Farmer-to-Farmer Extension Facilitated by Agricultural Training Institutions: A Case of NERICA Dissemination in Tanzania

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Abstract: The Kilimanjaro Agricultural Training Center (KATC) extension approach has disseminated cultivation techniques for irrigated rice across Tanzania. KATC provides training to extension officers and key farmers (KFs). It also helps subsequent farmer-to-farmer (FTF) extension from KFs to intermediate farmers (IFs) and then to other farmers (OFs). The long-term intensive training for irrigated rice was greatly simplified for the dissemination of NERICA1 that was recently released for rainfed rice fields. While the original approach involves a 12-day residential training and a season-long field follow-up, the simplified one only provides a 2-day residential training. Here, we investigated the extent to which the simplified approach diffused NERICA1. The FTF extension worked almost theoretically from KFs to IFs but not from KFs / IFs to OFs over three cropping seasons. However, the number of OFs gradually increased with little intervention, suggesting that this approach should have some mechanism that encourages participation of OF from an early dissemination stage.

Key words: Agricultural training, Extension system, Farmer-to-farmer, Technology transfer, Upland rice.

Rice is the second most consumed grain crop (after maize) in Tanzania (MAFC, 2009; USDA, 2014). The demand for rice usually exceeds the nation’s production and imports are relied on to supplement the domestic supply. In the recent 2012/2013 cropping season, for example, the country produced approximately 1.2 million tonnes of milled rice from 0.8 million hectares of rice fields (USDA, 2014). The production failed to meet the consumption of approximately 1.4 million tonnes, resulting in the importation of approximately 0.2 million tonnes of milled rice (USDA, 2014).

Thus, the country has been working to increase rice production, including the introduction of New Rice for Africa (NERICA) cultivars. NERICAs are interspecific hybrids between Oryza sativa and Oryza glaberrima developed by the Africa Rice Center (Jones et al., 1997). They grow well in rainfed conditions and potentially yield 4 – 7 t ha⁻¹ (AfricaRice, 2008). Since Tanzanian rice fields are cultivated mostly under rainfed conditions, the introduction of NERICAs is expected to increase the country’s rice production (Sekiya et al., 2013). Then, a series of adaptability trials were conducted by the Agricultural Research Institutes on station and on farm between 2003 and 2009. Based on the results, five of the more than twenty cultivars/lines proved adaptable and were released in December 2009.

In Tanzania, rice production techniques have been disseminated through the so-called “KATC approach” (MAFC, 2009; Mvuna, 2010). KATC is an acronym for the Kilimanjaro Agricultural Training Center that was established in 1994 to disseminate a technical package for irrigated rice cultivation in Tanzania (Ikegami, 1995; Ikegami, 2001). The KATC approach consists of two major components: (1) the joint technical training of farmers and extension officers and (2) the farmer-to-farmer (FTF) extension of the cultivation techniques (Table 1). KATC provides a series of technical training (both theories in the classroom and practical on-site application) to both extension officers and key rice farmers. Then, KATC helps the extension officers to facilitate the transfer of the knowledge the key farmers gained in the training to intermediate farmers and then to other farmers. The
KATC approach has been appreciated not only for its rapid dissemination of the technical package to many farmers but it also is credited with the substantially increased productivity of rice fields (MAFC, 2009; Mvuna, 2010). The KATC approach was adopted by other agricultural training institutes in the country and, as a result, the technical package of irrigated rice cultivation (Table 1) is now disseminated nationwide.

Therefore, the KATC approach was employed in an attempt to quickly disseminate NERICAs across the country. The cultivation of irrigated rice involves many theories and management techniques at different stages of plant growth. Thus, the KATC approach was designed to perform several interventions at different timings over the
entire cultivation period (Table 1). Since the cultivation of NERICAs is as simple as that of common crops in Tanzania such as maize and sorghum, the quantity and frequency of interventions can be greatly reduced from the original approach. This paper first describes a simplified version of KATC approach specifically designed for the dissemination of NERICAs. Second, we attempt to investigate the extent to which the simplified approach diffused NERICAs across the country after a two-year dissemination program.

