New seeds and women's welfare: A revolution revisited — The case of NERICA upland rice and gendered labor dynamics in Hoima District, Uganda

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Abstract
The NERICA upland rice varieties were developed in Africa for Africa to address the continent-wide rice challenge, poverty and food insecurity. The 'success' of the dissemination of NERICA among small-holder farmers has mainly been established econometrically by measuring production growth or household income gain. This type of analysis captures shifts in income poverty at household level, but it does not tell us anything about the intra-household dynamics. Therefore, this paper explores how aggregate household welfare outcomes in relation to NERICA were arrived at in Hoima District, Uganda, by examining intra-household production relation patterns and their consequences for individual household members' well-being. More specifically, the paper provides an illustration of the impact that the introduction of NERICA in Hoima District has had on the gendered labor dynamics in small-holder households, grounded in the local context and the lived experiences of particularly women farmers. While households that have adopted NERICA have become better off in economic terms, the extreme labor burden that NERICA demands affects women's well-being negatively by exacerbating their time poverty and drudgery.

Introduction

NERICA (New Rice for Africa) is a new group of high-yielding and stress-tolerant upland rice varieties developed in Africa for Africa to address the continent-wide rice challenge, poverty and food insecurity. As such, it has been described as a 'boon', a 'miracle' and a 'revolution' (Harsch, 2004; Kijima *et al.*, 2006). However, the 'success' of the dissemination of NERICA among small-holder farmers has mainly been established econometrically by measuring production growth or household income gain (Africa Rice Center, 2008; Agboh-Noameshie *et al.*, 2007; Diagne, 2006; Kijima *et al.*, 2006). This type of analysis captures shifts in income poverty at household level, as has been demonstrated in west Africa, where research shows decreasing inequalities in rice productivity between female- and male-headed farm households, calculated as surplus of production per hectare as compared to pre-adoption rice yields or as additional monetary gain per hectare of adoption (Africa Rice Center, 2008; Agboh-Noameshie *et al.*, 2007; Diagne, 2006; Kijima *et al.*, 2006). This suggests that NERICA is successfully addressing income poverty for these farmers at the household level. But, given prevailing gender systems where women and men do not have the same rights, resources, roles and responsibilities (World Bank, 2001), it is as important to find out how the distribution of costs and benefits are mediated between household members. In this paper, we explore how the aggregate household welfare outcomes in relation to NERICA were arrived at in Hoima District, Uganda, by examining intra-household production relation patterns[1] and their consequences for individual household members' well-being. We provide an illustration of the impact that NERICA has had on the gendered labor dynamics in small-holder households in Hoima District, grounded in the local context and the lived experiences, particularly of women farmers.

In Uganda, rice has been recognized as a major food and income earner. NERICA 4 was released in 2002 to address domestic rice production deficits and small-holder poverty and food insecurity. The market promptly embraced it, and so did the government. Backed by international donors and UN organizations, large investments have, since 2004, been channeled into different dissemination projects, generally managed by NGOs in collaboration with the private sector, targeting the many small-holders in the country. Over 40 000 ha of NERICA had been established by 2008, which was almost a third of the total area planted to rice, including paddy, indicating rapid adoption rates (Rice Breeders' Network, 2008; FAOSTAT, 2009). With assessments demonstrating its positive effects on households' income poverty, NERICA has been described as a "revolution" in Uganda (Kijima *et al.*, 2006).

Materials and methods

The study was mainly carried out in Hoima District, one of the first districts in Uganda where NERICA 4 was disseminated on a large scale and that boasts high adoption rates. The district has a typical savannah climate suitable for upland rice production. Rains are bimodal, ranging from 700 to 1000 mm per annum, with rice

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[1] 'Intra-household production relations' refers to how household members divide work among themselves, who is carrying out which task, in what capacity, and where. The term covers the 'division of labor', plus the preceding negotiations between unequals that must have taken place to arrive at that particular division. 'Patterns' refer to trying to find general patterns within the district as in contrast to the setup within a single household. So, the 'intra-household production relation patterns' is the 'general' setup in Hoima as opposed to individual households' unique intra-household production relations.

mainly being planted during the second, longer rainy season. Soils are mainly of low to medium fertility, with low amounts of organic material and poor moisture-retention capacity (Rwabwoogo, 2002; NEMA, 2003). With the district's total population approaching half a million, the demographic pressure on the land is well in excess of 100 persons per square kilometer and over 90% of the population is made up of rural dwellers, mostly small-holders (Rwabwoogo, 2002; NEMA, 2003; UBOS, 2009). A wide variety of food crops is represented, while tea, coffee and tobacco are the main cash crops. Rice has also become a cash crop since the introduction of NERICA; it is also becoming an appreciated food (Bergman Lodin, 2005).

