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State of climate smart agriculture (CSA) practices in the North Central and Northwest zones Nigeria

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Abstract

Agriculture is exposed to climate change. This is particularly the case for developing countries like Nigeria, which suffer from persistent food insecurity today while also facing substantial population growth and a high exposure to the adverse consequences of global warming. Climate-smart agriculture (CSA) practices seek to mitigate agriculture's contribution to climate change while building resilience and adaptation to the impacts of climate change and increasing the production of food crops. CSA is an approach to identify production systems that can best respond to the impacts of climate change and to adjust these systems to suit local conditions. In this study, we use descriptive statistics to characterize socio-economic characteristics of smallholder farmers in four states in Nigeria and identify the major needs, practices and constrains to CSA. Our results reveal that the mean farmer is an adult (40 years) male that has 10 members in their household and 12 years of farming experience, cultivating an area of 3 ha. The majority (87.2%) of farmers has adopted at least one climate resilient trait in crops. Farmers greatest needs on climate smart adaptation, mitigation and profitability were solutions to reduce in-season crop loss (56%), increase water use efficiency (42%) and increase productivity (54%), respectively. Our study intends to provide to a better understanding of the needs and motivations of local farming communities and a better understanding of their motivation to engage in CSA to develop and deploy more tailored initiatives for improving the resilience and productivity of smallholder farming systems.

Keywords Climate-smart agriculture, Climate change adaptation, Climate change mitigation, Nigeria, Smallholder farming

Introduction

Although small-scale subsistence agriculture is a minor contributor to climate change, the impacts that climate change has on it become increasingly visible and understood. Without proper adaptation, these negative impacts will lead to increased numbers of undernourished people (IPCC 2019). The reason why small-scale farming systems are highly susceptible to climate change and variability is that they are predominantly rainfed and climate dependent (Cohn et al. 2017). This condition makes countries with predominantly small-scale agricultural systems—such as those in Sub-Saharan Africa SSA—among the most affected by climate change (IPCC 2007).

Another reason for the high vulnerability of African food systems is the combined effect of climate change and population growth that both leads to increasing food demand and competition over water use (Cooper et al. 2008). This is the case in Nigeria, a predominantly agricultural country (70% of its population are engaged

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in farming) with a largely subsistence-based agricultural sector (88.4% are small holders) and a very rapidly growing population (Cervigni et al. 2013, UN 2022). Nigeria is one of the eight countries in the world that will concentrate more than half of the increase in world population projected by 2050 (UN 2022). Indeed, Nigeria's population, currently the sixth largest in the world, is expected to become the third largest in the world by 2050 (UN 2017), resulting in further pressure on the farming sector and natural resources.

As a response for the need to increase food security without compromising environmental quality and in support of the Paris Agreement on climate change, FAO developed the concept of Climate Smart Agriculture (CSA) (FAO, 2018, IPCC, 2019). Climate smart agriculture is an approach to transform farming that aims to deliver positive outcomes on three impact pillars, namely, intensification, adaptation, and mitigation to support food security under the new realities of climate change (Lipper et al. 2014, Taylor 2018). While the CSA concept has gained considerable traction in recent years, the empirical evidence bases to support country implementation strategies are still lacking (Lipper et al. 2018).

National and local-level planning of CSA needs to deal with uncertainties about the direction and rate of climate change, especially in contexts that lack information on appropriate spatial and temporal scales, as in Nigeria (Lipper et al. 2014, 2018, Vermeulen et al. 2012). For this reason, one of the action areas of CSA towards climate resilience is the generation of evidence and assessment tools to effectively implement CSA and to identify what constitutes "climate intelligence" in different biophysical and socioeconomic contexts (Lipper et al. 2014, 2018). Furthermore, it is also necessary to identify the barriers to CSA adoption and the means to overcome these barriers (Lipper et al. 2014).

