3ème Conférence Internationale sur les Sciences Appliquées et l'Innovation (CISAI-2025)
Proceedings Book Series –PBS- Vol 25, pp.37-50

Exploring gender disparities in the diffusion and adoption of climate-smart agricultural and climate information system technologies in Senegal

Blaise Waly Basse
Enseignant-Chercheur
Département Economie-Gestion, Université Assane Seck de Ziguinchor
bwbasse@univ-zig.sn

Omonlola Nadine Worou
Senegal coordinator
Accelerating Impacts of CGIAR Climate Research for Africa (AICCRA)
International Livestock Research Institute (ILRI)
n.worou@cgiar.org

Maya Moore
ILRI,
mayamoore@iri.columbia.edu

Joseph Emanuel Jacob
ILRI,
J.Emanuel@cgiar.org

Folosunso M. Akinseye,
ICRISAT,
Folorunso.Akinseye@icrisat.org

Houessionon Prosper
AfricaRice/ILRI
P.Houessionon@cgiar.org

Khalifa Mbow,
ILRI,
khalifambow2@gmail.com

Sophia Huyer
ILRI,
S.Huyer@cgiar.org

Abdrahmane Wane
ILRI,
A.Wane@cgiar.org

ISSN: 2961-6611

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Summary
Gender mainstreaming in the dissemination and adoption of climate-smart agricultural technologies (CSA) and access to the climate information system (CIS) can help mitigate the effects of climate change and reduce specific disadvantages suffered by women and young people. Focusing on 473 households in the Thies, Louga and Kaffrine regions, the results of the average treatment effect (ATE) method reveal a higher rate of resilient seed adoption among females. However, the rate of adoption of micro-dosing techniques and the use of climate information are higher among youth. A negative and significant adoption gap (GAP) confirms that not all of the population had been exposed to CSA and CIS technologies, hence the existence of a non-exposure bias justifying further dissemination.
JEL Classification: O33, Q12, J16
Keywords: Technology, Farmers, Adoption, Senegal

I. Introduction

Storms, floods, drought and the extinction (IPCC, 2021) have prompted UNESCO (2020) to call for a change in behavior and a reorganization of social structures. In Senegal, these climatic phenomena are reflected in irregular rainfall, resulting in water shortages and reduced agricultural yields, which can exacerbate food insecurity. Despite the adoption of crop irrigation systems to complement rain-fed systems, agricultural production systems in Senegal remain primarily dependent on rainfall. Irrigated farmland accounts for just 5% of the total harvested area, which is estimated at 2.3 million hectares (Xie and Ringler, 2015).

In addition, Senegal's agricultural sector features a gender-based division of labor that limits women's contributions. Women farm smaller plots on average and often lack access to necessary inputs, information, and funding, exacerbating a gender productivity gap and their vulnerability to climate change (DAPSA, 2020; UN Women Africa, 2019; Derenoncourt & Jaquet, 2022). These conditions affect their ability to generate income, emphasizing the need to integrate gender equality and social inclusion (GESI) into interventions focused on promoting access to the climate information system (CIS) and the use of climate-smart agricultural technologies (CSA).

Despite national efforts like the 2010 law on parity, the Emerging Senegal Plan (PSE, 2014), and the National Strategy for Gender Equity and Equality (SNEEG 2, 2016-2026), inter-gender inequalities persist. Senegal ranks 113th out of 144 countries in gender inequality, with a gender inequality index estimated at 55.2 in 2020 (EM2030, 2022). Reducing these inequalities, particularly in agrifood systems where women hold 66% of jobs in sub-Saharan Africa, requires equitable access to agricultural services and inputs to fully benefit from CSA practices (Nelson and Huyer, 2016).

It is in this context that the "Accelerating CGIAR Climate Research in Africa" (AICCRA) project is encouraging the adoption of CSA aimed at reducing gender disparities.However, the integration of gender into productive activities is not guaranteed and depend, in large part, on the ability of the Multidisciplinary Working Groups (GTP) and the National Civil Aviation and Meteorology Agency (ANACIM) to induce individual and/or collective behavioral change. Indeed, differences in climate vulnerability between men and women are rooted in social structures and discriminatory norms and institutions that shape patterns of access to resources based on gender, time use, income opportunities and access to services in rural areas (FAO, 2023). It is imperative to reduce the knowledge gap on gender-related disparities in CIS and CSA services.

The aim of this article is to assess the development of women and young people based on the principle of dissemination of CSA and CIS technologies implemented by AICCRA, in order to support GTP/ANACIM in identifying adoption factors that can reduce gender-related disparities in the use of agricultural technologies. The CSA and CIS technologies studied are climate-resilient

ISSN: 2961-6611

groundnut and cowpea seeds, participation in demonstration plots, regular visits to technology parks, and the receipt of climate information to facilitate agricultural decision-making. The study area covers the regions of Thiès, Louga and Kaffrine. Our aim is to identify adoption rates in the youth, female and male sub-populations. Our hypothesis is that the diffusion of CIS and CSA technologies is incomplete in the population, thus generating a certain disparity of adoption in the sub-populations.

Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system (Rogers, 1983). Thus, communicating the characteristics of the innovation will trigger motivations and induce behavioral change in the population. These behavioral changes may occur at both the individual or community level. For this reason, AICCRA has set up an intervention principle based on a participatory approach. AICCRA-Senegal works in close collaboration with entities such as *Agence Nationale de Conseil Rural et Agricole* (ANCAR), *Centre d'Etude Régional pour l'Amélioration de l'Adaptation à la Sécheresse* (CERAAS), *Institut Sénégalais de Recherches Agricoles* (ISRA), ANACIM and Jokalante. With a view to inducing the desired behavioral change at both the individual and community level (e.g., access to CIS and agricultural advisory services for smart farming), the aim of these interventions is to improve the well-being and resilience of farmers in the face of climate change (e.g., improved agricultural productivity, knowledge of good agricultural practices for smart farming, restoring biodiversity, increasing water resilience, boosting food security, etc.).

For both short- and long-term results to be realized, populations, particularly women and other disadvantaged groups, must first be made aware of the existence of the CIS and smart farming techniques advisory services set up by AICCRA at their disposal. This awareness is achieved through three different channels: radio, mobile telephones and traditional extension, each with their own condition and requirements to ensure inclusivity and efficacy. In terms of radio, AICCRA Senegal has signed up four community radio stations, broadcasting AICCRA-related content at times when target populations (e.g., women, disabled people, etc.) are most likely available to listen. As far as the cell phones, some areas in Senegal, especially rural ones, access to mobile telephones poses huge problems, due to a lack of means for women to obtain one, or sometimes limited coverage of the telephone network, especially in rural areas.[1] In addition, platforms like Jokolanté and iSAT conveyed awareness-raising messages for CSA. Therefore, it is important for internet to be widely accessible. Lastly, agricultural plots must be made available for agricultural extension agents to carry out demonstration activities.

In addition, awareness-raising activities carried out by female extensionists can facilitate communication. Indeed, in the Senegalese context, women are generally more open to listening to other women and are more willing to share their problems with other women without any feeling of restraint. Thus, access to information is seen as the precursor to behavioural change, which involves actual use (or application) of the climate information provided and the recommended smart farming practices.

II. MATERIALS AND METHODS

A. Study areas

AICCRA-Senegal operates in the regions of Kaffrine, Thiès and Louga, accounting for one-fifth of the national territory, with a population which primarily relies on rain-fed agriculture[2] as their main activity. Average annual rainfall in the Thiès region is between 400 to 600 mm, compared with 300 mm in the Louga region, and 400 to 860 mm in the Kaffrine region. In terms of the socio-demographic characteristics of farming households, agriculture is mainly dominated by men (ANSD,

[1] According to 2019 data, in Senegal, around 72% of households in urban areas have access to the internet at home, almost twice as many as in rural areas (38%) (OSIRIS 2019).
[2] According to ANSD (2023), 69% of households in the Louga region are involved solely in rain-fed agriculture.

ISSN: 2961-6611

2023). Indeed, the proportion of women in charge of plots is only 10% and 15% respectively in the Louga and Kaffrine regions. The Thiès region specializes mainly in horticulture, while food crops (millet, maize, sorghum and rice) dominate in the Louga and Kaffrine regions. However, in the Louga region, 38.6% of plots are devoted to crops such as cowpeas, watermelons, cassava and bissap (ANSD, 2023).

The Thiès region boasts significant hydro-agricultural potential, making it an area of intense market gardening activity. Dior soils account for 70% of arable land. It covers an area of 6,601 km2. The Louga region, on the other hand, is characterized by brown and red-brown soils, lateritic outcrops and tropical ferruginous soils with little leaching. After Dakar, the Thiès region has the greatest economic potential in Senegal. It owes this favorable economic position to the dynamism of the agriculture, livestock, fishing, tourism, crafts, trade and mining sectors (ANSD 2019b). The economy of the Louga region depends essentially on agriculture and livestock two sectors that are vulnerable to climatic conditions. The overwhelming majority of the region's population lives in rural areas, i.e. 78.3% (ANSD 2019c). The region's main economic activities are agriculture, livestock breeding, forestry, trade, handicrafts, women's entrepreneurship and land transport (ANSD 2019a).

B. Distribution of CSA and CIS technologies

Figures 1, 2 and 3 reveal a fairly even distribution of CIS technologies across the three regions, with 31.0%, 30.4% and 38.5% of households in Thiès, Louga and Kaffrine respectively being exposed to at least one CSA & CIS technology. However, a comparative analysis by technology shows that receiving climate information has affected more households (33.62% , n=159), followed by resilient seeds (19,03% , n=90) and microdosing techniques[3] (14,16% , n=67). Technology parks and demonstration plots were established in the communes of Mabo, Ndiognik, Mbeuleup, Thiel and Méouane by *Agence Nationale de Conseil Rural et Agricole* (ANCAR), ISRA, AfricaRice, and DRDR. While demonstration plots are available for extension agents to carry out demonstration activities, technology parks are plots set up by researchers to compare technological innovations with traditional farming practices, offering farmers the opportunity to evaluate and compare the performance of new crop varieties such as millet, cowpea and groundnut against their traditional varieties. These technologies, made available to farmers, have led to a significant increase in yields. With the aim of scaling up these innovations, AICCRA is multiplying approaches to encourage farmers and agropastoralists to visit technology parks. One of these strategies is the *"Kaay Ndékki"* concept. This innovative approach involves offering visitors, particularly farmers, a breakfast of coffee, milk and bread. During this convivial moment, park managers explain in detail the work being done, gather visitors' impressions and share information about the crops.