Materials and Methods

1. Comparison of the Administrative Set-ups of Conventional Extension versus KATC

Fig. 1 compares the administrative set-up of the KATC approach to that of the conventional agricultural extension in Tanzania. Historically, in the conventional system, Agricultural Research Institutes (ARIs) directly contact farmers through District Agricultural and Livestock Development Officers (DALDOs) and Village Agricultural Extension Officers (VAEOs) to introduce new technologies into farming communities (Fig. 1a). ARIs employ such techniques as on-farm trials for the demonstration of technologies (MAFC, 2009; Mvuna, 2010). ARIs assume that successful technologies spontaneously diffuse across farming communities.

In contrast, the KATC approach institutionalizes the farmer-to-farmer (FTF) extension mechanism (Fig. 1b). In this approach, Ministry of Agriculture Training Institutes (MATIs) play an important role in transferring new technologies while ARIs focus mainly on the research component rather than direct involvement in the technology transfer. In the conventional system, MATIs are mainly engaged in the production of extension officers who work in the forefront of dissemination mechanism. Some studies suggested that the intervention on “lead farmers” or “farmer-facilitators” (“key farmers” in our case) greatly affects the subsequent FTF dissemination of new technology (e.g. Alene and Manyong, 2006; Kiptot et al., 2006; Nathaniels, 2005). In the KATC approach, therefore, MATIs are also deployed forefront in an attempt to enhance the technology acquisition of key farmers through their expertise in agricultural education and facilitation. Because MATIs are widely distributed in Tanzania, the nation-wide dissemination program is also possible. In addition, DALDOs are more actively involved with the technology transfer than filling the limiting role of liaison between the central government and local farmers. DALDOs and VAEOs participate in the training courses with the farmers, as described below, and, as collaborators, they are required to facilitate each step of the dissemination mechanism. The KATC approach is possible through reorganization of administrative set-up without creating new institutions and/or employing extra human resources.
2. Preparatory Process for the Training Course

The Japan International Cooperation Agency (JICA) facilitated workshops in which ARI researchers and MATI crop tutors developed the dissemination mechanism (see Fig. 2) and the training modules (see Table 2). After these workshops, JICA provided seven MATIs (Ilonga, Igurusi, Ukiriguru, Mtwara, Tumbi, Maruku, and KATC) with training-of-trainers (TOT) workshops in which crop tutors learned how to teach the NERICA training course. During the TOT workshops, NERICA1 was selected for dissemination based on its palatability (Sekiya et al., 2013). Then, MATI-Ilonga produced approximately 5.0 and 2.5 t of NERICA1 seeds for distribution in 2010 and 2011, respectively. Although NERICAs are usually direct sown upland, a single seedling was transplanted in every hill after thoroughly leveling and puddling the lowland field. This practice allowed an extent of rouging and weeding that resulted in the production of well-filled, unmixed seeds. The seeds were then divided into 5-kg packages and distributed to the seven MATIs after the TOT workshops.

3. NERICA Dissemination Mechanism

Fig. 2 illustrates the NERICA dissemination mechanism. Each DALDO first selects four villages (Fig 2a) and the training modules (see Table 2). After these workshops, JICA provided seven MATIs (Ilonga, Igurusi, Ukiriguru, Mtwara, Tumbi, Maruku, and KATC) with training-of-trainers (TOT) workshops in which crop tutors learned how to teach the NERICA training course. During the TOT workshops, NERICA1 was selected for dissemination based on its palatability (Sekiya et al., 2013). Then, MATI-Ilonga produced approximately 5.0 and 2.5 t of NERICA1 seeds for distribution in 2010 and 2011, respectively. Although NERICAs are usually direct sown upland, a single seedling was transplanted in every hill after thoroughly leveling and puddling the lowland field. This practice allowed an extent of rouging and weeding that resulted in the production of well-filled, unmixed seeds. The seeds were then divided into 5-kg packages and distributed to the seven MATIs after the TOT workshops.
Table 2. Simplified KATC approach developed to disseminate NERICAs.