Recent studies documenting adoption on CSA practices in Nigeria have found high levels of adoption of early maturing and drought tolerant varieties (Onoja et al. 2019, Wahab et al. 2020), changing of planting dates, and diversification of crops (Onoja et al. 2019). The socio-economical factors influencing households' levels of awareness (and subsequent adoption) of CSA practices were access to loans and incentives, ownership of economic assets, multiple income sources, as well as older age and higher education of farmers (Mashi et al. 2022). For ensuring improved resilience of farmers, it was discussed that the best strategies should be capacity building, improved agricultural financing and extension services (Mashi et al. 2022) and to have a better access to early warning information on climate and irrigation facilities (Onoja et al. 2019).

This study contributes to understanding of the state of climate smart implementation on smallholder farmers in four states of North Central and Northwest Nigeria. We use descriptive statistics to characterize socio-economic characteristics of smallholder farmers in four states in Nigeria and identify the major needs, practices and constrains to CSA practices. By comparing our findings with other recently published studies, we draw conclusions on how to improve the situation of CSA practices and make recommendations on how to reduce the constrains identified for their promotion. The results are intended to form a pathway towards the development of context-specific, farmer-centric CSA programs in Nigeria.

Materials and methods

The study was conducted in four states of North Central and Northwest Nigeria, namely: Kano, Jigawa, Kaduna, and Nasarawa States and the Federal Capital Territory (Abuja). These states lie within latitudes 8 °N–12 °N and between longitudes 7 °E–10 °E (Fig. 1). The area covers the agro-ecological zones of Sudan Savanna, Northern Guinea Savanna, Southern Guinea Savanna and Derived Savanna. Nigeria has a gradient of declining precipitation (and relative humidity) amount towards the north. The climatic zone in the north of the country is Sahelian hot and semi-arid and savannah climate in the central regions of the country. There are two major seasons in Nigeria; the dry season occurs between November and March and the rainy season, between April and October. The main agricultural crops are vegetables (tomatoes, onions, and peppers), cereals and legumes (rice, maize, millet, wheat, sorghum, yam beans, soybean; FAO 2022).

We conducted surveys in smallholder farmers in the four states. We selected 21 Local Government Areas, and within them, purposive sampling was used to select 22 villages/communities (Fig. 1). We used Raosoft calculator[1] to determine the sampling size from a population of 26,000 farmers served by extension channels of the Syngenta Foundation for Sustainable Agriculture (SFSA) as of 2021. A total of 384 farmers was determined. Data were collected between March and May 2022 and organized in a questionnaire around the following themes:

A) Socio-economic characteristics.
B) Awareness and adoption of CSA practices and sources of awareness.
C) Needs of the smallholders in coping with climate change.

[1] http://www.raosoft.com/samplesize.html.

