Level (EL)	Technical Training Access (TTA)
Plot	Plot Distance (PD)	Group Perimeter property (GPP)	Group Plot Distribution (GPD)
Water	Mixed Water Use (MWU)	Reservoir (R)	
Water Technique	Pump Presence (PP)	Improved Irrigation (II)	
Economic	Agricultural Products Selling (APS)	Fertilizers purchase (FP)	

Regarding the social category, the initial goal was to include data on age, education levels and access to technical training. This choice was designed to highlight the possible differences between women, men and mixed organizations. At the same time, the level of education is an important variable

influencing the access to the main internal management positions, the knowledge of the necessary bureaucratic procedures to achieve any financial support and the general degree of sustainability of horticultural and drip irrigation interventions [9], including better levels of food security and children protection. Another sphere in which most of the times women may be excluded is the provision of technical training and suitable extension services [34] actually designed to the specific requirements and limits of women active in agricultural contexts (e.g., lack of mobility, lower level of education, etc.).

It is largely shared by academics and practitioners how land is even one of the main constraints in terms of gender equality all around the world [66,67]. In this study, three specific variables connected to the horticultural plots were considered: plot distance (from the village), plot property (by the village or the group) and plot distribution (if individual or communitarian). Indeed, it is demonstrated that, when the plot is closer to the home (less than 500 m), generally women spend less time cultivating it and are more motivated. Some authors [68,69] showed also a strong connection between the distance of the water source from the household (and the related time dedicated to women and children to collect water) and its positive effects in terms of productivity, nutrition, health and general empowerment, especially if the water source (especially clean water) is located less than 1 km from the village.

Within the category "water", we included the presence of a reservoir and the water uses (for domestic or production purposes). This latter aspect is particularly important since the different amounts dedicated to the water collection for other purposes (such as irrigation) than the domestic use is generally larger and it may subsequently create several competition problems [51].

Concerning the "water technique" category, this is generally one of the less analyzed aspects by researchers, despite its fundamental implications in terms of gender equality and project sustainability and accountability [70]. In this category, we inserted the presence of mechanical systems of water lifting (such as pumps, etc.) or the presence of improved systems (as drip irrigation).

Finally, looking at the economic category, on the basis of the main constraints normally faced by women in agriculture [71,72], we focused the attention on two main collected variables: the capacity of the famer organization to sell its agricultural products and the ability to carry out activities aimed to acquire productive inputs (such as fertilizers, etc.).

The five categories of proposed indicators cover different areas of the water management issues in horticulture. The proposed indicators are relatively easy to be periodically updated, as well as managed by practitioners and policymakers.

The purpose of the proposed indicators was to cover three main areas of analysis:

- Respondents characteristics (age, literacy rate, technical training level);
- Access to inputs (land, pumps, irrigation, fertilizers);
- Resources management (water use, products selling, method of perimeters allocation).

It is therefore possible to carry out a transversal analysis of collected data: on one hand, starting by each particular topic (plot, technique, water, etc.), as indicated in Table 2, and, on the other side, through a specific macro-area of study (see the previous bullet points).

This system of indicators has been applied to a specific project with peculiar characteristics and goals, but elaborating water gender indicators is an open and ongoing process that can be personalized according to the different purposes and applications of the involved stakeholders and apply also in other contexts.

2.4. Comparison among the Three Surveyed Groups (Women, Men and Mixed)

In order to have a complete picture of the indicators of the three types of FOs, as well as to compare them each other, we calculated a ratio. The ratio method seemed the more concise way to compare more than two groups. For each indicator, the ratios between the three surveyed groups (women, men, mixed) were calculated, in order to analyze how close or different they were among the

farmer organizations types. Basically, the closer the ratio was to 1, the more the gender differences were not present.

In particular, four classes of water gender inequality were selected as follows:

- No inequality: $0.9 \leq$ ratio < 1.1;
- Low inequality: $0.7 \leq$ ratio < 0.9 or $1.1 \leq$ ratio < 1.3;
- Medium inequality: $0.5 \leq$ ratio < 0.7 or $1.3 \leq$ ratio < 1.5;
- High inequality: ratio < 0.5 or ratio ≥ 1.5.

3. Results

The survey involved: 19 men's organizations, 77 women's organizations and 48 mixed organizations. In particular, 75 farmers organizations were based in Thiès, 46 in Diourbel and 23 in Fatick, involving a total of about 4800 individuals (56% women).

Each type of farmer organization had a different number of members (Table 3).

Table 3. Average number of members of the selected FOs.

FO Type	Average Number of Members	Standard Deviation	Max	Min
Women	67	41	200	10
Men	30	25	65	4
Mixed	31	41	320	2

In particular, the men's organizations were generally smaller groups, while the women's and mixed organizations were evidently more numerous groups. The mixed groups had an average of 21 men members and 45 women members. In the study sample, a good level of social capital and presence of women within the selected grassroots organizations can be observed. In particular, 50% of all of the involved organizations were women FOs, while around 50% of the organization leaders were women.

3.1. Indicator Values

In Table 4, the percentages (as decimal number) of the respondents for each indicator composing the five macro-categories of analysis (e.g., social, plot, water, water technique, economic) are calculated.

Table 4. The indicators values, divided by women, men and mixed farmer organizations.

Category	Indicators	Organization (%)		
		Women	Men	Mixed
Social	15 < age < 65	n.a.	n.a.	n.a.
	At least I level education	n.a.	n.a.	n.a.
	Technical training	n.a.	n.a.	n.a.
Plot	Plot distance < 500 m (from the village)	0.58	0.92	0.59
	Group perimeter property (or village)	0.47	0.46	0.52
	Group plot distribution (not individual)	0.30	0.15	0.30
Water Technique	Pump presence	0.51	0.92	0.85
	Improved irrigation system (drip or other)	0.07	0.54	0.46
Water	Reservoir (to facilitate the irrigation)	0.53	0.69	0.57
	Mixed water use (domestic and irrigation)	0.74	0.69	0.67
Economic	Agricultural product selling	0.65	0.92	0.93
	Fertilizer purchase	0.58	0.85	0.89

Unfortunately, despite our desirable aim, from Table 4, it clearly emerges how, during the research, it was not possible to investigate the class age, the educational level and the access to previous training sessions of the sample because, as already mentioned, the proposed indicators were elaborated after

the end of the questionnaires' submission and the social information was not directly included within such questionnaires.