Data were collected during 2008–2009 using a mixed methods approach covering quantitative, qualitative and participatory methods. A pre-survey was conducted in eight districts to establish a country baseline, after which a more detailed survey was undertaken in Hoima District covering 302 NERICA farmers in 18 villages. A stage-wise random sampling technique was used along with a pre-tested questionnaire. A diary study charting precise family labor input in NERICA production during 2008 was also performed with 13 households. Over 50 focus group discussions with farmers and children were conducted, often involving participatory methods such as mapping-and-ranking exercises, problem-tree analysis and calendar constructions. Key informant interviews were carried out with various rice value chain stakeholders in Hoima and Kampala. Finally, farmers were interviewed in Luwero and Wakiso districts, two other districts targeted early for NERICA dissemination.

The quantitative data collected were analyzed using, among others, t-tests and chi-square tests in SPSS computer program, while the qualitative data were explored in an inductive way and coded according to the different themes that arose throughout the analysis in line with grounded theory.

Results

Farmers in Hoima District dedicated more than one-third of their total cultivated area to NERICA (Table 1). The mean area of 0.45 ha is consistent with the findings at national level by Kijima *et al.* (2006). While household headship affected NERICA area, it did not affect the proportion of area planted to NERICA. This suggests that male-headed households plant a somewhat larger area to rice than female-headed households since they have better access to land. More than 75% of the total output was sold (Table 2). NERICA sales generated over half of these households' farm incomes (Table 3), and this in a context where the households invariably rely on this source. Thus, NERICA is of great importance to these households; the income generated from NERICA is the major benefit. But much research has shown that African women farmers do not always benefit from, and are sometimes adversely affected by, the introduction of new technologies (Doss, 2001), including high-yielding varieties with their often-associated improved management systems. Our study supported this — the benefits were not necessarily shared equitably between the different household members. Women in male-headed households were often neither able to decide the final destination of the output nor to establish the same control over the proceeds as their husbands — particularly not when the spouses have grown rice together on a joint plot as opposed to when the wife had her own rice plot. However, the costs to the farmers of producing NERICA were also highly gendered, and in the context of Hoima District in Uganda they invariably translated into labor.

Table 1. Household production performance with regard to headship, 2nd season 2008

	Head of household		All
	Male (N=274)	**Female (N=28)**	**(N=302)**
Total cultivated area (ha)	1.32* (0.05)	0.94* (0.08)	1.28 (0.04)
NERICA area (ha)	0.47* (0.02)	0.32* (0.04)	0.45 (0.02)
NERICA area as proportion of total cultivated area (%)	36.8 (1.0)	35.4 (3.4)	36.7 (0.9)
NERICA total production (kg)	1045*** (63)	588*** (74)	1007 (58)
NERICA yield (kg/ha)	2436 (163)	2160 (274)	2412 (151)

Numbers in parentheses indicate standard errors of means.
*, *** values within rows (i.e. between male- and female-headed households) are significantly different at the 5% and 0.1% levels, respectively.

Labor was the most frequently raised and returned-to topic during the various group discussions with farmers, who identified the labor-intensive nature of NERICA as their core production concern and constraint. Labor intensity was perceived by the farmers as implying two things: that the crop is time-consuming and/or labor-exhausting. 'Time-consuming' considered the total labor input in hours or days, while 'labor-exhausting' referred to invested drudgery measured in energy and sweat. The interviewed farmers almost uniformly shared

Table 2. NERICA: Crop uses, 2nd season 2007

	Head of household				All	
	Male (N=274)		Female (N=28)		(N=302)	
	kg	%	kg	%	kg	%
Home consumption	121	14.2	114	19.6	120	14.7
	(7)	(0.9)	(22)	(3.2)	(7)	(0.8)
Sale	901***	76.1	483***	69.3	862	75.5
	(48)	(1.2)	(70)	(4.7)	(44)	(1.1)
Seed	66	8.3	52	10.5	65	8.5
	(4)	(0.6)	(8)	(2.0)	(3)	(0.6)
Other uses (in-kind payments, gifts, storage losses, etc.)	17*	1.8	6*	0.7	16	1.7
	(3)	(0.5)	(3)	(0.4)	(3)	(0.4)
Total production	1100	100.4	655	100.1	1059	100.4
	(52)		(88)		(48)	

Numbers in parentheses indicate standard errors of means.
*, *** values within rows (i.e. between male- and female-headed households) are significantly different at the 5% and 0.1% levels, respectively.