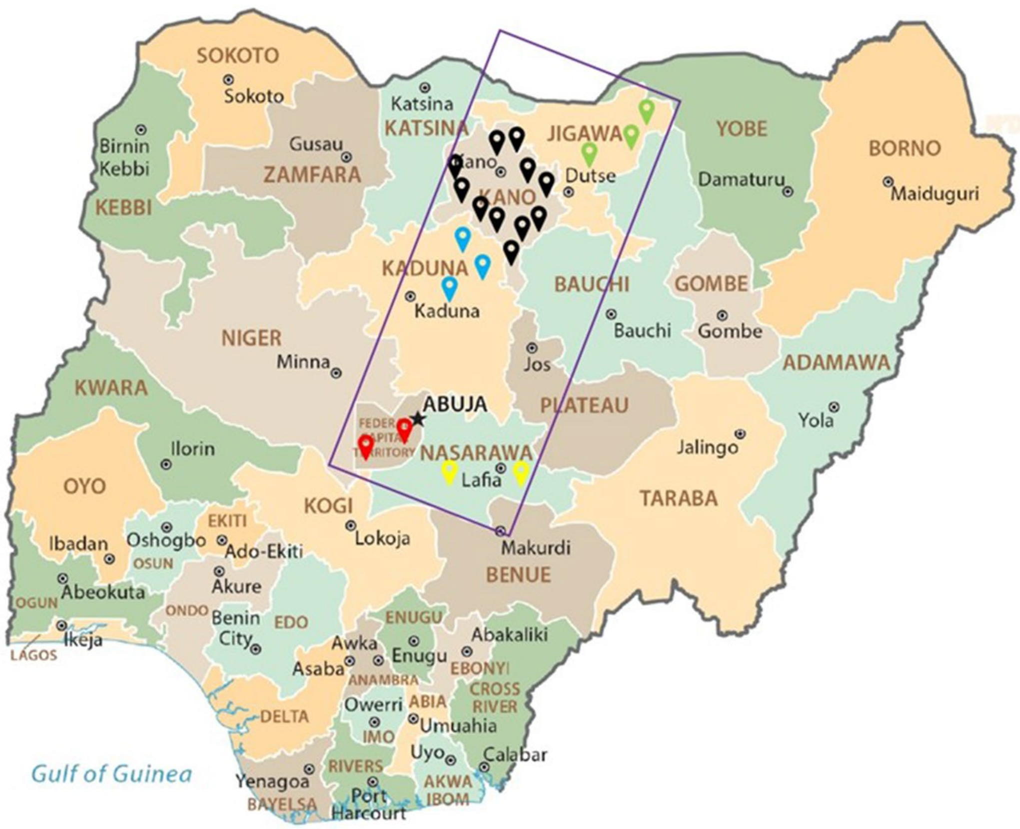

Fig. 1 Map of studied areas and locations of surveyed farmers. The colors of the pins denote the states where the locations are situated, namely, Kano (black), Jigawa (green), Kaduna (blue), Nasarawa (yellow) States, and the Federal Capital Territory, Abuja (red)

D) Adoption of climate smart traits in crops.
E) Constraints associated with the adoption of climate smart practices.

The survey was conducted in Hausa language, and we collected the data using KoBo Toolbox (KTB) software. After the data collection, data was cleaned and checked for consistency, completeness, errors, and outliers. The curated data set was then analyzed using Microsoft Excel, using descriptive statistics.

To get information on farmers needs for climate smart solutions and perceived benefits from CSA, we used the recently published SFSA terminology on climate-smart, resilient agriculture (Klauser 2021). This terminology categorizes several climate-smart practices and segments benefits deriving from CSA across the three CSA pillars.

Results

To better understand how demographic and socio-economic characteristics of farming households in Central and Northern Nigeria influence the perception and adoption of CSA practices and tools, we collected information on farmer age, income, education, and gender (Fig. 2). The distribution of farmers interviewed showed that 90% of them were men. Most men (88%) and to a slightly lesser extent, women (82.5%) have adopted at least one CSA practice in their farms. The age of adult respondents varied from 19 to 70 years, with an average age of 40 years. Most farmers were in the age category of adult (36–60 years; 58%) and youth (15–35 years; 40%) (Fig. 3). The percentage of adoption of CSA practices was higher in the adults (93%) than in the youth (78%), with a total (100%) of adoption among the senior citizens, above 61 years (Fig. 2).