Nonetheless, the unavailability of this type of social information and, thanks to the latest national statistical surveys, during the study, it was possible to extrapolate some key gender socio-economic data disaggregated at national and regional levels but not at the farmer organizations' scale.

Considering the education rates, in the three surveyed regions, women recorded a lower literacy rate (ranging from 23.9% of Diourbel to 43% of Thiès). Conversely, the literacy rate of men varied between about 55% (Diourbel) and 67.5% (Thiès) [73]. Another outcome concerned the different levels of input ownership fulfilled by Senegalese women, which appear, generally, poorly represented in the access to agricultural equipment: only 1.3% belong to women, compared with 98.7% for men. Moreover, women are slightly more present in joint-owned plots (5.2%) compared to 94.8% of men [74]. From the results analysis, it emerges how the women organizations appear the weakest, especially in relation to the water technique indicators, with a very low value regarding the improved irrigation systems (namely 7% against 54% of men and 46% of mixed). In addition, even the pumps system is present in only 51% of the surveyed women organizations, whereas this is almost always present within the men's organizations. The quite widespread absence of pumps within the women groups is generally translated into an increased workload and labor for women, and we are obliged to use buckets and/or watering cans to irrigate. On the other hand, women and men organizations show similar percentages on other water management issues: 53% of women have a reservoir against 69% of men, while the water use (both for domestic and irrigation purposes) is performed by 74% of women organizations and 69% of men. Such values demonstrate that, when the resource water is used also for the household necessities, the gender differences between farmer organizations are lower. Other remarkable gender differences are recorded in the most economic indicators, accentuating the women organizations weaknesses even in the horticultural products selling (65% of women versus 92% of men) and in the fertilizer purchase (58% for women versus 85% for men) operations. Finally, considering the mixed organizations, their related percentages are more similar to those recorded for men organizations (Table 3), underlining lower differences between these two groups in the whole water management process.

3.2. Indicator Ratios and Comparison

In Table 5, the indicators ratios are calculated (between women and men organizations, women and mixed organizations and men and mixed organizations), including the formal codes attributed to each of them during the processing phase. Moreover, in Table 5, the different levels of equality/inequality between the observed FOs are shown through a scale of different colors.

Table 5. The ratios of the investigated indicators and the different levels of inequality between the observed FOs.

Category	Indicator	Code	Women/Men Ratio	Women/Mixed Ratio	Men/Mixed Ratio
Land	Plot distance < 500 m (from the village)	PD	0.63 [a]	0.98 [b]	1.56 [c]
	Group perimeter property (or village)	GPP	1.02 [b]	0.90 [b]	0.88 [d]
	Group plot distribution (not individual)	GPD	2.00 [c]	1.00 [b]	0.50 [a]
Water Technique	Pump presence	PP	0.55 [a]	0.60 [a]	1.08 [b]
	Improved irrigation system (drip or other)	IIS	0.13 [c]	0.15 [c]	1.17 [d]
Water	Reservoir (to facilitate the irrigation)	R	0.77 [d]	0.93 [b]	1.21 [d]
	Mixed water use (domestic and irrigation)	MWU	1.07 [b]	1.10 [d]	1.03 [b]
Economic	Agricultural products selling	APS	0.71 [d]	0.70 [d]	0.99 [b]
	Fertilizer purchase	FP	0.68 [a]	0.65 [a]	0.96 [b]

Note: Legend: [a] = medium inequality; [b] = no inequality; [c] = high inequality; [d] = low inequality.

Table 5 makes evident high disparities in many indicators between women and men organizations, while more likenesses exist between women and mixed organizations.

In particular, a high level of gender inequality concerns the water technique issues: in particular, the mechanical systems for the water lifting (pumps presence—PP) and the improved irrigation systems (ISS). In these two features, women organizations present evident shortages. Such lack may be explained by the possible diverse levels of capacities, training or attitudes between the different involved farmer organizations or rather by the presence of gender, socio and cultural bias (as noticed by some Ghana's researchers in a study of 2013) [29]. In this step of the research, only some suppositions can be made before pursuing with a more qualitative and specific analysis.

In addition, the plot distance (PD) is critical because women' plots are more distant from the village than men (as observed by Oxfam International and Save the Children [75]). The collective plot distribution (GPD) is more applied by women and mixed organizations. However, they unlikely have a water reservoir (R), which facilitate the irrigation. The agricultural product selling (APS) is generally more performed by men and mixed organizations, while the fertilizers purchase (FP) of women and mixed FOs is less.

The plots' property (GPP) and the water use for domestic or irrigation purposes (MWU) do not represent a gender bias in these regions for the FOs.

Generally, we can observe a widespread inequality between the selected men and women FOs (Table 5), while women and mixed groups present more similar characteristics. This similarity may appear in contrast with another aspect that generally concerns the mixed groups. In this type of farmer organization, women often occupy a position of simple "agricultural workers", excluded by the internal decision institutions, in particular because of their lower level of education (necessary even for the most basic secretary and treasury/financial tasks), but also due to their lack of negotiation and mobility skills (suitable for participating in training sessions, etc.) to compare with men. To confirm such gender inequality representation within the mixed organizations, when we look at the specific leadership of each type of FOs, we can delineate the following dynamics. In the case of women's organizations, the FO leader is usually a woman (with a proportion ranging from 60% to 100%), while, in the case of men's organizations, the leader is always a man (100%). Another notable outcome concerns the mixed groups where women leaders only represent 34%.

Additional data that may confirm such general situations on inequality is the average number of FO members (see Table 3). Generally, women's groups present a larger average of members (67 individuals), which cultivate and spread the benefits of smaller surfaces of land (Table 6).

In addition, 46% of men organizations own the bigger plots of land (greater than five hectares), while the same size of plots is cultivated by only 14% of the women groups (Table 6). On the contrary, about one third of the sample women organizations exploit the smallest plots of land (less than one hectare). The mixed groups presented an average situation, with 50% of cultivating plots including between one and five hectares.