In the case of resilient seeds, technicians from ANCAR played an essential role, providing exhaustive monitoring of the process from sowing to harvesting, ensuring that participants had a thorough understanding of each stage. Their involvement covered producers' choices, seed placement, sowing follow-up, maintenance, harvesting and seed conservation. Their presence at every stage ensured constant monitoring and proactive adaptation to the specific needs of each beneficiary. Before the start of each campaign, a communication campaign was launched to inform all stakeholders of the arrival of the seeds and the announcement of the year's agricultural season. Producers were then organized into cooperatives to foster close collaboration and collective management of resources. Once the seeds had been received, they were distributed, followed by monitoring. Each beneficiary was closely monitored by an agent. Regular exchanges take place between producers and agents/technicians, with particular emphasis on advice throughout the agricultural cycle, including the germination phase and the fertilizer application period. Effective

[3] The microdosing technique consists of applying small quantities of appropriate mineral fertilizers to the seed holes of a crop.

ISSN: 2961-6611

pest control measures were put in place, with ANCAR supplying all seed beneficiaries with phytosanitary products.

Figure 1. CSA & CIS technologies in the Thiès area

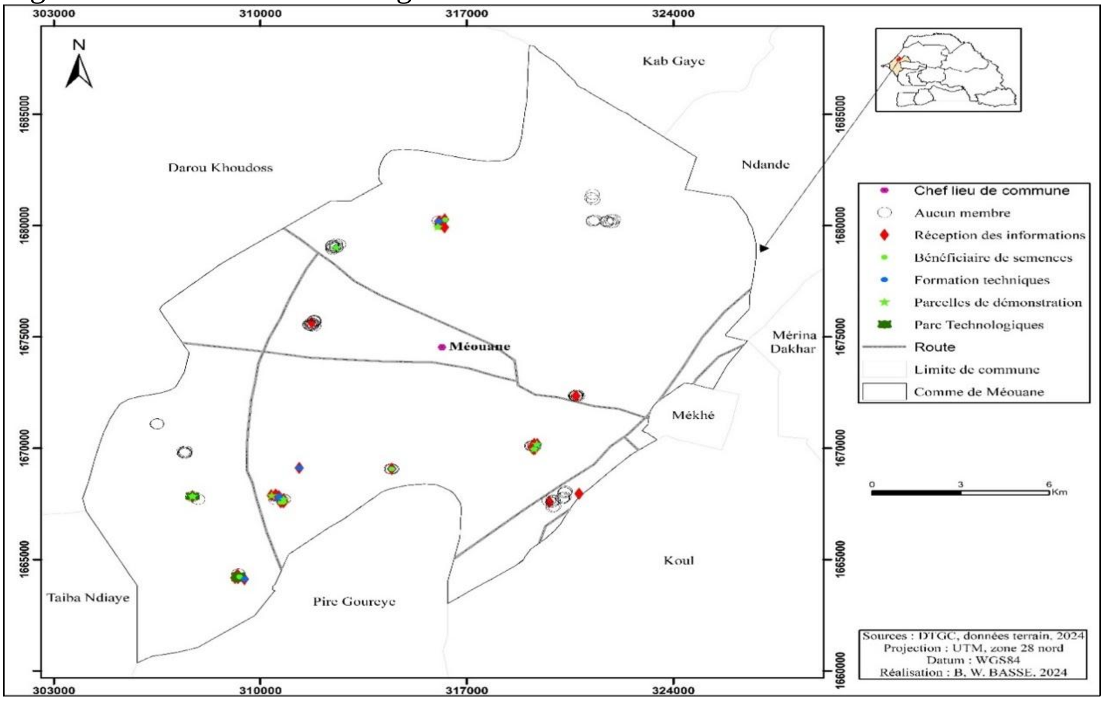
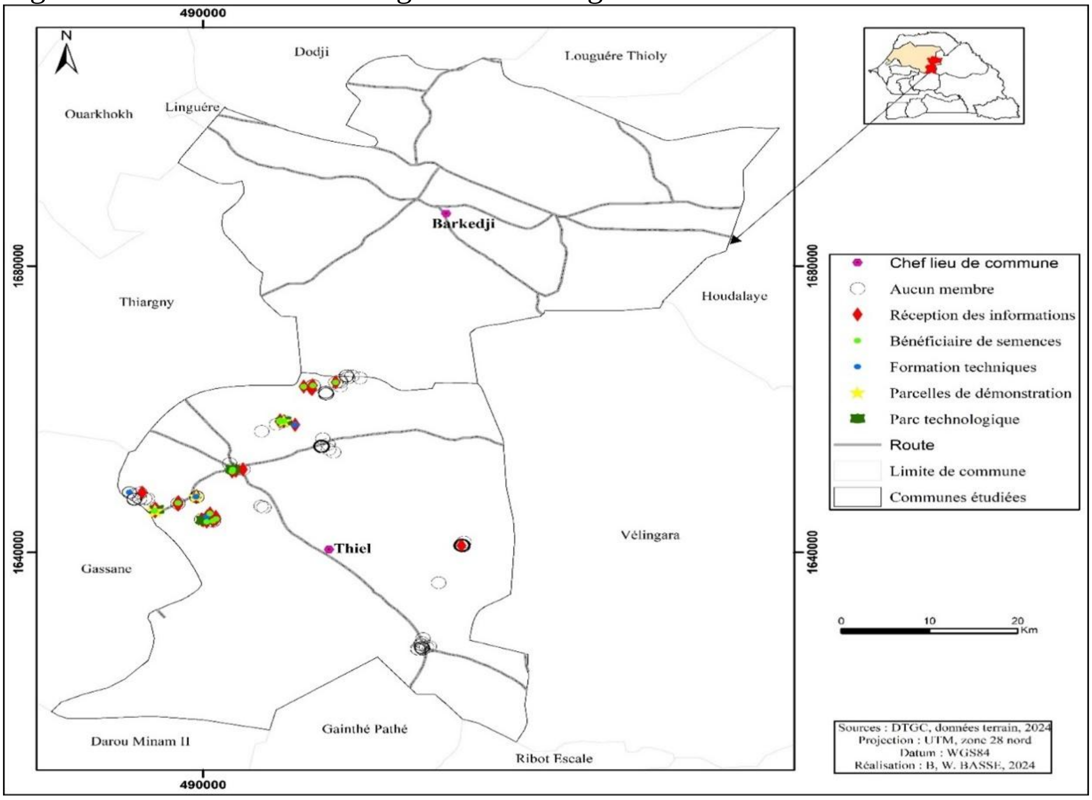
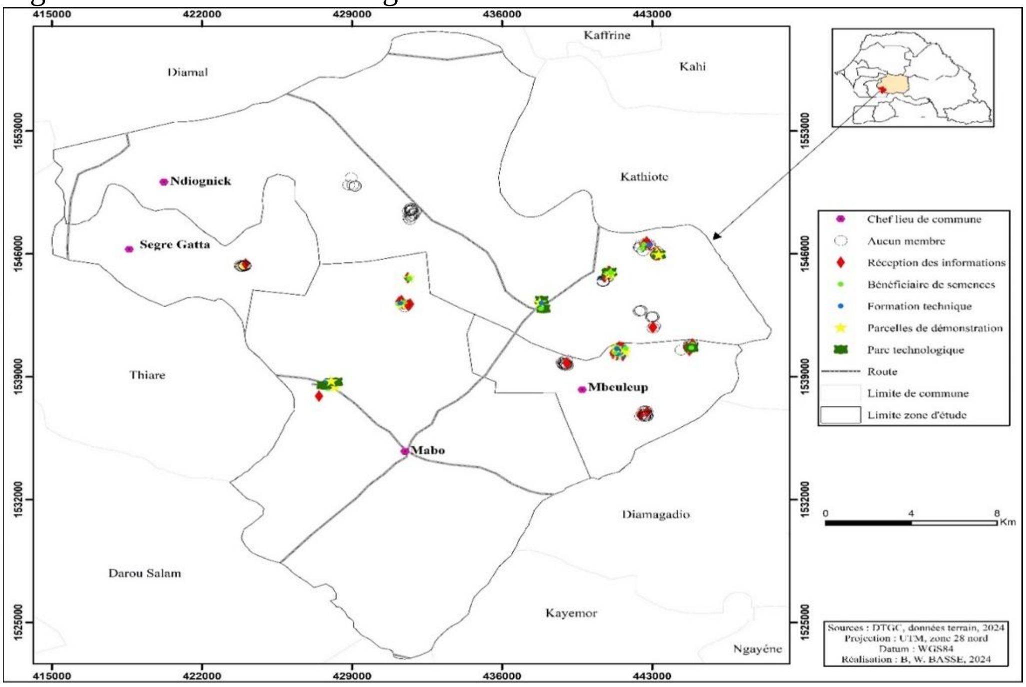


Figure 2. CSA & CIS technologies in the Louga area



ISSN: 2961-6611

Figure 3. CSA&CIS technologies in the Kaffrine area



C. Data collection and descriptive statistics