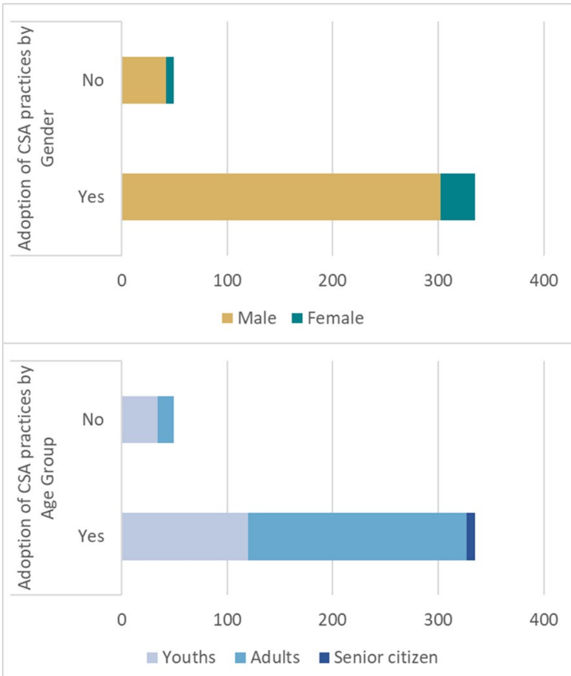

Fig. 2 Number of surveyed farmers (gender and age group) by the adoption of CSA

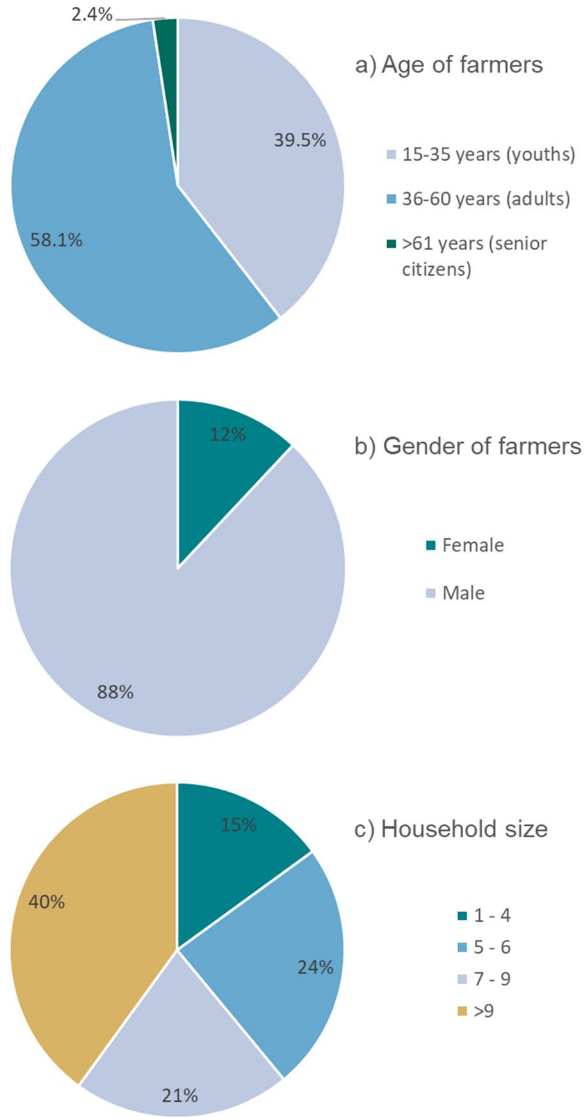

Fig. 3 Socio-economical characteristics of smallholder farmers

A surveyed farmer has a mean household of 10 members (9 among the non-adopters of CSA) and has an average of 21 years of farming experience. The adopters of CSA practices had, on average, more experience in farming (22 years) than the non-adopters (18 years). Regarding the size of their farms, the average farmer surveyed as well as the CSA adopters farmed on a mean area of 2.8 ha, while the non-adopters had slightly bigger (3.1 ha) farms (Table 1).

To then understand how farmers became aware of and learned about CSA practices and tools, collected quantitative information on what they perceive as the most important source of information, segmented by CSA practice or tool (Fig. 4). The major source of awareness of the farmers for CSA practices were predominantly the own farmers' observation and experience, especially for the practices of: "Mixed cropping", "intercropping", "crop rotation", "use of pesticides and fertilizer", "mulching" and "supplementary irrigation practices". The second major source of awareness were the extension agents. The CSA practices with less awareness and adoption (< 80%) from the surveyed farmers were soil testing, agroforestry, terracing and conservation tillage.

To better understand motivations for adopting CSA measures, we asked interviewed farmers on needs and expected benefits from adopting CSA practices, segmented by the three CSA pillars. On the pillar of CSA

Table 1 Summary statistics (mean) of socio-economic and demographic characteristics of the farmers, by adoption of CSA

Variable (x̄)	Pooled	Adoption of CSA practices		
		Yes	No	T-test
Age	39.5	40.5	32.8	5.1***
Household size	9.6	9.6	9.3	0.92
Years of education	10.1	10.2	9.6	0.32
Farming experience (years)	21.2	21.7	17.9	2.27***
Farm size (ha)	2.84	2.8	3.1	1.05