In Figure 2, it is possible to appreciate the main equalities (data closer to 1 corresponding to no difference) and inequalities (data farther away from 1 corresponding to big differences) between women, men and mixed FOs.

Table 6. Average perimeter size of each type of FO.

FO Type	Perimeter Size (ha) and Percentage on the Total		
	ha $\leq$ 1	1 < ha < 5	$\geq$5 ha
Women	35%	51%	14%
Men	23%	31%	46%
Mixed	18%	46%	36%

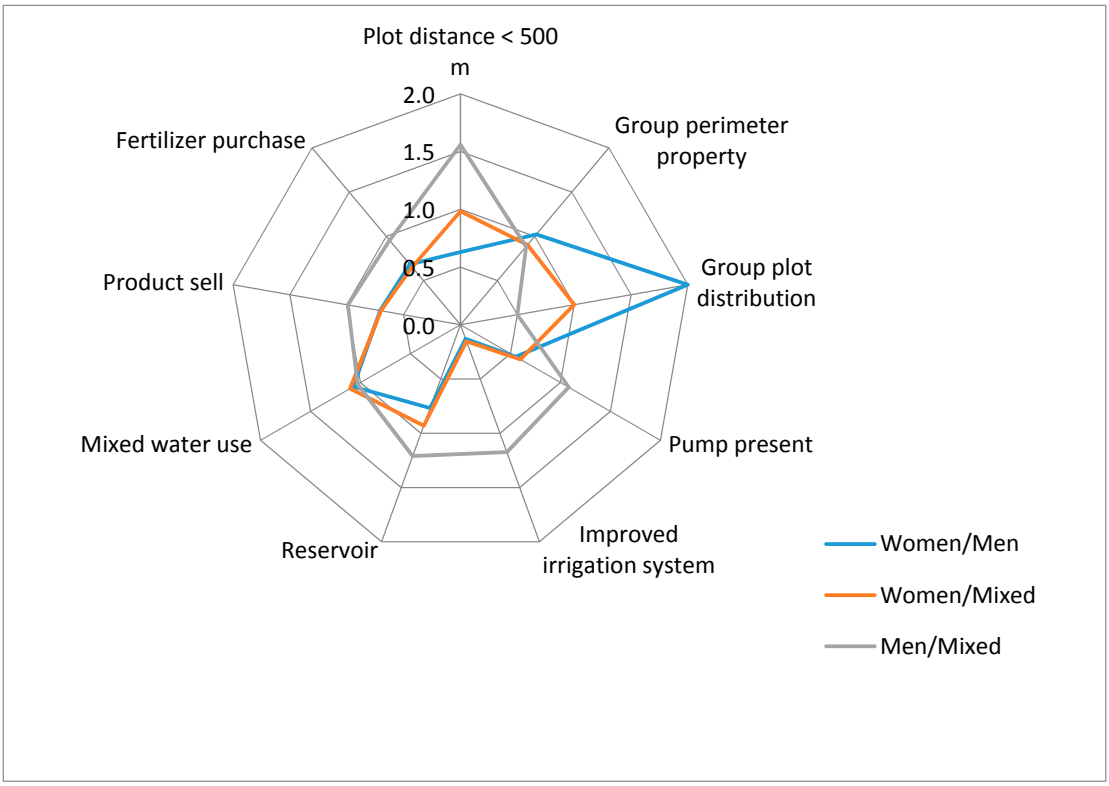

Figure 2. Indicators' ratio distribution.

In this figure, we especially highlighted the values of the plot distance from the village, where the women FOs appear very disadvantaged with respect to the men organizations. Furthermore, the same inequality between female and male FOs can be observed in relation to the technical solutions used to improve the plot irrigation methods (e.g., the presence of reservoirs, pumps and improved irrigation systems).

3.3. Gender Issues within the Local WUAs

With this regards, in the study we made an initial analysis aimed to study the gender component (e.g., the women participation and active presence) within the local Water User Associations (WUAs).

In Senegal, in the '80, the Senegalese government transferred the management responsibilities to the WUAs, even if maintaining the ownership rights of the water infrastructures. In the mid '90s the Senegalese government further enhanced the decentralization of the water management tasks by reinforcing the role of the WUAs and by fostering a greater private sector participation [76].

Despite Senegal has been frequently presented by some International Development Agencies [77,78] as a best practice in terms of private-public partnership for the water management system, many constrains can be observed, as the dependence on the scarce government funds for the renewal and maintenance operations and the weak governance, managerial and technical skills of the WUAs [79]. One of such limits, not enough considered by the mentioned literature, is the quite small space dedicate to the analysis of the gender component between the water management programmes and technical reports, which appear almost gender-blind.

If we look at the research sample, we can find the confirmation of the quite transparent role of women within such institutions (where they are largely present but without effective decision making power on access and management of resources, market, etc.) as well as the generic lack of gender-sensitive data. Despite some problems of missing information (unfortunately the questionnaire presented 34 missing information on the whole sample of 61 water user associations) on the 27 WUAs which contain this information only three names of women appear, namely the 11.1% of the total.

Accordingly it can be argued that this exclusion may negatively influence the final access of irrigation resources to women.

4. Discussion and Conclusions

One of the main purposes of the paper was to contribute to the debate around the new Sustainable Development Goals SDGs 5 and 6. Nonetheless, despite the progresses and the better openness shown by such SDGs, through more inclusive and differentiated decision-making processes [80,81] promoted by the international community, the distance between the official "discourses" and the field conditions is still far from being covered [82]. Indeed, one of the research outcomes is a critical discussion about the difficulties and the sensitive use of indicators, frequently observed in the field by researchers and practitioners in the M&E of water-related gender issues. The trend to rather focus the general efforts towards more suitable, efficient and sustainable solutions aiming to value existing data and surveys, instead of engaging new additional and "expensive" campaigns for the data gathering, is increasingly shared by academics and practitioners [83]. In this framework, the paper states that the use of easily attainable and understandable systems of water gender indicators, based on already existing databases, may allow (under certain circumstances such as the joint implementation of qualitative and participatory tools) not only to highlight the gender differences in terms of access, management and use of water for rural development purposes, but also to consequently better adapt the future and current projects' implementation.