| Training | Topic | Contents | Method | Location / Period / Duration |
|----------|-------|----------|--------|-----------------------------|
| < Major component 1: Joint technical training of farmers and extension officers > | Baseline survey | No baseline survey is conducted | | |
| Residential training | NERICA Dissemination Mechanism | - Roles of KF, IF, VAEO and DALDO in the NERICA dissemination program | T | MATIs / Sep-Nov / 2 d |
| | NERICA Characteristics | - Differences between NERICAs and Tanzanian cultivars (suitable for upland, early-maturing, high yields under rainfed conditions) | T | |
| | - Appearances of seeds, panicles and plants | | T | |
| | - Susceptible to flooding during seedling establishment | | T | |
| | NERICA Cultivation Techniques | - Land preparation (cleared, ploughed and harrowed right before the rainy season) | T | |
| | - Sowing technique (drilling or dibbling) | | T | |
| | - Sowing density (0.3 m × 0.018 m for drilling; 1 seed hill⁻¹ and 0.3 m × 0.125 m for dibbling: 7 seeds hill⁻¹) | | T | |
| | - Sowing depth (3-4 cm) | | T | |
| | - Sowing time (the onset of rainy season) | | T | |
| | - Fertilizer (not necessary if unavailable. 21 and 45 d after emergence if urea is available) | | T | |
| | - Weeding (20 and 44 d after emergence) | | T | |
| | - Harvesting (30 d after 50% flowering) | | T | |
| Demo-field Establishment: Theory | - Functions of demo-field (production field, showcase and seed supply center of NERICAs) | T | |
| | - Area (0.1 ha: 25 m × 40 m) | | T | |
| | - Sowing (drilling: 25 m × 20 m and dibbling: 25 m × 20 m) | | T | |
| | - The Pythagorean theorem | | T | |
| Demo-field Establishment: Materials Making | - 12-m (3 m + 4 m + 5 m) long ropes for the Pythagorean theorem | T & P | |
| | - 130-m (25 m × 2 + 40 m × 2) long ropes for the field | | T & P | |
| | - 29-m long ropes with marks at 0.125-m intervals for sowing (dibbling) | | T & P | |
| Demo-field Establishment: Practice (Field Work) | - Drawing a rectangle (25 m × 40 m) using the 12-m and 130-m long ropes | T & P | |
| Seed Production Techniques | - Sowing (drilling and dibbling) seeds using the 20-m long rope | | T | |
| | - High quality seeds (cultivar purity, no damage and viability) | | T | |
| | - Production of high quality seeds (field selection, land preparation, seed dormancy, nutrient management, roguing, harvesting, drying, cleaning, storage and seed treatment) | | T | |
| | - Seed certification system (field inspection, seed test and seed class) | | T | |
| Action Plan: Group Work | - Nomination of intermediate farmers (IFs) | P | |
| | - Planning the dates for training IFs, land preparation, sowing and harvesting | | P | |
| Action Plan: Presentation | - Presentation of action plans | P | |
| | - Receiving a certificate of NERICA training course, 4 packages of NERICA1 seed, 4 NERICA uniforms and 4 NERICA production manuals | | P | |

< Major component 2: Farmer-to-farmer extension >

In-field training | Neither In-field training nor Monitoring & Planning is conducted. The FTF extension is monitored by VAEOs alone (“the post-training monitoring”). |

Monitoring & Planning

MATIs = Ministry of Agriculture Training Institutes, KF = key farmer, IF = intermediate farmer, VAEO = Village Agricultural Extension Officer, DALDO = District Agricultural and Livestock Development Officer, T = Theory in the classroom, P = Practical on-site application.
in Table 2. During the course, theories are taught using slides and handouts, and then practice is conducted in the fields.