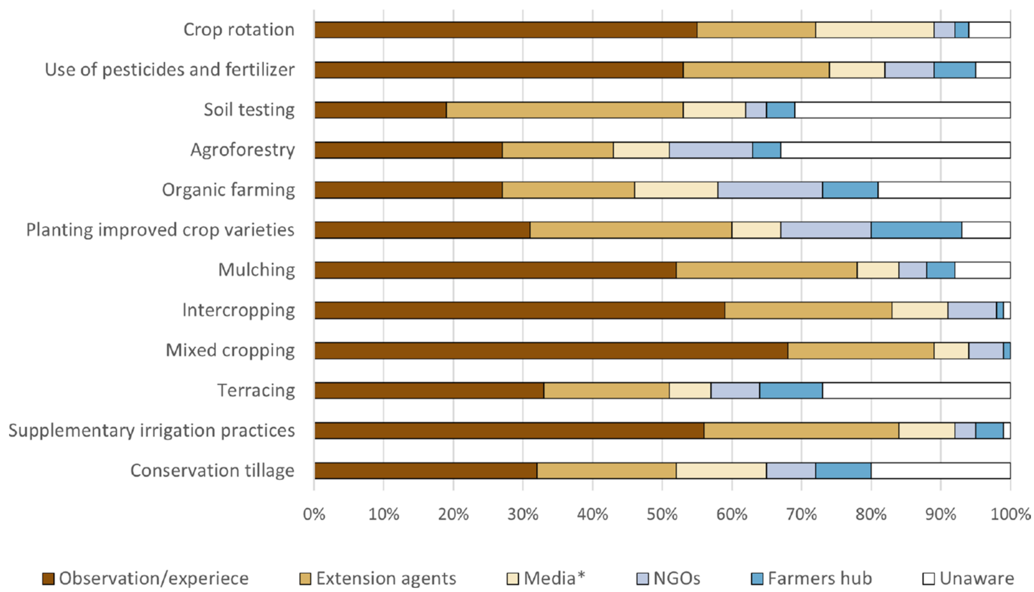

Fig. 4 Adoption of CSA practices by farmers and main source of information that led to adoption

(adaptation), the greatest need of farmers was "reducing in-season crop loss" (56%), followed by "reduction of post-harvest loss" and, to a lesser extent, "diversification of farming income" and "diversification of cropping systems". From the CSA mitigation-related needs, the most urgent was "increase water use efficiency (42%)", followed by "increase input efficiency" and "increase land-use efficiency". Finally, the CSA pillar on profitability had a greatest need to "increase productivity", followed by "decrease cost of production (per crop unit)" (Fig. 5).

Finally, to establish a baseline on CSA adoption, we collected quantitative information on what tools and practices farmers have adopted to date. The great majority of farmers in the survey (87.2%) had adopted at least one climate resilient trait of crops (Fig. 6). We assume that the source of these genetics mostly includes publicly-bred cultivars with genetics developed by the CGIAR and delivered through local extension systems. The climate resilient traits most adopted were: early maturation (84.1%), pest and disease resistance (74.7%), drought tolerance (67.2%), heat tolerance (50.5%) and flood tolerance (46.9%). Among genders, both majority of men and women surveyed had adopted at least 1 climate resilient trait (88% in both men and women). The trait most adopted among women was pest disease resistance (88%) and among men it was early maturation (84%). By age category, the highest rate of adoption was in senior farmers (all of them had adopted at least 1 trait), while it was 93% of adults and 77% of young that have adopted at least 1 trait (Fig. 6).

Discussion

The intent of this paper is to understand farmer perceptions towards CSA in order guide project design to more farmer-centric, context-specific interventions that both tackle the most important farmer needs whilst creating beneficial outcomes across the three pillars of CSA. This will guide future Syngenta Foundation—and hopefully other donor and NGO initiatives—to improve local smallholder farming by responding to local needs and considering the local demographic and socio-economic context. The focus of this research is Central and Northern Nigeria, a region heavily exposed to climate change, rapid population growth and natural resource degradation (Haider 2019).

