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# GENDER DISPARITIES INFLUENCE ON ADOPTION OF CLIMATE SMART TECHNOLOGIES IN SEED POTATO PRODUCTION IN OL-KALAU SUB COUNTY KENYA

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**Abstract:** *Climate Smart Agriculture (CSA) offers farmers' the opportunity to improve their economic and food security status. However, farmers' success in adoption of CSA technologies is constrained by gender disparities, i.e., level of education, access to knowledge in CSA, access to finances, availability and nature of CSA technologies, cultural norms and values, attitude of farmers towards the CSA, access to land and lack of CSA skills. This study therefore aimed at determining the variance in adoption of CSA technologies in seed potato production as influenced by gender disparities in Ol-kalau sub-county of Nyandarua county, Kenya. The study results indicated that with the exception of attitude of farmers' there were significant gender differences in adoption of CSA technologies, with males dominating in all CSA practices. Financial services are major reasons why most farmers have not adopted CSA practices. In order to enhance female farmers, women should be encouraged to participate in ventures that help them access, generate and mobilize resources so that they can acquire credit; be supported to access relevant CSA knowledge, skills and resources. Thus, they will be able to offer supplementary support to their male counterparts in adoption of seed potato CSA farming technologies.*

**Keywords**: *Gender disparities, adoption, climate-smart technologies*

## 1. Introduction

Irish Potato (*Solanum tuberosum*) originated from the Andean regions of Bolivia and Peru and was introduced into Spain from South America in mid-sixteenth century. From Spain, it was introduced to nearby countries and was being cultivated moderately in many European regions. By the seventeenth century, the potato was then distributed beyond Europe into India and China and by the eighteenth century to Japan (Lim, 2016). It became so extensively spread around the globe and it's important was introduced in Africa by Christian missionaries at the end of the 17$^{th}$ century through the establishment of small plantations (International Plant Biotechnology Outreach (IPBO, 2019). Its tubers were swiftly adopted in many diets and become part of the feeding habits of the urban and rural populations. Today, over 158 countries grow potatoes worldwide and Kenya is among these. Asia and Europe produced more potatoes between 2007 and 2017 with 71% of the world's production total. This is because it is produced as both food and cash crop in these regions (FAOSTAT, 2020).

The world's population is expected to increase by one-third by 2050 Food and Agriculture Organization (FAO, 2014). With the expected increase in population, agriculture will have to make noticeable adjustments to produce enough food (Otto *et al.*, 2017). However, this production is currently jeopardized by climate change. In case of inappropriate measures, agriculture and food systems will be at higher risk (Thornton *et al.*, 2014). One of the visible risks and effects is low agricultural productivity of the major crops (maize, wheat, cassava, potato, rice, beans) as a result of crop failure due to soil degradation coupled with prolonged dry spells (FAO, 2019). This affects the majority of African countries whose economy relies on agriculture (Olorunfemi *et al.*, 2020) leading to 48% of the population in poverty .

## 2. Literature Review

### 2.1 Seed Potato Production in Africa

Potato production now ranks the third world food crop due to its contribution to the alleviation of food insecurity in the world and gaining more importance in the sub-Saharan Africa (IPBO, 2019).

The growing number of potato consumers, interest in potato use as feed for the livestock industry, the need for processed potato products that lead to higher demands of the potato by the food industries, fuel the increasing demand for potato in Africa. Potato exportation potential is another factor that increases potato demand and a typical example in Africa is Egypt that increases its production to satisfy herself, sell to her neighbors and the European food market (FAO, 2008). African countries have various needs for the potato for example utilized as food, seed and or feed. The potato is a very versatile food crop and can be used in multivariate ways. It is eaten cooked and is cooked in different ways such as boiling, steaming, deep frying and roasting (Lim, 2016).

In Sub-Saharan Africa women provide nearly half of the agricultural labor force. Their labor productivity is rated as low due to lack of access of productive resources such as land, certified seeds, technology, extension services and credit as their male counterparts. Gendered institutions, information and knowledge-related constraints contribute to women limited uptake of agricultural technology. Agricultural management and the operation of irrigation equipment require adequate knowledge and skills training. However, most women in Sub-Saharan Africa have little access to extension services and training as a result of gendered institutional biases (Farnworth, 2015). Because of time constraint, a few women attend trainings on potato production done by extension officers therefore those trainings are primarily attended by men (Laxaa, 2015).