The survey was carried out in Wolof by AICCRA among 473 households in the Thiès, Louga and Kaffrine regions using a three-stage stratified sampling method. In the first stage, a sample of *communes* corresponding to primary units was drawn at random; in the second stage, a sample of villages/*quartiers* was drawn at random in each *commune*. Finally, in the third stage, a list of farming households in each village/*quartier* was drawn at random. The data were collected at the household level. Of the 473 households surveyed, 80.3% were headed by adult males. This can be attributed to the targeting of heads of households, resulting in few young heads of household being represented. This reflects the country's sociological structure, where large families typically live together in the same compound, with a head of household responsible for resource distribution. For the purposes of the analysis, we used the 15-35 age group, according to the definition of young people in the African Union charter.

Table 1 outlines the socio-demographic characteristics of the different groups of technology users (CSA&CIS) and non-users (non-CSA&CIS). The average age of young people in both CSA&CIS and non-CSA&CIS was 30, while the average age of women was 49 in CSA&CIS and 50 in non-CSA&CIS. In the male sub-population, the average age was 53 in CSA&CIS and 57 in non-CSA&CIS. However, in all three groups, the average age is lower in the CSA&CIS population with a significant difference in the male sub-population. The vast majority of heads of household are married. It is only in the non-CSA&CIS adult female category that we find the lowest rate of married heads of household (58.3%). Widowhood is more widespread among adult women, where 41.7% of non-CSA&CIS women are widows. This reflects the reality of the country in general, and of the zone in particular, where tradition grants men a monopoly of authority within the family, and the woman is only head of household in the event of the man's death.