It has been clearly shown by researchers [84] how the same effects of drip irrigation projects may completely differ according to each geographical, institutional and socio-cultural background. For such reasons, it is clear that the results coming from the application of such systems of indicators may diverge according to different contexts. Thus, this case study should be mainly intended as a "user friendly" proposal to efficiently use available data in order to elaborate some SMART indicators on gender and water management issues in agriculture.

The main findings of the study proved and confirmed both the initial assumptions and the discussed literature about gender and water concerns in agriculture. In particular, the application of this system of water gender indicators to such sample of FOs allowed for delineating the following main gender features:

- 50% of all of the involved organizations were women FOs;
- the female leaders represented around the 50% of the total leaders;
- female and mixed organizations seemed more similar (but, at the same time, in the mixed groups, women leaders represented only one third of the total);
- the women's FOs were generally more numerous groups which cultivate smaller surfaces of land (one third of the women organizations exploited the smallest plots of land, less than one hectare);
- the women's plots were more distant from the village than those of the men;
- the women organizations appeared more weak in the product selling (65% of women versus 92% of men) and in the fertilizer purchase (58% for women versus 85% for men) operations;
- the women organizations presented very low values on the improved irrigation systems (namely, 7% against 54% of men and 46% of mixed);
- the water pumps were present in only 51% of the surveyed women organizations.

One of the limitations of this study is the limited scale of analysis of the research (three small regions of Senegal), while other previous studies were applied to a huger range of countries. Such criticism does not deliver a big comparative view but at the same time allows for highlighting several differences even existing at a very small scale.

From this study around indicators, the necessity clearly emerges to include a more widespread "social" dimension (with data as age, education, previous participation in technical training, etc.) since the beginning of the data gathering processes, the pre-implementation and the M&E phases of such rural development programs.

An additional interesting point to be developed in the future steps of the research is the inclusion, within the proposed system, of a sub-indicator on gender workload. Indeed, as already mentioned in relation to other types of technical projects, even in the case of drip irrigation interventions, the risk to affect the general position of the involved women is frequently noticed [41]. Conversely, in some cases [59], the application of drip irrigation systems may entail a generic decrease of the workload for all of the involved farmers, thus, perhaps, even for the women generally entitled to the manual watering operations. Unfortunately, during this phase of the study, it was not possible to calculate such workload sub-indicators because of the lack of suitable collected data. Indeed, the survey questionnaires were submitted before the implementation of the project activities in order to identify the main starting conditions of the selected FOs and of their horticulture perimeters.

Analyzing water access, distribution, and use in rural contexts implies studying governance issues—in particular "how decisions about water resources are made, by whom, at what geographical scales, and to whose benefit" [85]. The same assumptions are valid in relation to the gender equality mechanisms. A suitable attention should be dedicated to the active and actual participation of women in the management committees of farmer organizations, in technical training and in water management associations. Real participation allows for dealing with the fair access of women farmers to the extension services for agriculture [86,87]. In addition, "an effective participation of women within technical and agricultural projects can strengthen both their position and decision power within households and farmer and/or water management organizations, as well as improve the women's compliance with rules and maintenance problems" [48]. At the same time, as observed by other researchers [88], an actual and equitable participation of the farmers (both women and men) within the irrigation process management generally generates greater levels of economic performance, energy saving and productivity. Many studies [45,46,89] emphasized the positive effects in terms of environmental and socio-economic sustainability due to collective actions managed by women. important and effective consequences are strictly connected with the actual—not only as part of the "official machinery" [89]—application of the gender equality concepts in the development interventions. However, from the short analysis made to study the gender component within the local WUAs, the limited presence of women leaders within such intermediate organizations emerged. Thus, given the strong water dimension of the project, the potential changes in the water management group composition during the future implementation steps should be actively monitored, from a huge gender perspective. In order to achieve this goal and to better assess such women decision-power, the insertion of a specific WUA sub-indicator could be a suitable solution to improving the quality and the outreach of the whole system of the proposed water gender indicators.

Thanks to this study, we can see how making a gender-based analysis (through a system of water gender indicators) may allow to more deeply understand some more or less "hidden" water governance mechanisms and their related implications in terms of policy making [65]. The application of a suitable system of water gender indicators is important during the whole project stages, starting from the identification to the design, implementation and monitoring–evaluation steps. Indeed, a robust system of water gender indicators may allow a better and more efficient management of the agricultural interventions, by virtue of its capacity to compare and jointly show the several dimensions connected to gender equality and water management issues. At the same time, this type of research should be jointly accompanied by rigorous qualitative and participatory surveys, in order to achieve a more in-depth overview of the complexity behind gender and water management issues within agricultural interventions. Thus, the next desirable steps of our study would be testing and joint and shared discussion about the potentialities and limits of such indicators with a significant representation of the sample organizations, following the criteria adopted by research in the action approach.

About the value of such water gender indicators, but also the need to be integrated with more participatory tools, some important points emerged from the research First, the difficulty to find a good representation of women within the decision-making bodies of FOs, second the strong connection

between gender data availability, effective participation, access to (water) resources, freedom to manage them and real representation and power of women within their communities.

Throughout this study, we have become more conscious of the limitations frequently addressed regarding the indicators as potential "tools of power and creation of knowledge" and expression of personal and subjective visions of the world [90]. For these reasons, in order to achieve an actual and concrete implementation of the above-mentioned SDGs in the field, we would also stress the need to ensure the gathering of real and effective "data for people by the people", implying a greater ownership of such indicators by the target populations, even thanks to the inclusion of their personal perceptions, as stressed by many researchers [91], on the value and the potential of the water gender indicators.