### 2.2 An Overview of Seed Potato Production in Kenya

In Kenya, access of technology affects women's labor productivity in terms of efficiency and effectiveness. The government of Kenya in its big four agenda aims at ensuring food security. This is also supported by Sustainable Development Goals (SDGs) namely; second (2) SDG on zero hunger focuses on ending all forms of malnutrition by addressing nutritional needs of adolescent girls, pregnant and lactating women and older person by 2030, double agricultural productivity and incomes of small-scale food producers in particular women through equal access to land, other productive resources, inputs, knowledge and financial services. Thirteen (13) SDG on climate action targets to strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries, integrate climate change measures into national policies, strategies and planning, create awareness on climate change mitigation, adaptation, impact reduction and early warning and raising capacity for effective climate change-related planning and management focusing on women, youth and marginalized communities. As a result of climate change and change of land use patterns in Kenya smallholder farmers have been introduced to various climate-smart technologies/innovations to deal

with the problems of low crop yield, loss of soil fertility, constrained water supply, post-harvest losses, weed and pest control among other farming challenges.

The adoption of improved agricultural technologies/innovations among farmers at any given time is as a result of the interaction with various factors including certain personal and institutional characteristics (Gkartzios *et al*., 2022). Women play an indispensable role in agriculture, innovativeness and improving the quality of life in rural areas. However, their contribution often remains concealed due to some social-economic barriers and gender bias (Peterman *et al.,* 2014). Adoption of innovation in agricultural production is paramount as it aids in the reduction of drudgery and time spent (e.g., use of motorized sprayer for rapid application of pesticides during crop protection) on agricultural activities which invariably increase productivity and efficiency.

Kenya in particular, show an increase in temperatures and regular climate shocks in terms of droughts and floods. This, together with the growing population in Kenya that is expected to increase to 95 million by 2050, creates a risk of famine (Netherlands Development Organization (SNV), 2019). Over 75% of the population is directly or indirectly employed in the agriculture sector and the sector contributes to about 26% of Kenya's gross domestic product (GDP). Kenya's economy will mostly be affected if appropriate precautions against climate change are not taken.

According to (Bolt *et al.*, 2019), the productivity of potato, the second most important staple food crop in Kenya is being lowered by climate change. The study by (Hammond,2018) showed that climate-smart potato varieties can improve potato productivity in various environments from sea level to high mountain conditions where potato smallholder farmers predominate. In addition to temperature regimes and solar radiation, consideration of several factors that include soil characteristics, nutrient availability and water use efficiency is important for the success of adopting this CSA practice.

Adoption of seed potato technologies help overcome the climate change challenges, breeding efforts by the International Potato Centre (CIP) have prioritized context specific heat tolerance, earliness, disease tolerance and water use efficiency (CIP, 2016). The following; Unica, Lenana, Wanjiku, Chulu and Nyota varieties have been developed by the breeders and are used by the farmers in Kenya to reduce risk of yield losses due to stress intolerance and late blight and viral diseases (CIP, 2016). However, for better results, these resistant varieties may be accompanied with the use of Phyto sanitation and cultural practices, clean fields, biological control and disease-free tubers (Agutta,, (2015). Crop rotation is also one of the CSA approaches that has been adopted by farmers in Kenya.

Nyandarua County's plan to increase potato yields to 15 tons/ha by 2022 opted for agroforestry, water harvesting and planting of the short cycle and drought-tolerant potato varieties as major CSA practices to achieve this (GoK, 2018). However, the study by (Leal Filho *et al.*, 2019) gives an overview of the bottlenecks that continue to hinder the registration of the expected success. He attributes low adaptation of CSA to the lack of information on appropriate CSA practices, resource insufficiencies and lack of incentives to the farmers (Nyasimi *et al.,* 2017), This has led to inappropriate and ineffective practices of CSA. This creates a research gap that prompts the need to evaluate why women are not able to participate in adoption of climate-smart agricultural practices in seed potato production in Nyandarua County, Kenya.