Of all three categories, the level of education is lowest in the female population, with 62.5% and 45.8% respectively in the CSA&CIS and non-CSA&CIS categories being uneducated. Most male heads of household have attended Koranic school: 74.1% and 78% in both types of household in the

ISSN: 2961-6611

adult male category. Agriculture is the main activity. However, livestock farming is still dominated by adult men. Trade is more developed in the young CSA&CIS category. In the study area, most household members cultivate the same plot of land. The Wolof ethnic group is in the majority across all categories.

TABLE 1: Average comparison of variables used by gender

Variables	Young people			Women adults			Men adults		
	CSA& CIS (N=18)	**Non-CSA& CIS (N=35)**	**Test diff.**	**CSA& CIS (N=16)**	**Non-CSA& CIS (N=24)**	**Test diff.**	**CSA& CIS (N=139)**	**Non-CSA&CIS (N=241)**	**Test diff.**
Age	30.83	30.60	-0,23	49.37	50.20	0,83	53.99	57.38	3,38***
Married (%)	94.44	91.42	-0,03	75.00	58.33	-16,67	99.28	99.17	-0,11
Widow (%)	-	2.85	0,03	25.00	41.66	16,67	0.71	0.82	0,11
No level of education (%)	27.77	8.57	-19,21*	62.50	45.83	-16,67	14.38	15.35	0,96
Koranic school (%)	50.00	68.57	18,57	25.00	41.66	16,67	74.10	78.00	3,91
Farming as main activity (%)	83.33	82.85	-0,48	75.00	62.50	-12,5	97.84	94.19	-3,65*
Breeding as main activity (%)	33.33	14.28	-19,05	18.75	12.50	-6,25	43.88	45.64	1,76
Trade as main activity (%)	38.88	14.28	-24,6**	18.75	12.50	-6,25	18.70	9.95	-8,75***
Household size	4.66	6.02	1,36	6.68	5.41	-1,27	6.07	5.57	-0,5
Number of men in household	5.55	5.85	0,3	7.87	7.08	-0,79	7.74	7.34	-0,4**
Number of women in household	5.33	7.08	1,75	6.50	5.16	-1,33	7.18	6.27	-0,91
Household members cultivate the same plot (%)	88.88	74.28	-14,6	87.50	75.00	-12,5	76.25	80.08	3,82
Wolof ethnic group (%)	66.66	51.42	-15,24	62.50	75.00	12,5	78.41	62.24	-16,18***
Serer ethnic group (%)	27.77	17.14	-10,63	25.00	16.66	8,33	17.98	11.20	-6,78*
Fulani ethnic group (%)	5.55	25.71**	20,16	12.50	8.33	-4,17	2.87	22.40	19,53***
Percentage of women (%)	5.55	28.57	23,01**	-	-		-	-	

D. Method for estimating the average treatment effect (ATE)

The conceptual framework of the ATE estimation model is based on the causal model of Rubin (1974) which is generally adapted to the analysis of the situation in which a treatment may or may

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not be administered to an individual. In the context of adoption, the status of the treatment corresponds to the status of exposure to the technology. Exposure is defined as knowledge of the technology, made possible by public information and awareness. In the context of our study, exposure means knowledge of CSA and CIS technologies. Let t a binary variable determining the status of exposure to CSA and CIS technologies. $t_i = 1$ means that the producer has been exposed to CSA and CIS technologies (and therefore knows about them) and $t_i = 0$ means that he has not been exposed. Exposure is assumed to have an effect on the adoption of CSA and CIS technologies, which is an outcome variable.

The causal model of Rubin (1974) considers that for a given outcome variable, there are two potential outcome variables, corresponding to what an individual's situation would be under each of the alternatives, i.e., if the individual benefits from the treatment $y_i = 1$ and if they do not $y_i = 0$. These two outcomes are never observed at the same time for the same individual, as it is impossible to be both exposed and unexposed at the same time. As a result, for a treated individual, Y_1 is observed while Y_0 is unknown, and vice versa. The value corresponding to the result that would have been achieved if the individual had not been treated is called the "counterfactual" in the econometric evaluation literature (Rubin, 1974).