At the end of the two-day residential training course, action plans are developed in which 12 intermediate farmers (IFs) are nominated (four KFs × three IFs) (see Fig 2b) and the dates for training the IFs, land preparation, sowing, and harvesting are planned (Table 2). Each KF receives four packages of NERICA1 seeds (20 kg in total), four NERICA uniforms (each consisting of a T-shirt and a cap) and four NERICA production manuals (see Fig 2c). Upon returning to their villages, each KF gives each IF one package of seeds (sufficient for 0.1-ha cultivation and calculated based on seed weight, planting density, and the number of seeds per hill), a uniform, and a production manual. Under the guidance of the VAEOs, KFs instruct the IFs on field management and KFs and IFs both establish 0.1-ha portions of their own fields as demo-fields. The demo-fields function as (1) production fields of the KFs and IFs, (2) showcases of the newly released cultivar, and (3) seed supply centers to their villages (Table 2). Each KF and IF then selects three other farmers (OFs) and provides each OF with 5 kg of seeds for the next cropping season.

4. Rice Production Environments in Tanzania

Each MATI promoted the NERICA training course to its neighboring district offices where upland rice was produced. Then, 15 districts agreed to join the course for the 2010/2011 and 2011/2012 cropping seasons (see the geographic distribution of districts in Fig. 3). Muheza, Bagamoyo, and Lindi, all in the coastal zone, have long histories of rice (Oryza sativa L.) cultivation (Carpenter, 1978; Lu and Chang, 1980). Rice is mostly produced in small fields (0.01 – 0.1 ha) in the inland valleys where rainwater gathers down slopes. Morogoro, Ulanga, Mvomero, and Kilosa are located where a number of irrigation schemes have been constructed to make full use of their many rivers. Rainfed lowland rice fields attain relatively high productivity owing to frequent rainfall and upland rice fields are also found in mountainous terrains. Makete and Kyela also are located where many irrigation schemes have been constructed to make full use of their many rivers. Rainfed lowland rice fields attain relatively high productivity owing to frequent rainfall and upland rice fields are also found in mountainous terrains. Ruangwa is a district where severe water shortage often occurs. In these districts, rice is mostly grown in small fields in the inland valleys. The central part of the country has a semi-arid climate where drought-resistant crops like sorghum and millets are mainly grown.

5. Evaluation

After the 2010/2011 cropping season, JICA facilitated another workshop in which DALDOs and VAEOs who participated in the 2010/2011 training course reported to ARI researchers and MATI crop tutors the number of KFs and IFs who grew NERICA1 and its yields in each demo-field. Paddy yields were estimated using a local method. First, farmers dry the grain on the ground under the sun for a few days. Then, the farmers pack the dried grain into paddy packing bags by scooping it up with plastic buckets. The VAEOs weigh one bucket of grain using a spring balance scale and multiplies the weight of one bucket by the total number of buckets to calculate the total grain weight.

After the 2012/2013 cropping season, some crop tutors visited all the districts listed in Fig. 3 (except Makete and Missenyi) to interview 927 farmers who had cultivated
NERICA1 during the 2010/2011, 2011/2012, or 2012/2013 cropping seasons. Each farmer provided the interviewers with information about the cultivated area, cultivation techniques employed, estimated yield, yield limiting factors, means of seed acquisition, his/her impressions of NERICA1, and so on.

Results and Discussion

1. FTF Extension from KFs to IFs and the Performance of NERICA1

Table 3 shows the results of the 2010/2011 training. During this cropping season, 140 KFs participated in the training, 137 KFs of which established demo-fields. While 420 farmers were expected as IFs, 373 IFs actually established demo-fields. Thus, the technology transfer rate, defined as the ratio of the number of actual growers to the number of farmers theoretically expected, was 88.8%. The technology transfer rate in Ulanga was as low as 29.2% due to confusion among VAEOs and farmers after one VAEO deceased during the demo-field establishment. In total, 510 demo-fields were established nationwide in the 2010/2011 cropping season. Therefore, the simplified KATC approach worked almost theoretically in terms of the FTF extension from KFs to IFs.