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Abbreviations

ANSD	National Statistic Agency of Senegal
FAO	Food and Agriculture Organization
FOs	Farmer Organizations
GIE	Groupements d'Intérêt Economique
GPF	Groupements de Promotion Féminine
GPII	Gender Performance Indicator for Irrigation
IWMI	International Water Management Institute
MAER	Senegalese Ministry of Agriculture
M&E	Monitoring and Evaluation
SDGs	Sustainable Development Goals
SEAGA	Socio-economic and Gender Analysis
UN	United Nations
UNDP	United Nations Development Program
WB	World Bank
WUAs	Water User Associations

References

1. United Nations Development Program (UNDP). UNDP policy and programme brief. In *UNDP Support to the Implementation of the 2030 Agenda for Sustainable Development*; United Nations Development Program (UNDP): New York, NY, USA, 2016.
2. Holden, E.; Linnerud, K.; Banister, D. The imperatives of sustainable development. *Sustain. Dev.* **2017**, *25*, 213–226. [CrossRef]
3. Kumar, S.; Kumar, N.; Vivekadhish, S. Millennium development goals (MDGS) to sustainable development goals (SDGS): Addressing unfinished agenda and strengthening sustainable development and partnership. *Indian J. Community Med.* **2016**, *41*. [CrossRef] [PubMed]
4. Kabeer, N. Gender equality and women's empowerment: A critical analysis of the third millennium development goal 1. *Gend. Dev.* **2005**, *13*, 13–24. [CrossRef]

5. Van Koppen, B.; Hussain, I. Irrigation, Gender and Poverty: Overview of Issues and Options. In *Pro-Poor Intervention Strategies in Irrigated Agriculture in Asia, Proceedings of the Regional Workshop and Policy Roundtable, Colombo, Sri Lanka, 25–27 August 2004*; International Water Management Institute (IWMI): Colombo, Sri Lanka, 2004; Available online: https://core.ac.uk/download/pdf/6764857.pdf (accessed on 23 April 2017).
6. Njuki, J.; Waithanji, E.; Sakwa, B.; Kariuki, J.; Mukewa, E.; Ngige, J. *Can Market-Based Approaches to Technology Development and Dissemination Benefit Women Smallholder Farmers? A Qualitative Assessment of Gender Dynamics in the Ownership, Purchase, and Use of Irrigation Pumps in Kenya and Tanzania*; IFPRI Discussion Paper 01357; International Food Policy Res Institute: Washington, DC, USA, 2014; Available online: http://www.ifpri.org/publication/can-market-based-approaches-technology-development-and-dissemination-benefit-women (accessed on 14 May 2017).
7. Freeman, H.A.; Silim, S.S. Commercialization of smallholder irrigation: The case of horticultural crops in semi-arid areas of eastern Kenya. In *Private Irrigation in Sub-Saharan Africa, Proceedings of the Regional Seminar on Private Sector Participation and Irrigation Expansion in Sub-Saharan Africa, Accra, Ghana, 22–26 October 2001*; International Water Management Institute (IWMI): Colombo, Sri Lanka, 2002; Available online: http://publications.iwmi.org/pdf/H030881.pdf (accessed on 3 June 2017).
8. Upadhyay, B. Women and natural resource management: Illustrations from India and Nepal. *Nat. Res. Forum* **2005**, *29*, 224–232. [CrossRef]
9. Jobbins, G.; Kalpakian, J.; Chriyaa, A.; Legrouri, A.; El Mzouri, E.H. To what end? Drip irrigation and the water-energy-food nexus in Morocco. *Int. J. Water Resour. Dev.* **2015**, *31*, 393–406. [CrossRef]
10. Wanvoeke, J.; Venot, J.P.; Zwarteveen, M.; de Fraiture, C. Performing the success of an innovation: the case of smallholder drip irrigation in Burkina Faso. *Water Int.* **2015**, *40*, 432–445. [CrossRef]
11. Karlberg, L.; de Vries, F.W.P. Exploring potentials and constraints of low-cost drip irrigation with saline water in sub-Saharan Africa. *Phys. Chem. Earth Parts A/B/C* **2004**, *29*, 1035–1042. [CrossRef]
12. Woltering, L.; Pasternak, D.; Ndjeunga, J. The African market garden: The development of a low-pressure drip irrigation system for smallholders in the sudanosahel. *Irrig. Drain.* **2011**, *60*, 613–621. [CrossRef]
13. Robbiati, G.; Faye, A.; Ngom, Y.; Ngom, M.; Valori, F. Exploitations Horticoles Avec Irrigation Goutte-A-Goutte Dans le Bassin Arachidier. Available online: https://documentslide.org/exploitations-horticoles-avec (accessed on 8 December 2017).
14. Turral, H.; Svendsen, M.; Faures, J.M. Investing in irrigation: Reviewing the past and looking to the future. *Agric. Water Manag.* **2010**, *97*, 551–560. [CrossRef]
15. Food and Agriculture Organization. *SEAGA Sector Guide on Irrigation*; Socio-Economic and Gender Analysis Program: Rome, Italy, 2001; Available online: http://www.makeeverywomancount.org/images/stories/documents/FAO_SEAGASectorGuide-Irrigation_2001.pdf (accessed on 18 April 2017).
16. Buechler, S. Gendered vulnerabilities and grassroots adaptation initiatives in home gardens and small orchards in Northwest Mexico. *Ambio* **2016**, *45*, S322–S334. [CrossRef] [PubMed]
17. De Moraes, A.F.J. Advances and setbacks in women's participation in water management in Brazil. In *Political Ecology of Women, Water, and Global Environmental Change*; Buechler, S., Hanson, A.M., Eds.; Routledge: New York, NY, USA, 2015; pp. 77–97.
18. Buechler, S.; Sen, D.; Khandekar, N.; Scott, C.A. Re-Linking Governance of Energy with Livelihoods and Irrigation in Uttarakhand, India. *Water* **2016**, *8*, 437. [CrossRef]
19. Postel, S.; Polak, P.; Gonzales, F.; Keller, J. Drip irrigation for small farmers: A new initiative to alleviate hunger and poverty. *Water Int.* **2001**, *26*, 3–13. [CrossRef]
20. Van Koppen, B.; Hope, L.; Colenbrander, W. *Gender Aspects of Small-Scale Private Irrigation in Africa*; IWMI Working Paper 153; International Water Management Institute (IWMI): Colombo, Sri Lanka, 2012.
21. Aladuwaka, S.; Momsen, J. Sustainable development, water resources management and women's empowerment: The Wanaraniya Water Project in Sri Lanka. *Gend. Dev.* **2010**, *18*, 43–58. [CrossRef]
22. Faurès, J.M.; Santini, G. *Water and the Rural Poor: Interventions for Improving Livelihoods in Sub-Saharan Africa*; International Fund for Agricultural Development (IFAD): Rome, Italy, 2008.
23. Kablan, M.K.A.; Dongo, K.; Coulibaly, M. Assessment of Social Vulnerability to Flood in Urban Côte d'Ivoire Using the MOVE Framework. *Water* **2017**, *9*, 292. [CrossRef]