The observed adoption outcome Y can be written as a function of the two potential adoption outcomes Y_1 and Y_0 and the exposure status t as follows:

$$Y = TY_1 + (1 - T)Y_0 \qquad (1)$$

In the case of our study, where the adoption outcome is a binary variable taking the value 1 if the producer adopts the CSA and CIS technologies or 0 otherwise, then the expected value corresponding to the average adoption outcome of the CSA and CIS technologies boils down to the probability corresponding to the adoption rate measure (proportion of adopters in the population). The various treatment effects can therefore be written as follows:

ATE: Average Treatment Effect on the population, representing the potential adoption rate for the entire population: $ATE = E(TY_1) = P\ (Y_1 = 1)$ (2)

ATE1: Average Treatment Effect on the treated sub-population, i.e., the adoption rate among the exposed (those who have been made aware of CSA and CIS technologies):

$$ATE1 = E\ \left(\frac{Y_1}{T} = 1\right) = P\ \left(Y_1 = \frac{1}{T} = 1\right) \qquad (3)$$

ATE0: Average Treatment Effect on the untreated sub-population, i.e. the potential adoption rate among the unexposed (those who have not been made aware of CSA and CIS technologies):

$$ATE0 = E\ \left(\frac{Y_1}{T} = 0\right) = P\ \left(Y_1 = \frac{1}{T} = 0\right) \qquad (4)$$

If $Y_0 = 0$ the expression of the observed adoption outcome as a function of the potential adoption outcome and exposure status reduces to: $y = Ey_1$

This expression shows that the observed adoption outcome variable is a combination of the exposure variable and the potential adoption outcome variable, hence the name: Joint Population Exposure and Adoption Rate, better known as *Joint Exposure and Adoption* :

$$(JEA). E(Y) = E(TY_1) \qquad (5)$$

The average difference between JEA and ATE is called the adoption gap (GAP), which provides information on the demand for the technology. This GAP is given by the following equation:

$$GAP = E(Y) - E(TY_1) \qquad (6)$$

The difference in mean between ATE and ATE1 is called positive selection bias.

(PSB), given by equation : $PSB = E(TY_1) - E\ \left(\frac{Y_1}{T} = 1\right)$ (7)

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The procedure for estimating the average treatment effect is based on the following equation, which identifies $ATE(X)$which underlies the conditional independence (CI) hypothesis (Diagne and Demont, 2007):

$$ATE(X) = E(y_1|x) = E(y|x, t = 1) = g(x, \beta) \quad (8)$$

Where g is a known (non-linear) function of the covariate vector x and the parameter β must be estimated using the method of least squares or maximum likelihood using the observations (y_i, x_i) concerning the sub-population familiar with CSA and CIS technologies with y as the dependent variable and x the vector of explanatory variables. With an estimated parameter $\hat{\beta}$the predicted values $g(x_i, \hat{\beta})$ are calculated for all observations in the sample i in the sample (including observations in the sub-population without access) and ATE, ATE1 and ATE0 are estimated by taking the mean of the predicted values $g(X_i, \hat{\beta}) = 1, \dots . n$ across the whole sample (for ATE) and the respective sub-samples (for ATE1 and ATE0).

$$\widehat{ATE} = \frac{1}{n}\sum_{i=1}^{n} g(X_i, \hat{\beta}) \quad (9)$$

$$\widehat{ATE}1 = \frac{1}{ne}\sum_{i=1}^{n} T_i, g(X_i, \hat{\beta}) \quad (10)$$

$$\widehat{ATE}0 = \frac{1}{n - ne}\sum_{i=1}^{n} (1 - T_i), g(X_i, \hat{\beta}) \quad (11)$$

The effects of adoption determinants as measured by the marginal effects K of the K-dimensions vector of covariates $x$given a point $\bar{x}$ are estimated as follows:

$$\frac{\partial E(y_{1\setminus\bar{x}})}{\partial x_k} = \frac{\partial E(\bar{x}, \hat{\beta})}{\partial x_k} \qquad k = 1, \dots . K \qquad (12)$$

The hypothesis considered in this research is based on the selection of observables. Exposure to CSA and CIS technologies is a phenomenon partly exogenous to the producer. Indeed, a producer does not choose to be exposed to CSA and CIS technologies, although he may undertake actions (participation in meetings, membership of farmers' organizations, training, etc.) that will facilitate his exposure to CSA and CIS technologies. However, certain unobservable factors mean that exposure is not totally exogenous, which can lead to a bias that may overestimate adoption (Diagne, 2006). In the study area, the extension of CSA and CIS technologies is channeled through supervisory structures (JOKALANTE, ANCAR, ISRA, DRDR, etc.), so this potential bias can be overlooked. In order to minimize this bias, a stratified random sampling plan by village (clusters) was chosen. All estimations were performed with Stata 15 software, using the adoption command developed by Diagne and Demont (2007).

III. RESULTS

Table 2 shows the adoption rates of the different technologies introduced. The results reveal that the current adoption rate of resilient seeds in the youth sub-population is 21.8%, with an adoption gap of 31.5%. However, these rates are 33.9% and 28.4% respectively in the female sub-population. In the male sub-population, the current resilient seed adoption rate is 19.7%, with an adoption gap of 13.4%. However, the results reveal that potential adoption rates (ATE0) in the unexposed sub-population for women and youth are higher than adoption rates in the exposed sub-population. This implies a targeting problem in the dissemination of resilient seeds for the adult women and youth category, and that these two groups are willing to change their behavior and adopt resilient seeds if they have access to them. Despite the heterogeneity in the adoption of resilient seeds, it is still relevant to continue the dissemination and extension of resilient seeds in the entire population, since adoption GAPs are statistically significant.

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With regard to the use of climate information, the current reception rate is higher and similar in the female and male categories, at 33.8% and 33.9% respectively. However, the information reception gap is widest among young people (24.2%), with a higher potential reception rate (59.6%). This result means that the probability of using climate information is higher in the population of producers in this category. This result can be explained by the fact that young people have been found to take more risks in adopting technological innovations (Chandio and Yuansheng, 2018).