The mean yield across the demo-fields (N = 510) was 1.04 t ha\(^{-1}\). This yield level was twice that of the national average yield for upland rice (0.5 t ha\(^{-1}\)) and similar to that of rainfed lowland rice (1.0 t ha\(^{-1}\)) in Tanzania (MAFC, 2009). The highest mean yield of 2.88 t ha\(^{-1}\) was recorded in Muheza, and some KFs produced as much as 4.0 – 5.4 t ha\(^{-1}\) of paddy, making neighboring farmers eager for NERICA1 seeds. The cultivar also became popular in Bagamoyo, Morogoro, and Ulanga, where the mean yields were relatively high. It is important to note that these high yields were achieved without the use of fertilizers. This might be due to the large capacity of NERICA1 to exploit soil nutrients. Further studies should be conducted on the nutrient acquisition of this cultivar.

The mean yields of KFs are consistently higher than those of IFs in all the districts. The higher yields of KFs should be ascribed to their technical advantage in the NERICA cultivation. However, it is still unclear whether this technical advantage existed from the time when KFs were selected by the village assemblies or was developed by participation in the NERICA residential training course. The elucidation of this technical advantage may help not only IFs but also KFs improve their cultivation techniques and eventually increase their yields.

In Lindi, Nachingwea, Makete, Kyela, and Bukombe, farmers started cultivation one to two months after the onset of the rainy season due to late implementation of the training course. As a result, the plants were subjected to terminal drought that greatly reduced the yields. These results strongly suggest that training should be conducted early and preferably completed before the onset of the rainy season.

2. Technical Diffusion beyond Key/Intermediate Farmers

The interviews conducted after the 2012/2013

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Table 3. Number of NERICA1 growers, trained farmers, and farmers in theory with mean grain yields of NERICA1 plants in the 2010/2011 cropping season.

| District      | Key farmer (KF) | Intermediate farmer (IF) | Total          |
|---------------|-----------------|--------------------------|----------------|
|               | AG / TF         | Mean yield [min – max]   | AG / FT (TR)   | Mean yield [min – max] | AG / FT | Mean yield (t ha\(^{-1}\)) |
| Muheza        | 16 / 16         | 3.25 [2.25 – 5.40]       | 48 / 48 (100)  | 2.76 [1.35 – 4.23]     | 64 / 64 | 2.88                        |
| Bagamoyo      | 15 / 16         | 1.95 [0.00 – 5.84]       | 40 / 48 (83.3) | 1.39 [0.00 – 5.63]     | 55 / 64 | 1.54                        |
| Morogoro      | 16 / 16         | 1.76 [0.40 – 2.88]       | 47 / 48 (97.9) | 1.55 [0.00 – 4.00]     | 63 / 64 | 1.61                        |
| Lindi         | 15 / 16         | 0.82 [0.00 – 2.30]       | 45 / 48 (93.8) | 0.64 [0.00 – 3.80]     | 60 / 64 | 0.68                        |
| Nachingwea    | 12 / 12         | 0.40 [0.10 – 1.04]       | 35 / 36 (97.2) | 0.31 [0.05 – 1.80]     | 47 / 48 | 0.33                        |
| Ulanga        | 15 / 16         | 1.27 [0.75 – 2.70]       | 14 / 48 (29.2) | 1.14 [0.45 – 3.15]     | 29 / 64 | 1.21                        |
| Makete        | 16 / 16         | 0.00 [0.00 – 0.00]       | 48 / 48 (100)  | 0.79 [0.00 – 1.80]     | 64 / 64 | 0.86                        |
| Kyela         | 16 / 16         | 1.10 [0.30 – 2.25]       | 48 / 48 (100)  | 0.00 [0.00 – 0.00]     | 64 / 64 | 0.20                        |
| Bukombe       | 16 / 16         | 0.35 [0.00 – 2.34]       | 48 / 48 (100)  | 0.15 [0.00 – 1.80]     | 64 / 64 | 0.20                        |
| Total         | 137 / 140       | 1.23                     | 373 / 420 (88.8) | 0.97                    | 510 / 560 | 1.04                   |