Our research shows that most farmers are familiar with the basic concept of CSA and benefits derived from applying climate-smart solutions (Fig. 6). This aligned to findings of similar studies in other regions of Nigeria and tropical West Africa (Onoja et al. 2019; Wahab et al. 2020). More so, most farmers already adopt at least one climate-smart solution (Fig. 6) with adoption of CSA solution being independent of farm size and gender. However, there is a tendency of decreased adoption amongst young farmers and farmers with limited experience in farming (Fig. 2, Table 1), highlighting the need to continuously train farmers and pay particular attention to supporting younger farmers when engaging in agriculture (Babbie 2016). Farmers seem to prefer adopting solutions that do not require substantial changes in farming

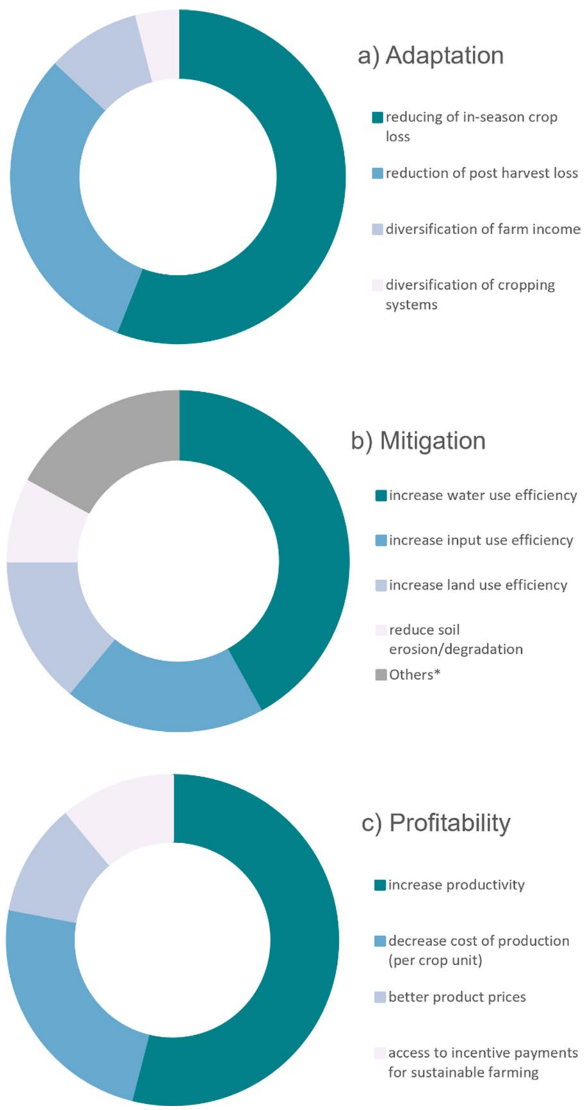

Fig. 5 Categorization of benefits from the adoption of climate-smart practices as prioritized by surveyed farmers for (**a**) Adaptation (**b**) Mitigation and (**c**) Profitability

practices, nor acquisition of know-how, or substantial up-front investment. These include improved, stress-tolerant genetics or more diverse production systems. For the delivery of improved genetics, it will be vital to better understand current delivery mechanisms and the contribution of public and private bodies to make sure that these delivery channels can sustain and grow. Amongst other factors, a focus on seed and genetic gain might be a consequence of a limited reach of existing extension systems, be they public or private, that demonstrate CSA farming tools and practices and support farmers in adopting them. This was evident when farmers had to select sources of information that led to the adoption of CSA practices (Fig. 3). Independently of CSA practice or solution, the most selected source of information was farmers own experiences or observations and not public or private extension systems. When being asked about what benefits farmers expect from adopting new practices or solutions, most farmers preferred an increase of productivity and/or reduction of crop loss, highlighting the importance of farming to achieve food security at farm and family level as well as the importance of selling produce through local, informal market systems (Apata et al. 2017).

Conclusions and recommendation

Our study suggests that surveyed farmers in Central and Northern Nigeria have a good understanding of CSA tools and practices and what benefits to expect when adopting them. They also have already adopted some CSA tools and practices, most notably resistance traits against biotic and abiotic stress. However, the adoption of solutions that more knowledge-intense or substantial up-front investment, such as soil management and testing and agroforestry, is generally low. This, among other factors can partially be explained by the lack of local extension networks that demonstrate and help farmers adopt such solutions. Moreover, access to investment capital and risk management tools may be also required to further de-risk farmer adoption (Klauser and Negra 2020). We hence consider it important to tackling these underlying barriers for the adoption of CSA tools and practices rather than «pushing» these solutions without considering the (dis-)enabling environment, which has limited the impact of many interventions to promote climate-smart and regenerative farming systems to date (Giller et al. 2021). Only bundled efforts that combine access to knowledge, finance and risk management can drive adoption of more complex CSA solutions.