### 2.3 Gender disparities in adoption of CSA technologies in seed potato production

According to William *et al.,* (2015) farmers face risks caused by effects of CSA hazards and challenges of managing risks associated with new technologies adoption that are costly and only benefit them after many years of production. Social demographic variables have focused more on gender relations and the normative

environment including institutional focus along the potato value chain. According to Mudege *et al.,* (2016), Institutional factors such as access to credit and market by men and women and their influence on adoption of improved varieties and productivity has influenced women's adoption of climate-smart agriculture technologies. Moreover, gender relations and norms have also influenced the way women adopt new technologies when it comes to seed potato production (McGuire *et al.,* 2022). Men and women farmers who are not able to access finances may not be able to access resources nor adopt to CSA practices. According to Kristjanson *et al.,* (2012), success of CSA is determined by implementation of sustainably practices on institutional behavioural change to influence different policies. Inequality between men and women in access to credit has been seen as a stepping stone inhibiting implementation of CSA. Babugura, (2021) discovered that transformational CSA practices entail those activities that contribute to improved livelihood. According to Farnworth *et al.,* (2018) women are capable as male partners but lack access to credit facilities making them harvest low yields in their farms. Access to credit also affects control of ownership of assets. Women face more bottlenecks while trying to access credit due to lack of collateral such as land to act as security in financial institutions that can enable them access credit facilities. Thus, women have less access to man power, agricultural inputs, technologies that are required for CSA practices. Stakeholders such as government agencies and NGOs should assess role of women in CSA and the hiccups they face while accessing credit. Implementation of formal corporative and women farmers groups will help women farmers mobilize resources so that they can acquire credit facilities and break the barriers that existed while seeking financial services. Gender gap in access to resources such as capital, assets, land as well as knowledge and information has exacerbated the gender gap in productivity between men and women (Quisimbing *et al.,* 2014).

The results of this study are consistent with UN women (2017) report that identified challenges relating to financial services as a major reason why most women have not adopted climate smart agricultural practices in Nigeria. In many Africa developing countries, most bank account holders are men and women are constrained in accessing financial tools. Inability to access credit facilities is a global issue challenging women in gainful agricultural production. Njiraini *et al.,* (2018) argues that lack of credit hinders women from procuring improved agricultural inputs such as certified seeds, fertilizers and other technologies for high yields. According to Fletschner *et al.,* (2014), normative environment creates and shapes opportunities and structures for men and women for adoption of agricultural technologies. Numerous social factors limit women's access to resources and information, which in turn influence adoption of new technologies and access to benefits of seed potato production. Therefore, to increase investments in seed potato production, both women and men should be supported to have access to finance, land that's suitable for seed production, access to technologies and skills in using them.

Mudege *et al.,* (2016), further noted that, gender relations reveal the division of labor and allocation of resources between men and women as well as how value is given and power is mobilized during the production of seed potatoes. In this study, men significantly dominated over women in access to finances, land and therefore they had more power in mobilizing of resources for production of seed potato. Gender inequalities in social economic factors tend to favor men than women in most cases. This limit women access to resources causing a big barrier to women's adoption of new technologies, which are needed in order to practice what the technologies demand to be done by the farmers. For these reasons, it's recommended that women be prioritized in access to knowledge and training on CSA skills, access to finance that will enable them access new technology necessary for seed potato production. These will empower women to efficiently practice the CSA technologies in seed potato production, leading to higher yields and incomes in rural households.

In Nyandarua County, adoption of seed potato technologies is practiced by men mostly while women are less involved. However, research indicates that previous studies that has been carried out in the past have not specifically based their interest on gender disparities that affects women adoption of climate smart technologies and very little quantitative information has been collected. This study therefore aimed at filling a gap by finding out gender disparities for women not involving themselves in adoption of climate smart technologies providing up to date information.

## 3. Research design

This study adopted a case study research design. Sample size of 130 respondents was obtained using stratified random sampling procedure. Questionnaires and interview schedules were used to collect data. The instruments were pilot tested in Njoro sub-county to determine reliability which was found to have a coefficient of 0.82 indicating the instruments were reliable. The data was analyzed qualitatively and quantitatively. Findings of the study were presented using frequency tables.

## 4. Results and discussion

### 4.1 Socio-Economic Factors on Farmers Adoption of CSA Technologies

This study was interested on how selected set of socio-economic factors affected farmers adoption of CSA technologies. They included: level of education, available technology, access to knowledge on CSA, access to finances, cultural norms and values, attitude of farmers, nature of technology, access to land and lack of CSA skills.