24. Cleaver, F.; Elson, D. *Women and Water Resources: Continued Marginalization and New Policies*; Gatekeeper Series 49; International Institute for Environment and Development: London, UK, 1995; pp. 1–10. Available online: http://mekonginfo.org/assets/midocs/0003073-environment-women-and-water-resources-continued-marginalisation-and-new-policies.pdf (accessed on 11 February 2017).
25. Green, C.; Baden, S. Integrated water resources management: A gender perspective. *IDS Bull.* **1995**, *26*, 92–100. [CrossRef]
26. Zwarteveen, M.Z. Water: From basic need to commodity: A discussion on gender and water rights in the context of irrigation. *World Dev.* **1997**, *25*, 1335–1349. [CrossRef]
27. Moyo, R. Impact and Sustainability of Drip Irrigation Kits, in the Semi-Arid Lower Mzingwane Catchment, Limpopo Basin, Zimbabwe. Master's Thesis, University of Zimbabwe, Harare, Zimbabwe, 2005.
28. Buechler, S. Climate-water challenges and gendered adaptation strategies in Rayón, a riparian community in Sonora, Mexico. In *A Political Ecology of Women, Water and Global Environmental Change*; Buechler, S., Hanson, A.-M., Eds.; Routledge: New York, NY, USA, 2015; pp. 99–118.
29. Dittoh, S.; Awuni, J.A.; Akuriba, M. Small pumps and the poor: A field survey in the Upper East Region of Ghana. *Water Int.* **2013**, *38*, 449–464. [CrossRef]
30. Van Koppen, B. *A Gender Performance Indicator for Irrigation: Concepts, Tools and Applications*; Research Report 59; International Water Management Institute (IWMI): Colombo, Sri Lanka, 2002.
31. Van Houweling, E.; Hall, R.P.; Sakho Diop, A.; Davis, J.; Seiss, M. The role of productive water use in women's livelihoods: Evidence from rural Senegal. *Water Altern.* **2012**, *5*, 658–677.
32. Quisumbing, A. Male-female differences in agricultural productivity: Methodological issues and empirical evidence. *World Dev.* **1996**, *24*, 1579–1595. [CrossRef]
33. Quisumbing, M.A.R.; McClafferty, B.F. *Food Security in Practice: Using Gender Research in Development*; International Food Policy Res Institute: Washington, DC, USA, 2006.
34. Oseni, G.; Corral, P.; Goldstein, M.; Winters, P. Explaining gender differentials in agricultural production in Nigeria. *Agric. Econ.* **2015**, *46*, 285–310. [CrossRef]
35. Hill, R.V.; Vigneri, M. Mainstreaming gender sensitivity in cash crop market supply chains. In *Gender in Agriculture: Closing the Knowledge Gap*; Quisumbing, A., Meinzen-Dick, R., Raney, T., Croppenstedt, A., Behrman, J., Peterman, A., Eds.; Springer: Dordrecht, The Netherlands, 2014; pp. 315–341.
36. Doss, C.R.; Morris, M.L. How does gender affect the adoption of agricultural innovations? *Agric. Econ.* **2000**, *25*, 27–39. [CrossRef]
37. Van Koppen, B.; Namara, R.; Safilios-Rothschild, C. *Reducing Poverty through Investments in Agricultural Water Management*; IWMI Working Paper 10; International Water Management Institute (IWMI): Colombo, Sri Lanka, 2006; Available online: http://www.iwmi.cgiar.org/Publications/Working_Papers/working/WOR101.pdf (accessed on 9 April 2017).
38. Haile, A.M.; Depeweg, H.; Stillhardt, B. Smallholder Drip Irrigation Technology: Potentials and Constraints in the Highlands of Eritrea. *Mt. Res. Dev.* **2003**, *23*, 27–31. [CrossRef]
39. Upadhyay, B. Drip irrigation: An appropriate technology for women. *Appropr. Technol.* **2003**, *30*, 31–33.
40. Harris, L.M.; Gantt, W. *Gender and Shifting Water Governance: Differential Effects of Privatization, Commodification, and Democratization*; Tenure Brief 6; University of Wisconsin: Wisconsin, DC, USA, 2007; Available online: https://minds.wisconsin.edu/handle/1793/22157 (accessed on 6 March 2017).
41. Veldwisch, G.J.A.; Borsboom, V.; Ingen-Housz, F.J.M.; Zwarteveen, M.Z.; Post Uiterweer, N.C.; Hebinck, P.G.M. Low-cost drip irrigation in Zambia: Gendered practices of promotion and use. In *Drip Irrigation for Agriculture: Untold Stories of Efficiency, Innovation and Development*; Venot, J.P., Kuper, M., Zwarteveen, M., Eds.; Earthscan: New York, NY, USA, 2017; pp. 204–218.
42. Byerlee, D.; De Janvry, A.; Sadoulet, E. Agriculture for development: Toward a new paradigm. *Annu. Rev. Resour. Econ.* **2009**, *1*, 15–31. [CrossRef]
43. Agarwal, B. Gender and forest conservation: The impact of women's participation in community forest governance. *Ecol. Econ.* **2009**, *68*, 2785–2799. [CrossRef]
44. Agarwal, B. *Gender and Green Governance. The Political Economy of Women's Presence within and beyond Community Forestry*; Oxford University Press: Oxford, UK, 2010.
45. Van Koppen, B.; Hussain, I. Gender and irrigation: Overview of issues and options. *Irrig. Drain.* **2007**, *56*, 289–298. [CrossRef]