Furthermore, we consider it important that such efforts are tailored to and target young farmers to encourage them taking up practices and tools that will increase the productivity and resilience of their farming ventures and increase the likelihood of them succeeding when doing so.

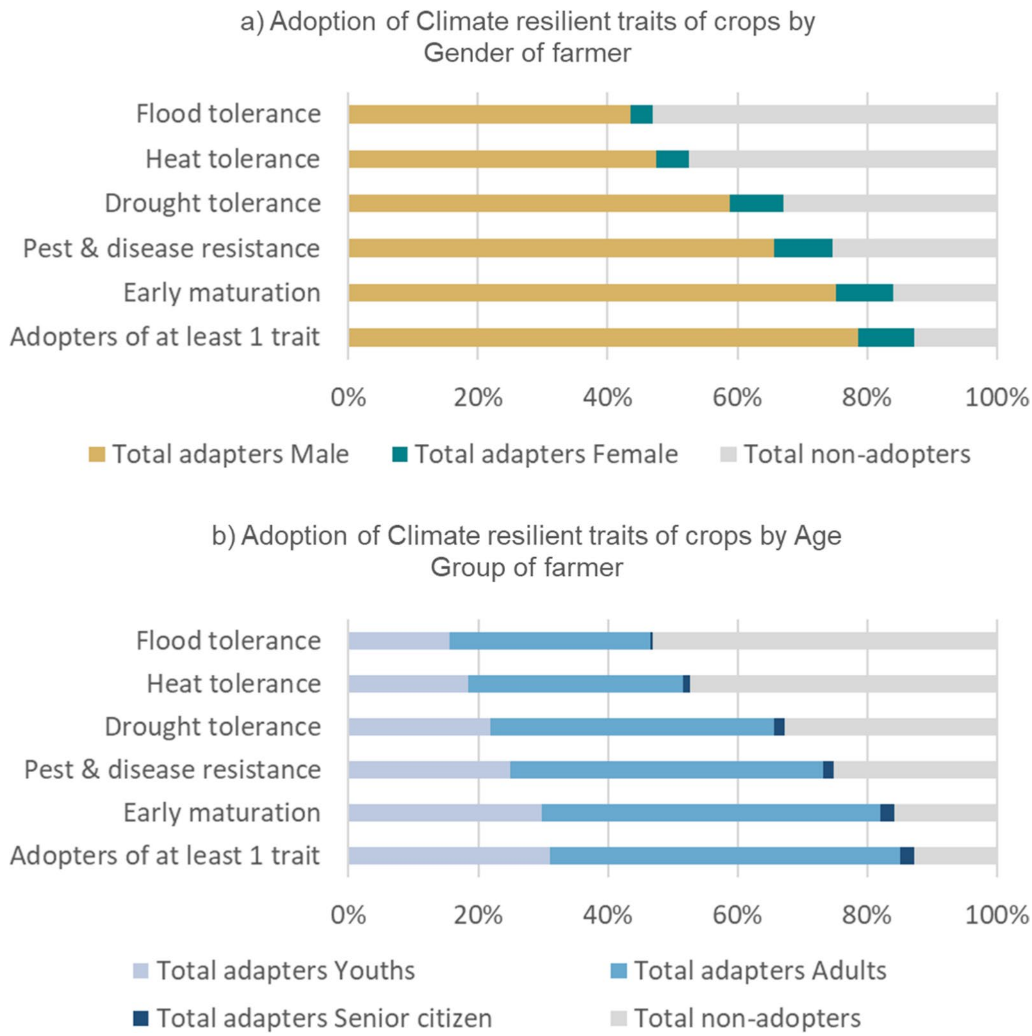

Fig. 6 Adoption of Climate-resilient traits of crops by demographic characteristics of farmers

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Author contributions
All authors read and approved the final manuscript.

Declarations

Competing interests
Not applicable.

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