The results are summarized in Table 1 below

*Table 1: Effect of Socio-Economic Factors on Farmers Adoption of CSA Technologies*

| Socio-economic factors | Very much | Much | Moderate | Low | Very low | Total |
|---|---|---|---|---|---|---|
| Level of education | 3 (2.4%) | 15 (12.1%) | 13 (10.5%) | 60 (48.4%) | 33 (26.6%) | 124 (100%) |
| Available technology | 5 (4%) | 16 (12.9%) | 22 (17.7%) | 48 (38.7%) | 33 (26.6%) | 124 (100%) |
| Access to knowledge on CSA | 7 (5.6%) | 18 (14.5%) | 19 (15.3%) | 53 (42.7%) | 27 (21.8%) | 124 (100%) |
| Access to finances | 76 (61.3%) | 22 (17.7%) | 4 (3.2%) | 15 (12.1%) | 7 (5.6%) | 124 (100%) |
| Cultural norms and values | 6 (4.8%) | 17 (13.7%) | 19 (15.3%) | 45 (36.3%) | 37 (29.8%) | 124 (100%) |
| Attitude of farmers | 3 (2.4%) | 3 (2.4%) | 5 (4%) | 44 (35.5%) | 69 (55.6%) | 124 (100%) |
| Nature of technology | 5 (4%) | 14 (11.3%) | 27 (21.8%) | 60 (48.4%) | 18 (14.5%) | 124 (100%) |
| Access to land | 14 (11.3%) | 33 (26.6%) | 19 (15.3%) | 37 (29.8%) | 21 (16.9%) | 124 (100%) |
| Lack of CSA skills | 3 (2.4%) | 20 (16.1%) | 27 (21.8%) | 54 (43.5%) | 20 (16.1%) | 124 (100%) |

### 4.1.1 Disparities in access to education

From the study results, most of the respondents (75%) stated that their level of education had low (little) and very low effect on their adoption of CSA technologies associated with seed potato production. Those who perceived the extent of education level as having low and very low effects in adoption of CSA technologies comprised of 48.4% and 26.6%, respectively. Those who described the extent of education as having much and very much effect comprised a cumulative of 14.5%. About 10.5% felt that level of education affected their adoption of CSA technologies moderately. The level of education of the household head influences the kind of decision made on behalf of the entire household with regard to seed potato farming. According to Mwangi *et al.,* (2015), more educated farmers are likely to make better decisions as well as quickly adopt new technologies in farming as compared to their less educated counterparts. Abebe *et al.*, (2013) also agree to this study findings and argues that more and improved education translates to better decision making due to the acquisition of more knowledge which increases one's intellectual capability on matters to do with seed potato production. Mwangi *et al.,* (2015), noted that younger and more educated farmers are, on average, more productive than older farmers and more likely to adopt new farming technologies. Others have argued that there is a positive correlation between being literate and total farming income. Therefore, the age and level of education of a farmer is an important characteristic in adoption of technologies, innovations and management practices such as climate smart agricultural practices. This is an interesting finding because many studies claim that a higher level of education affects adoption of technologies, as it influences levels of understanding and skills development positively. This is possible because Nyandarua farmers have been growing potatoes since independence. Therefore, they probably feel that there is no difficulty in adopting the CSA technologies they have been exposed to in recent times.

### 4.1.2 Disparities in access to available technology

Majority of the respondents (65.3%) described that available technology affected the extent of their adoption of CSA technologies in a low extent. Those who perceived the extent of effect that available technology had on their adoption of CSA technologies as low and very low comprised 38.7% and 26.6%, respectively. Those who described the extent of effect as much and very much comprised a cumulative of 16.9%. About 17.7% felt that available technology affected their adoption of CSA technologies moderately.

Similar to level of education, the majority (65.3%) of farmers were not challenged by the level of CSA technologies being introduced with regard to seed potato production. This is probably due to the fact that (field) seed and ware potato production did not differ much, apart from the period prior to harvesting where dehaulming is required. Possible differences are in storage, which was not covered in this study.