For microdosing technology, the adoption rate could reach 56.8% in the youth sub-population, whereas this rate is estimated, at the time of the survey, at 26.1% in the category of men aged over 36. This result implies that young people are more likely to adopt microdosing, with a joint exposure and adoption rate of 23.6%, which is higher than the rate estimated for the male sub-population (15.7%). This may be due to the fact that young people tend to have more education and therefore take more risks in taking new initiatives than their older producer counterparts (Dontsop-Nguezet *et al.*, 2011). For the demonstration plots, the results show an adoption gap of 5.2% with a potential adoption rate of 13.5%.

IV. DISCUSSION

These results reveal heterogeneity in the adoption rates of CSA & CIS technologies in Senegal. This heterogeneity in the adoption of CSA technologies has been documented among farmers in other parts of West Africa. For example, Oboussou et al (2023) found that, in Benin, more men than women adopted soil and water conservation practices and improved livestock management systems. In contrast, women (94.9%) were more likely than men (87.5%) to adopt improved crop production systems. In Kenya, Ngigi and Muange (2022) find gender gaps in access to CIS. These authors reveal that men have significantly greater access to early warning systems and adaptation advisory services. In contrast, women have better access to weather forecasts.

Our results reveal the existence of an adoption gap, indicating that the current intervention principle is necessary but not sufficient to increase adoption of CSA & CIS technologies. This is acceptable insofar as adoption behavior depends on multiple factors that need to be integrated. Indeed, most household members farm on the same plots, with a certain division of agricultural tasks. This state of affairs does not facilitate individual adoption of technologies. Thus, to trigger motivation and bring about gender mainstreaming in the dissemination and adoption of CSA & CIS technologies, it is important to build on social norms, promote the rights of individuals and groups, and finally empower men, women and communities. Oboussou et al (2023) show that gender, age, farm size, land ownership, access to labor, contact with the project, information on climate change and livestock ownership are significant determinants of the adoption of CSA & CIS technologies in Benin. This approach of integrating different categories of the population is necessary because the lack of consideration to the gender issue can render CSA&CIS technologies ineffective (Bernier *et al.*, 2015). In Kenya, Tesaye et al (2022) found that the installation of climate-smart villages promoted gender equality and empowered women.

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TABLE 2: Adoption rates of CSA&CIS technologies by sub-group

Parameters		Young people	Adult women	Adult men
Resilient seeds	ATE	53.31***	62.28***	33.14***
	ATE1	47.52***	53.03***	35.57***
	ATE0	58.20***	78.05***	30.12***
	JEA	21.78***	33.88***	19.72***
	GAP	-31.52***	-28.40***	-13.42***
	PSB	-0.05	-0.09**	0.02***
Receiving climate information	ATE	55.28***	46.46***	54.89***
	ATE1	59.64***	52.94***	58.53***
	ATE0	50.53***	35.01***	49.88***
	JEA	31.11***	33.82***	33.85***
	GAP	-24.17***	-12.64***	-21.04***
	PSB	0.04***	0.06*	0.03***
Microdosing	ATE	56.47***	-	26.14***
	ATE1	50.53***	-	28.26***
	ATE0	61.67**	-	23.49***
	JEA	23.58***	-	15.67***
	GAP	-32.89**	-	-10.47***
	PSB	-0.05	-	0.02***
Technology parks	ATE	-	-	13.53***
	ATE1	-	-	14.94***
	ATE0	-	-	11.76***
	JEA	-	-	8.32***
	GAP	-	-	-5.21***
	PSB	-	-	0.01***
Demonstration plots	ATE	-	5.72***	5.43***
	ATE1	-	5.92***	5.93***
	ATE0	-	5.46***	4.76***
	JEA	-	3.37***	3.37***
	GAP	-	-2.35***	-2.05***
	PSB	-	0.19	0.50

Note: * p<0,1 ; ** p<0,05 ; *** p<0,01

V. CONCLUSION

This study examined heterogeneity in the adoption of CSA&CIS technologies across sub-populations (youth, men, women) from three regions in Senegal. Analysis of the results identified two lessons for agricultural technology dissemination policy. A negative and significant adoption gap (GAP) confirms the fact that not all the population had been exposed to CSA&CIS technologies, hence the existence of a non-exposure bias justifying further dissemination in the study area. The results also reveal a targeting problem in the youth and women sub-populations regarding climate-resilient seeds. Thus, an identification approach needs to be developed in order to select young people and women more likely to adopt resilient seeds. This targeting problem was also noted for the adoption of the microdosing technique in the youth sub-population.

ACKNOWLEDGMENTS

The study was carried out as part of the AICCRA project. The views and opinions expressed in this document are the sole responsibility of the author. We thank all AICCRA partners (ISRA, ANCAR, CEERAS, AfricaRice, DRDR) for fruitful discussions and the interviewers for proactive collaboration.

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REFERENCES

ANSD, Situation économique et sociale de la région de Kaffrine, 2023 www.ansd.sn/sites/default/files/2024-01/SES-Kaffrine_2020-2021-rev.pdf.