Table 3. NERICA market performance, 2nd season 2007 and 1st season 2008 (merged)

	Head of household		All
	Male (N=274)	Female (N=28)	(N=302)
Total household income (US$)	840*** (70)	337*** (66)	793 (64)
Farm income (US$)†	697* (65)	289* (64)	658 (60)
Farm income share of total income (%)	84.6 (1.6)	84.3 (4.4)	84.5 (1.5)
Realized income from NERICA (US$)	301* (21)	154* (39)	287 (19)
NERICA share of farm income (%)	54.9 (2.1)	60.4 (6.0)	55.4 (2.0)

Data refer to cash income only. Numbers in parentheses indicate standard errors of means. Currency conversion: UGX 1000 = US$ 0.509 (2010–01–28, www.oanda.com).
† Farm income includes sale of food crops, sale of nonfood cash crops and sale of animals and animal produce.
*, *** values within rows (i.e. between male- and female-headed households) are significantly different at the 5% and 0.1% levels, respectively.

the view that NERICA demands more labor and causes more 'suffering' [sic] than the other crops they cultivated: "There is more money in rice but rice is more labor-intensive compared to other crops" (Kaigo village).

However, there were certain farming activities in the NERICA production cycle that led farmers to this conclusion. When the farmers in the survey were asked "Which is the most time-consuming task in NERICA production?", more than 60% reported crop protection, or bird-scaring, and about a quarter weeding (Table 4). Bird and weed control were also identified by the farmers in the group discussions as the two most labor-exhausting activities.

Due to the prevailing labor burden-sharing arrangement among households in Hoima (outlined in Table 5), women and men were not engaged in the same capacities in rice production: certain tasks were mainly carried out by women and certain tasks mainly by men, especially when the spouses grow NERICA on a joint plot, which was the dominant arrangement.[2] The outcome of the gendered division of labor is that bird-scaring and weeding, i.e. the two most labor-intensive tasks, were mainly shouldered by women.

According to women farmers, NERICA was even *the most* labor-intensive crop they grew. Table 6 presents the findings from crop ranking exercises where women and men farmers separately scored and ranked the most important crops they grew (their subjective decision on which to include) with regard to the crops' effects on

[2] In those cases where the spouses had separate rice plots, or where they had one joint plot and the wife also had her own, women normally performed what Whitehead (1990) calls a "dual productive role" by contributing to the household's farm production both by providing unremunerated family labor for their husbands' plots or for joint ones (the output of which they often were not in control of), at the same time as they managed and were in control of their own plot. Most of the farmers explained that when the spouses had separate plots, the wife had to help her husband in his field, but that there was no reciprocity in this arrangement, so that she had to manage her own alone or with help from her children. In those cases where they did exchange labor, it was still pointed out that the husband's plot was always the prioritized one — that was where they went first.

Table 4. Most time-consuming task in NERICA production (1st rank, %)

	Sex of respondent†		All
	Male (N=197)	Female (N=102)	(N=299)
Crop protection	58.4 (3.5)	67.6 (4.7)	61.5 (2.8)
Weeding	28.4 (3.2)	16.7 (3.7)	24.4 (2.5)
Land preparation	11.7 (2.3)	8.8 (2.8)	10.7 (1.8)
Other tasks	1.5 (0.9)	6.9 (2.5)	3.3 (1.0)
Total	100.0	100.0	99.9

Numbers in parentheses indicate standard errors of means.
† Chi square statistically significant at the 5% level.

Table 5. The gendered division of labor in Hoima District

Activity	Men	Women
Land preparation	+++	+
Planting	+/++	++/+++
Weeding	+	+++
Crop protection, including bird-scaring	+	+++
Harvesting	+/++	++/+++
Threshing	+++	+

Sources: Interviews with farmers and key informants. Where there was much variability across households, we have noted two different shares such as +/++ to provide a more balanced representation.