### 4.1.3 Disparities in access to knowledge

Access to knowledge on CSA had affected farmers' adoption of CSA technologies in a low extent as confirmed by most of the respondents (64.5%). Those who perceived the extent of effect that access to knowledge on CSA had on their adoption of CSA technologies as low and very low comprised 42.7% and 21.8%, respectively. Those who described the extent of effect as much and very much comprised a cumulative of 20.1%. About 15.3% felt that access to knowledge on CSA affected their adoption of CSA technologies moderately. Kenya is equipped with Information Communication Technology (ICT); phones radios and television are dominant among farmers. These enables farmers to reach out to extension officers via phone, listening to radio and watching television provides them with rich knowledge on CSA technologies thus convenient since farmers can do other roles while listening (Manfre & Nordehn, 2013). Male farmers had a

greater adoption in access to knowledge through phone and internet as they own the smart android phone that they use to browse in the internet unlike their female counterparts who do not own the smart android phone.

### 4.1.4 Disparities in access to finances

The adoption of CSA comes with a cost in terms of purchasing the technologies such as the irrigation equipment. From the study results, access to finances was considered to have "very much" (61.3%) and "much" (17.7%) effect on adoption of CSA technologies by 79% of the respondents. Those who described the extent of effect as low and very low comprised a cumulative of 17.7%. About 3.2% felt that access to finances affected their adoption of CSA technologies moderately. Most of farmers have low incomes thus access to finances may directly and greatly influence the practice of CSA (Lipper, 2017) Access to finance is a critical factor for adoption of technologies in field of crop production. The results of this study are consistent with UN women (2017) report that identified challenges relating to financial services as a major reason why most women have not adopted climate smart agricultural practices in Nigeria. In many Africa developing countries, most bank account holders are men and women are constrained in accessing financial tools. Inability to access credit facilities is a global issue challenging women in gainful agricultural production. Njiraini *et al.,* (2018) argues that lack of credit hinders women from procuring improved agricultural inputs such as certified seeds, fertilizers and other technologies for high yields. In these study men significantly dominated over women in access to finances, and therefore they had more power in mobilizing of resources for production of seed potato.

### 4.1.5 Disparities in cultural norms and value

Cultural norms and values were considered to have a low effect on adoption of CSA technologies by 66.1% of the respondents. Those who perceived the extent of effect that cultural norms and values had on their adoption of CSA technologies as low and very low comprised 36.3% and 29.8%, respectively. This was because most of farmers had attended trainings and capacity building workshops that had reduced their belief in stereotypes and norms that added little value to their current livelihoods. Those who described the extent of effect as much and very much comprised a cumulative of 18.5%. About 15.3% felt that cultural norms and values affected their adoption of CSA technologies moderately. Responses from key informants indicated that "*Cultural norms affected female farmers in some areas where they were not allowed to make furrows as it was believed if they put their legs apart in the furrows the seed potato will not grow"* Findings of this study agrees with McGuire *et al.,* (2022) Who stated that cultural norms and value affects women negatively by complicating their ability to adopt some CSA technologies more than their male counterparts. Gender relations and norms have also influenced the way women adopt new technologies when it comes to Seed potato production.

### 4.1.6 Disparities in attitude of farmers

Expression of negative attitudes (by some in the community) that discourage farmers from growing seed potato was described as having very little (low) effect on their adoption of CSA technologies by an overwhelming majority of 91.1% respondents. Those who perceived the extent of effect that attitude of farmers had on their adoption of CSA technologies as low and very low comprised 35.5% and 55.6%, respectively. Those who described the extent of effect as much and very much comprised a cumulative of 4.8%. About 4% felt that attitude of farmers affected their adoption of CSA technologies moderately. Therefore, Ol Kalau farmers are convinced of the importance of seed potato production. This implies that no amount of negativity will deter them in venturing into seed potato production, once given the chance.

### 4.1.7 Disparities in nature of technology

The extent of effect that nature of technology had on farmers' adoption of CSA technologies was mainly low as explained by 62.9% of the total respondents. Those who perceived the extent of effect that nature of technology had on their adoption of CSA technologies as low and very low comprised 48.4% and 14.5%, respectively. Those who described the extent of effect as much and very much comprised a cumulative of 15.3%. About 21.8% felt that nature of technology affected their adoption of CSA technologies moderately. This was so because some Climate Smart Technologies have been scaled out in Nyandarua County. Moreover, different stakeholders and government agencies had over time introduced different technologies to improve the farmers production level.