ANSD, Situation économique et sociale de la région de Thies,2023 www.ansd.sn/ses-regionales?field_year_value=2019&field_regions_ses_target_id=9

ANSD, Situation économique et sociale de la région de Louga, 2023. www.ansd.sn/ses-regionales?field_year_value=2019&field_regions_ses_target_id=15.

Bernier Q, Meinzen-Dick RS, Kristjanson PM, Haglund E, Kovarik C, Bryan E, Silvestri S, Gender and institutional aspects of climate-smart agricultural practices: evidence from Kenya. *CCAFS Working Paper*, 2015.

Chandio AA, Yuansheng J, Determinants of Adoption of Improved Rice Varieties in Northern Sindh, Pakistan. *Rice Science*, 2018, 25(2), p.103-110.

DAPSA, Rapport de la phase 1 de l'Enquête Agricole Annuelle (EAA) 2019-2020, 2020. Rapport Final EAA 2019-2020 | Direction de l'Analyse, de la Prévision et des Statistiques Agricoles - DAPSA.

Derenoncourt E, Jaquet S., AICCRA-Senegal Gender-Smart Accelerator Grant concept note, 2022, p.15. AICCRA-Senegal Gender-Smart Accelerator Grant concept note | CGIAR GENDER Impact Platform.

Diagne A, Demont M. 2007. Taking a new look at empirecal models of adoption: average treatment effect estimation of adoption rate and its determinants. *Agricultural Economics* , 2007, p.201-210.

Dontsop-Nguezet PM, Diagne A, Okoruwa VO, Ojehomon V. 2011. Impact of Improved Rice Technology (NERICA varieties) on Income and Poverty among Rice Farming Household in Nigeria: A Local Average Treatment Effect (LATE) Approach. *Quarterly Journal of International Agriculture*, 2011, 50(3), p.267-291.

EM2030, EM2030. Un « retour à la normale » ne suffit pas : l'Indice du Genre dans les ODD 2022 d'EM2030. Equal Measures 2030, Woking, 2022, 2020. https://www.equalmeasures2030.org.

FAO, The status of women in agrifood systems. Rome, 2023 https://doi.org/10.4060/cc5343en

GIEC. 2021. Résumé à l'intention des décideurs. In: Changement climatique 2021: les bases scientifiques physiques. Contribution du Groupe de travail I au sixième Rapport d'évaluation du Groupe d'experts intergouvernemental sur l'évolution du climat [publié sous la direction de Masson-Delmotte,V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, et B. Zhou], *Cambridge University Press*, 2021. IPCC-AR6_WGI_SPM_Stand_Alone_WMO_FR_06.indd.

Ministère de la Femme, de la Famille et de l'Enfance (MFFE), Stratégie nationale pour l'équité et l'égalité de genre 2016-2026, 2016. **www.directiongenre.com**.

Nelson S, Huyer S., A gender-responsive approach to climate smart agriculture. Evidence and guidance to practitioners. Practice Brief Climate smart agriculture. *Global Alliance for Climate Smart Agriculture (GACSA)*, 2016.

Ngigi M.W., Muange E.N, Access to climate information services and climate-smart agriculture in Kenya: a gender-based analysis. *Climatic Change*, 2022, p.174(21). https://doi.org/10.1007/s10584-022-03445-5

Obossou E.A.R, Chah, JM, Anugwa, IQ. *et al.*, Gender dimensions in the adoption of climate-smart agriculture technologies in response to climate change extremes in Benin. *Reg Environ Change* 23, 93 (2023). **https://doi.org/10.1007/s10113-023-02085-4**.

Parienté W. 2008. Analyse d'impact: l'apport des évaluations aléatoires. Stateco n°103: 5–17.

ISSN: 2961-6611

PSE. 2014, *Plan Sénégal Emergent*, 2008. **PSE | Ministère de l'Economie, du Plan et de la Coopération**.

Rogers EM, Diffusion of innovations. Free Press, A division of Simon & Shuster, Inc, 1995.

Rubin DB, Estimating causal effects of treatments in randomized and nonrandomized studies. *Journal of Educational Psychology*, 1974, *66*(5): p.688-701. https://doi.org/10.1037/h0037350.

Tesfaye A, Radeny M, Ogada MJ, Recha JW, Ambaw G, Chanana N, Solomon D, Gender empowerment and parity in East Africa: evidence from climate-smart agriculture in Ethiopia and Kenya, *Climate and Development*, 2023, *15*(9): p.768–778. **https://doi.org/10.1080/17565529.2022.2154124**.

UNESCO, Rapport mondial de suivi sur l'éducation, Inclusion et éducation : Tous, sans exception. Place de Fontenoy, 2020. http://creativecommons.org/licenses/ by-sa/3.0/igo/

UN Women Africa, The gender gap in agricultural productivity in sub-Saharan Africa: causes, costs and solutions, *Policy Brief No. 11. East and Southern Africa Regional Office*, 2019.

World Bank, FAO, IFAD. 2015, Gender in climate-smart agriculture, *Module 18 for the gender in agriculture sourcebook*, 2015.

Xie H, Ringler C., Investir dans l'irrigation pour assurer la sécurité alimentaire dans le futur – perspective 2050 au Sénégal. 2 p ; IFFPRI, Country Brief, 2015. 130063. pdf (ifpri.org).

ISSN: 2961-6611