Table 6. Women's and men's scores for the most important crops they grow with regard to the two dimensions of labor intensity

Crop	Time-consuming†		Labor-exhausting†		
	Women Ruhunga	Men Kigabu	Women Ruhunga	Men Kigabu	Men Ruhunga
Rice (NERICA)	10	4	10	7	8
Cassava	8	10	9	7	2
Banana	10	10	3	7	–
Groundnut	7	3	6	6	5
Coffee	–	10	–	7	5
Maize	7	3	6	7	2
Bean	5	2	5	7	–
Millet	7	–	8	–	–
Sweetpotato	5	–	7	–	–
Tobacco	–	–	–	–	10
Cabbage	6	–	2	–	–
Greens	3	–	4	–	–
Tomato	4	–	2	–	–
Onion	2	–	1	–	–

Summary results for one group of women and two groups of men in Ruhunga and Kigabu villages.
– Unranked crops.
† Scale 1–10, where 10 is most time-consuming/exhausting.

them as women and men, respectively. Women farmers considered rice both the most *labor-exhausting* and *time-consuming* crop that they grew (the time criterion received the highest score alongside banana), while men farmers rather perceive the crop's demand on their energy and time as moderate. Since women were carrying out most of the most labor-intensive activities, this sheds light on why more women than men found it so labor-intensive to grow rice. Even men pointed out that rice is particularly burdensome for women, or their wives. Furthermore, the farming activity that men are mainly responsible for — land preparation — was also the activity that the households mainly hired labor for, with more than half reporting doing so, while 42% used hired labor for weeding and only 4% for bird-scaring. Men's labor was further replaced and saved as households used subsidized tractor hire services or hired oxen to plow the land, although such partial mechanization of the land preparation only benefited 12.6% of the sample. However, there were no similar services available that could save women's labor with regard to bird and weed control.

Farmers explained that birds, particularly the conspicuous and destructive Red-billed Quelea (*Quealea quelea*), can easily wipe out the whole rice crop. This was powerfully communicated by one of them during a group discussion: "Birds love it a lot. Some people even lose most of their harvest to the birds" (Kihamba village). This is well-known in Uganda and many other countries in Africa (Edyegu, 2010; Elliott, 2000). Therefore, the farmers need to guard the crop properly from dawn till dusk during its most vulnerable stages,

translating into 12–13 h/day. The attacks were allegedly concentrated at two points: during the first 4 weeks after planting and during germination; then again from flowering stage up to harvest — which easily claimed an entire month or more of the farmers' full and nonnegotiable attention. More than a third of the total time invested in NERICA production was for bird-scaring (Table 7). However, it was not only in absolute terms that NERICA was time-consuming. Given that the farmers stated that they did not need to perform this task for other crops, bird-scaring in rice is therefore also a relative disadvantage compared to those crops. Figure 1 gives further voice to farmers' experiences in relation to birds.

Table 7. Diary study log of family labor hours in NERICA production (N=13)

Activity	Total time (h)†	Proportion of total labor (%)‡	Productivity (h/ha)§¶
Land preparation	360 (69)	19.6 (4.2)	813 (195)
Planting	208 (38)	10.7 (1.3)	353 (52)
Weeding	265 (55)	11.2 (1.7)	519 (124)
Bird-scaring	652 (102)	36.9 (4.2)	1334 (277)
Harvesting	371 (64)	21.6 (3.3)	776 (158)
Total family labor	1783 (193)	100.0	3751 (521)

Data refer to the second season 2008. The numbers in parentheses indicate standard errors of means.
† For bird-scaring and harvesting there are 2 missing cases (mc).
‡ For all activities there are 2 mc.
§ For land preparation, planting and weeding there is 1 mc, for bird-scaring and harvesting there are 3 mc.
¶ Data transformed into hectares for comparative purposes. The figures are unrealistic since nobody was growing 1 ha of rice (they would not be able to invest 3751 hours of family labor in that); this is also the reason why they are not growing more than they are (approx. 1 acre or 0.404 ha).