46. Wennink, B.; Nederlof, S.; Heemskerk, W. *Access of the Poor to Agricultural Services: The Role of Farmers' Organizations in Social Inclusion*; Bulletin 376; KIT Royal Tropical Institute: Amsterdam, The Netherlands, 2008; Available online: http://www.kit.nl/sed/wp-content/uploads/publications/1287_Access-web-deelI.pdf (accessed on 2 October 2017).
47. Van Koppen, B. Water rights, gender, and poverty alleviation. Inclusion and exclusion of women and men smallholders in public irrigation infrastructure development. *Agric. Hum. Values* **1998**, *15*, 361–374. [CrossRef]
48. Meinzen-Dick, R.; Zwarteveen, M. Gendered participation in water management: Issues and illustrations from water users associations in South Asia. *Agric. Hum. Values* **1998**, *15*, 337–345. [CrossRef]
49. Doss, C. Data needs for gender analysis in agriculture. In *Gender in Agriculture: Closing the Knowledge Gap*; Quisumbing, A., Meinzen-Dick, R., Raney, T., Croppenstedt, A., Behrman, J., Peterman, A., Eds.; Springer: Dordrecht, The Netherlands, 2014; pp. 55–68.
50. Food and Agriculture Organization. *The State of Food and Agriculture: Women in Agriculture: Closing the Gender Gap for Development*; FAO: Rome, Italy, 2011; Available online: http://www.fao.org/docrep/013/i2050e/i2050e.pdf (accessed on 9 February 2017).
51. Sullivan, C.A.; Meigh, J.R.; Giacomello, A.M. The water poverty index: Development and application at the community scale. *Nat. Resour. Forum* **2003**, *27*, 189–199. [CrossRef]
52. Seager, J. *Sex-Disaggregated Indicators for Water Assessment, Monitoring and Reporting*; Gender and Water Series; WWAP UNESCO: Paris, France, 2015; Available online: http://unesdoc.unesco.org/images/0023/002340/234082e.pdf (accessed on 20 May 2017).
53. Kalpakian, J.; Legrouri, A.; Ejekki, F.; Doudou, K.; Berrada, F.; Ouardaoui, A.; Kettani, D. Obstacles facing the diffusion of drip irrigation technology in the Middle Atlas region of Morocco. *Int. J. Environ. Stud.* **2014**, *71*, 63–75. [CrossRef]
54. World Bank. *Reengaging in Agricultural Water Management. Challenges and Options*; World Bank: Washington, DC, USA, 2006; Available online: http://siteresources.worldbank.org/INTARD/Resources/DID_AWM.pdf (accessed on 1 October 2017).
55. Postel, S.L. Entering an era of water scarcity: The challenges ahead. *Ecol. Appl.* **2000**, *10*, 941–948. [CrossRef]
56. Senegalese National Statistic Agency (ANSD). *Recensement Général de la Population et de l'Habitat, de l'Agriculture et de l'Elevage 2013: Rapport Définitif*; General Census Report 2013; Senegalese National Statistic Agency (ANSD): Dakar, Senegal, 2014. Available online: http://www.ansd.sn/ressources/RGPHAE-2013/ressources/doc/pdf/2.pdf (accessed on 10 January 2017).
57. Maertens, M.; Swinnen, J.F. Trade, standards, and poverty: Evidence from Senegal. *World Dev.* **2009**, *37*, 161–178. [CrossRef]
58. Kelly, V.; Reardon, T.; Diagana, B.; Fall, A.A. Impacts of devaluation on Senegalese households: Policy implications. *Food Policy* **1995**, *20*, 299–313. [CrossRef]
59. Centrone, A.; Calvo, A. Dinamiche di genere nella gestione della crisi alimentare. Un'ipotesi di sviluppo dal basso nella filiera del riso lungo la Valle del fiume Senegal (Gender dynamics in the food crisis. A hypothesis of bottom-up approach in the rice supply chain along the Senegal River Valley). *Quaderni di Donne e Ricerca* **2014**, *35*, 1–56.
60. Senegalese National Statistic Agency (ANSD). *Situation Economique et Sociale de la Région de Thiès en 2009*; Economic and Social Situation of the Thies Region in 2009; Senegalese National Statistic Agency: Dakar, Senegal, 2010. Available online: http://www.ansd.sn/ressources/ses/SES_Thies_2009.pdf (accessed on 11 December 2017).
61. Senegalese National Statistic Agency (ANSD). *Regional Statistics Service of Fatick, Situation Economique et Sociale de la Region de Fatick en 2008*; Economic and Social Situation of the Fatick Region in 2008; Senegalese National Statistic Agency (ANSD): Dakar, Senegal, 2009. Available online: http://www.ansd.sn/publications/annuelles/SES_Region/SES_Fatick_2008.pdf (accessed on 10 February 2017).
62. Senegalese National Statistic Agency (ANSD). *Regional Statistics Service of Diourbel, Situation Économique et Sociale de la Région de Diourbel en 2009*; Economic and Social Situation of the Diourbel Region in 2009; Senegalese National Statistic Agency (ANSD): Dakar, Senegal, 2010. Available online: http://www.ansd.sn/publications/annuelles/SES_Region/SES_Diourbel_2009.pdf (accessed on 10 February 2017).