### 4.1.8 Disparities in access to land

Most of the respondents (46.7%) described the extent of effect that access to land had on their adoption of CSA technologies as low. Those who perceived the extent of effect that access to land had on their adoption of CSA technologies as low and very low comprised 29.8% and 16.9%, respectively. Those who described the extent of effect as much and very much comprised a cumulative of 37.9%. About 15.3% felt that access to land affected their adoption of CSA technologies moderately. In Kenya for example, conflicts and land disputes pose a significant threat to sustainable agricultural development initiatives like CSA (Anuga *et al.,* 2019). Women unlike their male counterparts are more constrained by lack of title deed to practice the CSA and have little interest in adopting sustainable CSA practices whose benefit can be realized later in life after a long time (Duffy *et al.,* 2017). This affirmed the continued fragmentation of land into smaller units as a result of high population that has hindered agricultural mechanization which is one of the CSA practices. Due to continued sub-division of land (triggered by increased human population), the farm size in Nyandarua county was lower than the range of 4.5 - 8 Ha previously reported for this area by Romney *et al.,* (2004), Schreiber (2000) and Baltenweck *et al.,* (1998). According to Muia *et al.,* (2011), an average farm size in Nyandarua County was 3.5 Ha.

### 4.1.9 Disparities in lack of CSA skills

From study results, about 59.6% of the respondents described the extent of effect that lack of CSA skills had on their adoption of CSA technologies as low. Those who perceived the extent of effect that lack of CSA skills had on their adoption of CSA technologies as low and very low comprised 43.5% and 16.1%, respectively. Those who described the extent of effect as much and very much comprised a cumulative of 18.5%. About 21.8% felt that lack of CSA skills affected their adoption of CSA technologies moderately. Farmers training influences their adoption to CSA technologies. However, in Kenya, male farmers are the primary beneficiaries of CSA skills and this is attributed to their ability to attend agricultural-based seminars trainings and workshops (Kane *et al.,* 2018). Whereas female farmers lack CSA skills as they are constrained by their triple gender roles that limit them time to attend agricultural trainings, seminars and workshop thus have less CSA skills compared to their male counterparts. Bolt *et al.,* (2019) states that "giving potato farmers in Kenya training on benefits and costs of crop insurance as CSA practice help them have details of what is required and increases the chances of adoption". Providing knowledge to small holder farmers on the use of technologies and why they should be used through training triggers them to adopt (Kane *et al.,* 2018).

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## 5. Conclusions

From the study results, the following conclusions have been drawn:

The study set out to evaluate the disparities among men and women in accessing necessary resource and how this allocation influences adoption of CSA practices in seed potato production in Kenya, and important potato growing country with challenges in seed production.

Access to finances had a remarkable effect on adoption of CSA technologies among seed potato farmers this was so because the adoption of CSA comes with a cost in terms of purchasing the technologies. In addition, cultural norms and values affected female farmers significantly reducing their participation in seed potato production. Access to knowledge and skills on CSA can be successfully achieved through trainings and seminars where the females are able to attend and get enlighten on different CSA technologies to adopt as far as seed potato production is concerned. Attitude of other farmers did not affect any gender as most of seed potato farmers are convinced on importance of seed potato production.

Gender inequalities in social economic factors tend to favor men than women in most cases. This limit women access to resources causing a big barrier to women's adoption of new technologies, which are needed in order to practice what the technologies demand to be done by the farmers.

### 5.1 Recommendations

The study recommends that; men and women farmers should be encouraged to participate in ventures that help them access, generate and mobilize resources so that they can acquire credit; be supported to access relevant CSA knowledge, skills and land. Cultural norms and values affecting women participation in seed potato production should be put into consideration during implementation and interventions. Gender roles should not be assigned according to cultural stereotyping and biological roles. In order to create time for female farmers to participate in agriculturally based training, workshops and seminars in CSA seed potato production, women should be prioritized in access to knowledge and training on CSA skills, access to finance that will enable them access new technology necessary for seed potato production. Greater workload with gender roles reduces female participation in adoption of CSA seed potato production. Time saving technologies for domestic chores (cleaning utensils, washing clothes and cooking) would act as best solution in creating the much-needed time required for women participation in seed potato production, leading to higher yields and incomes in rural households.

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