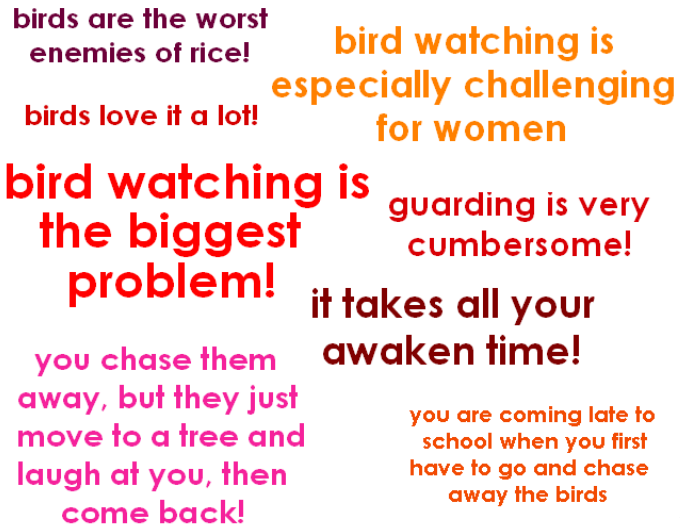

Figure 1. Respondents' voices on bird-scaring

As has been noted, crop protection was carried out mainly by women and children in these communities, hence it was also considered as particularly demanding for and by these groups. When the household had several rice plots, the wife often had to divert her labor to the joint or her husband's plot, as one woman explained: "then you find that you have to leave your garden to children … If you are unfortunate to find that your children are in school you have to leave it to the birds" (group of women, Ruhunga village). During this time, the birds — or the rice — were controlling these women's lives. Some reported that they felt like "slaves to the rice" [sic] not being able to even look after themselves, link up with friends, participate in functions and so on. Others described how they needed to "bring the kitchen to the garden" [sic]. The children themselves also complained. In Kyambara village, for example, they raised the problem of how bird-scaring was affecting their schooling in a negative way, with one of them saying: "At times we miss the whole day [of school] when we guard the whole day" (school child).

It seems that this new demanding dimension of crop protection has made men, who previously never participated, to start engaging in crop protection. But their participation was not undifferentiated: men usually came in for the second bird-scaring round, and then for fewer hours. Some men explained their participation

resulting from rice being such an important crop (money-wise) that they did not dare to completely entrust their wives and children to do the bird-scaring job properly.

Protecting the crop from depredation means that the farmers, mainly women and children, have to run up and down in the field, shouting, waving, clapping hands, throwing stones and sometimes trying to scare the birds off with rattles and drums. This also means that this activity is labor-exhausting. The farmers were struggling to find an acceptable alternative, but they stated that bird-scaring methods not involving humans were not efficient; the birds quickly get used to scarecrows, strips of cassette tapes, tied up plastic bags (kites) and pieces of CDs or mirrors that they also used (see Edyegu, 2010).

While bird-scaring was very time-consuming in both absolute and relative terms (Table 7), weeding did not stand out in the same way, claiming only one-tenth of all the time invested in the crop. However, farmers said that weeding NERICA was more time-consuming than other crops, as the quotes in Figure 2 suggest. NERICA claimed substantially more hours than other crops, with the exception of tobacco (Table 8). The explanation is that most farmers weeded NERICA three times, or at least twice, while other crops only once, since rice was more susceptible to weeds: if the weeds are not perfectly controlled, they will take a great toll on the output. This has also been widely described elsewhere (NaCCRI, 2009; Africa Rice Center *et al.*, 2008).

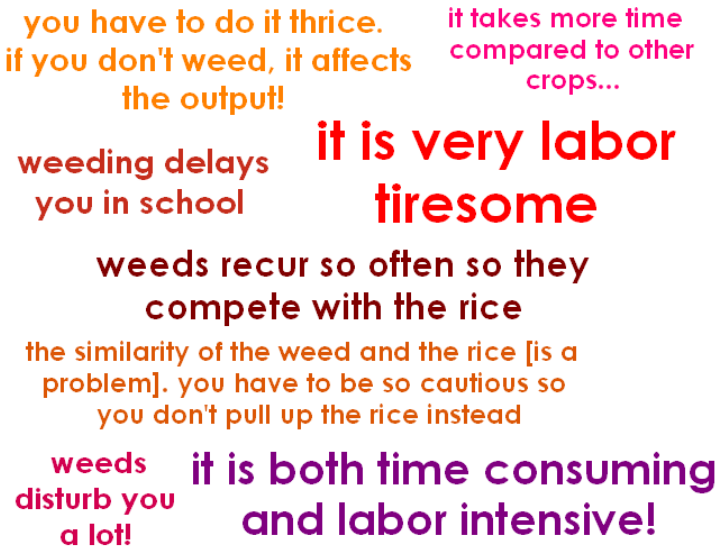

Figure 2. Respondents' voices on weeding

Table 8. Seasonal family labor demands for selected crops in Uganda as reported by different studies; in total and for weeding†