63. Centrone, F.A.; Bock, B.B.; Mosso, A.; Calvo, A. The Role of Gender Indicators in Rural Development Programmes. In *Gender and Rural Globalization: International Perspectives on Gender and Rural Development*; Bock, B.B., Shortall, S., Eds.; Centre for Agriculture and Bioscience International: Wallingford, UK, 2017.
64. Molle, F.; Mollinga, P. Water poverty indicators: Conceptual problems and policy issues. *Water Policy* **2003**, *5*, 529–544.
65. Lu, F.; Ocampo-Raeder, C.; Crow, B. Equitable water governance: Future directions in the understanding and analysis of water inequities in the global South. *Water Int.* **2014**, *39*. [CrossRef]
66. Lastarria-Cornhiel, S.; Behrman, J.A.; Meinzen-Dick, R.; Quisumbing, A.R. Gender equity and land: Toward secure and effective access for rural women. In *Gender in Agriculture: Closing the Knowledge Gap*; Quisumbing, A., Meinzen-Dick, R., Raney, T., Croppenstedt, A., Behrman, J., Peterman, A., Eds.; Springer: Dordrecht, The Netherlands, 2014; pp. 117–144.
67. Agarwal, B. Environmental action, gender equity and women's participation. *Dev. Chang.* **1997**, *28*, 1–44. [CrossRef]
68. Pickering, A.J.; Davis, J. Freshwater availability and water fetching distance affect child health in sub-Saharan Africa. *Environ. Sci. Technol.* **2012**, *46*, 2391–2397. [CrossRef] [PubMed]
69. Graham, J.P.; Hirai, M.; Kim, S.S. An Analysis of water collection labor among women and children in 24 Sub-Saharan African countries. *PLoS ONE* **2016**, *11*. [CrossRef] [PubMed]
70. Ray, I. Women, water, and development. *Annu. Rev. Environ. Resour.* **2007**, *32*. [CrossRef]
71. Meinzen-Dick, R.; Johnson, N.; Quisumbing, A.R.; Njuki, J.; Behrman, J.A.; Rubin, D.; Waithanji, E. The gender asset gap and its implications for agricultural and rural development. In *Gender in Agriculture: Closing the Knowledge Gap*; Quisumbing, A., Meinzen-Dick, R., Raney, T., Croppenstedt, A., Behrman, J., Peterman, A., Eds.; Springer: Dordrecht, The Netherlands, 2014; pp. 91–115.
72. Boserup, E. *Woman's Role in Economic Development*; Routledge: Abingdon, UK, 2007.
73. Senegalese National Statistic Agency (ANSD). *Deuxième Enquête de Suivi de la Pauvreté au Sénégal en 2011*; Final Report of the Second Senegalese Poverty Survey; Senegalese National Statistic Agency (ANSD): Dakar, Senegal, 2013. Available online: http://anads.ansd.sn/index.php/catalog/17 (accessed on 19 May 2017). (In French)
74. Ministère de l'Agriculture et de l'Equipement Rural du Sénégal (MAER). *Rapport d'Analyse des Résultats de l'Enquête Agricole 2010–2011*; Agricultural Survey Report Analysis; Ministère de l'Agriculture et de l'Equipement Rural du Sénégal (MAER): Dakar, Senegal, 2012. Available online: http://www.au-senegal.com/IMG/pdf/rapport_de_pre_sentation_des_re_sultats_de_finitifs_de_la_campagne_agricole_2012-2013.pdf (accessed on 30 May 2017). (In French)
75. Hazard, E.; Troc, H.; Valette, D. Rising Food Prices in the Sahel: The urgency of long-term action. *Oxfam Policy Pract.* **2008**, *8*, 88–100.
76. Hanatani, A.; Fuse, K. Linking resource users' perceptions and collective action in commons management-an examination of water supply systems in Southern Senegal. *Water Policy* **2012**, *14*, 127–147. [CrossRef]
77. United States Agency for International Development. Senegal Water and Sanitation Profile. March 2010. Available online: http://www.washplus.org/sites/default/files/senegal2010.pdf (accessed on 28 September 2017).
78. African Development Bank (AFD). *Senegal: Rural Water Supply and Sanitation Initiative Program Status*; African Development Bank (AFD): Abidjan, Cote d'Ivoire, 2015.
79. Diallo, O. *Levers of Change in Senegal's Rural Water Sector*; Water and Sanitation Program Report; World Bank: Washington, DC, USA, 2015.
80. Le Blanc, D. Towards integration at last? The sustainable development goals as a network of targets. *Sustain. Dev.* **2015**, *23*, 176–187. [CrossRef]
81. Sachs, J.D. From millennium development goals to sustainable development goals. *Lancet* **2012**, *379*, 2206–2211. [CrossRef]
82. Cornwall, A. Women's Empowerment: What Works? *J. Int. Dev.* **2016**, *28*, 342–359. [CrossRef]
83. United Nations. A World that Counts. In *Mobilizing the Data Revolution for Sustainable Development*; The United Nations Secretary-General's Independent Expert Advisory: New York, NY, USA, 2014; Available online: http://www.undatarevolution.org/wp-content/uploads/2014/12/A-World-That-Counts2.pdf (accessed on 3 June 2017).
84. Van der Kooij, S.; Zwarteveen, M.; Boesveld, H.; Kuper, M. The efficiency of drip irrigation unpacked. *Agric. Water Manag.* **2013**, *123*, 103–110. [CrossRef]

85. Perreault, T. Custom and contradiction: Rural water governance and the politics of usos y costumbres in Bolivia's irrigators' movement. *Ann. Assoc. Am. Geogr.* **2008**, *98*, 834–854. [CrossRef]
86. Ragasa, C.; Berhane, G.; Tadesse, F.; Taffesse, A.S. Gender differences in access to extension services and agricultural productivity. *J. Agric. Educ. Ext.* **2013**, *19*, 437–468. [CrossRef]
87. Peterman, A.; Behrman, J.A.; Quisumbing, A.R. A review of empirical evidence on gender differences in nonland agricultural inputs, technology, and services in developing countries. In *Gender in Agriculture: Closing the Knowledge Gap*; Quisumbing, A., Meinzen-Dick, R., Raney, T., Croppenstedt, A., Behrman, J., Peterman, A., Eds.; Springer: Dordrecht, The Netherlands, 2014; pp. 145–186.
88. Kosanlawit, S.; Soni, P.; Shivakoti, G.P. The Relationship between Effective and Equitable Water Allocation, Local Rice Farmer Participation and Economic Well-Being: Insights from Thailand's Chiang Mai Province. *Water* **2017**, *9*, 319. [CrossRef]
89. Arora-Jonsson, S. Forty years of gender research and environmental policy: Where do we stand? *Women's Stud. Int. Forum* **2014**, *47*, 295–308. [CrossRef]
90. Merry, S.E.; Conley, J.M. Measuring the world: Indicators, human rights, and global governance. *Curr. Anthropol.* **2011**, *52*, S83–S95. [CrossRef]
91. Njuki, J.; Mapila, M.; Kaaria, S.; Magombo, T. Using community indicators for evaluating research and development programs: Experiences from Malawi. *Dev. Pract.* **2008**, *18*, 633–642. [CrossRef]