Crop	Total family labor input (h/ha)	Family labor input: weeding (h/ha)	Source of data
Tobacco	n.a.	620	Our survey
NERICA‡	3751	519	Our diary study
Banana§	390	146	Bagamba *et al.* (1998)
Bean	998	274	Kijima *et al.* (2007)
Maize	719	210	Kijima *et al.* (2007)
Coffee‡¶	472	185	Bagamba *et al.* (1998)
Groundnut§	287–395	158	Obuo *et al.* (2003)

† Data transformed into hectares for comparative purposes.
‡ Including hours to apply chemical herbicides.
§ Own calculation for total family labor input drawing on Obuo *et al.* (2003).
¶ Own calculation since the Bagamba *et al.* (1998) data cover annual labor demand and not seasonal.

As for bird-scaring, farmers also found weeding labor-exhausting. While weeding can be assumed to always be backbreaking work, it makes a world of difference if you have to do it once or three times. And again, since it was a mainly female domain, it was also primarily affecting women and children. While men were seemingly increasing their engagement as a response to the larger number of weedings, their participation was not yet on par with women's. Men mostly got involved in the second round when a hoe was used, as compared to the first and third rounds mainly carried out by women and children using their hands (which is more exhausting). If the household hired labor for weeding, it was normally for the second weeding; and when the spouses had separate

plots or the wife in addition to the joint plot had her own, the labor was usually channeled to the husband's plot or the joint one.

Discussion

While Hoiman households as units gain from cultivating NERICA upland rice and become better off in economic terms (decreasing their income poverty), there are highly problematic aspects in the production with regard to labor that affect some household members' well-being more negatively than others'. The extreme labor burden NERICA induces on women and children exacerbates their time poverty and drudgery, but potentially it may also reduce or prevent the formation of their social and human capitals when, for example, women find themselves having little or no time to socialize or participate in different organized groups, and children repeatedly miss out on school. Furthermore, given the invariably patriarchal structure of the households, many women are not in control of the output, hence the money generated by NERICA sales does not necessarily reach the women's pockets, or at least not a fair share, despite their heavy involvement in the production.

In Asia, the new high-yielding varieties became a locomotive in the Green Revolution. If Uganda, as well as other African countries, wants to maintain, or even further, the 'NERICA Revolution', it is crucial that farmers embrace the crop in a sustained manner. Adoption is not an irreversible state, and there are systematic dropouts in some districts in Uganda (such as in Luwero and Wakiso). Women that we have interviewed there were not able to cope with the new and grueling labor, so the rice consequently failed and the households therefore soon opted out of production. High dropout rates have also been recorded by Kijima (2008), who surveyed 240 households in nine districts in 2004 and then again in 2007. In more than half of the re-surveyed districts, the dropout rates ranged from more than a quarter to almost two-thirds.

Uganda clearly needs to boost national rice production in order to satisfy domestic demand and achieve food security. However, the sub-optimal distribution of labor, combined with the inefficient distribution of productive inputs between men and women, as well as the unequal sharing of proceeds and benefits within farm households, may jeopardize the success of future interventions and the chances of achieving sustainable results in regard to NERICA. Therefore, interventions should not only aim at improving rice adoption, production and productivity in general, but also have a particular focus on increasing the productive capacity of farming activities in which women are engaged, i.e. to increase women's *management ability*. This calls for the current labor bottlenecks associated with weeding and bird-scaring to be addressed if women's time poverty and drudgery are to decrease. It is imperative that women farmers benefit from the introduction of NERICA just as much as men farmers do, and that their contributions and concerns are considered equally. In relation to aggregate technology dissemination efforts, this calls for careful analysis by research organizations, donors and service providers at every stage of a dissemination project so as to understand how gender is affecting adoption and the well-being of individuals in relation to that.

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