AG / TF = Actual growers / Trained farmers, AG / FT = Actual growers / Farmers in theory, TR = Transfer rate (AG / FT \times 100%), min = minimum yield, max = maximum yield. In theory, 16 KFs (four KFs \times four villages) and 48 IFs (16 KFs \times three IFs) establish their demo-fields. In Nachingwea, however, farmers from only three villages participated in the training due to financial constraints of the district office. Yields were estimated as follows; farmers dry the grain on the ground and pack it into rice packing bags by scooping it up with plastic buckets. Then, the Village Agricultural Extension Officers (VAEOs) weigh one bucket of grain using a spring balance scale and multiplied the weight of one bucket by the total number of buckets (see Materials and Methods for details).
cropping season revealed that, while the majority of farmers became NERICA1 growers through our NERICA dissemination mechanism, some farmers had previously obtained the NERICA1 seeds through the ARIs’ NERICA on-farm trials. NERICA1 growers were then classified into 10 types as described in Table 4 based on the training period, the farmer class, and the seed source.

The interviews also revealed that the technical diffusion from KFs to IFs and then to OFs did not occur as anticipated (see Table 5). In the 2010 /2011 trainings, 99 KFs\(^A\) (the superscript corresponds to the one in Table 4) transferred the NERICA technology to 227 IFs\(^B\). Thus, 978 OFs \((99 \text{ KFs}^A \times 3 \text{ OFs each}) + (227 \text{ IFs}^B \times 3 \text{ OFs each})\) were expected in the next season. However, only 174 OFs\(^B\) actually grew NERICA1 in the 2011 /2012 cropping season. The situation was the same for the 2011 /2012 trainings. While 62 KFs\(^H\) trained 146 IFs\(^I\), only 61 OFs\(^J\) grew NERICA1 in 2012 /2013. These results indicate that the simplified KATC approach did not work theoretically beyond KFs and IFs.

Farmers suggested in the interviews that the technology failed to reach the expected number of OFs due to a lack of guidance by the VAOEs. Indeed, due to financial constraints, none of the district offices secured sufficient budget for the post-training monitoring, and as a result, the VAEOs were unable to visit villages in their charge when KFs and IFs were supposed to diffuse their NERICA technology to OFs. However, there was an increase in the number of OFs from the first \((N = 60)\) to the second \((N = 174)\) season and again from the second to the third season \((N = 209)\) (see Table 5). It seems likely that the drought resistant characteristics of NERICA1 attracted the attention of OFs. OFs in Bukombe and Nzega in particular, where rainfall shortage greatly affected performances of rice

### Table 4. Types of NERICA1 farmers that were interviewed after the 2012 /2013 cropping season.

| Training period | Farmer class | Type | Descriptions |
|-----------------|--------------|------|--------------|
| 2010 /2011      | KF           | A    | KFs who participated in the training courses before the 2010 /2011 cropping season |
|                 | IF           | B    | IFs who were trained by KFs\(^A\) during the 2010 /2011 cropping season |
|                 | OF           | C    | Farmers who previously obtained seeds from the ARI’s on-farm trials |
|                 | D            |      | OFs who obtained seeds from either the ARI’s on-farm trials\(^C\) or KFs\(^A\) / IFs\(^B\) |
| 2011 /2012      | KF           | E    | Farmers who previously obtained seeds from the ARI’s on-farm trials and became KFs\(^H\) before the 2011 /2012 cropping season |
|                 | IF           | F    | IFs who were trained by KFs\(^H\) during the 2011 /2012 cropping season |
|                 | OF           | G    | Farmers who previously obtained seeds from the ARI’s on-farm trials |
|                 | H            |      | OFs who obtained seeds from either the ARI’s on-farm trials\(^G\) or KF\(^H\) / IF\(^I\) |

Some crop tutors of Ministry of Agriculture Training Institutes (MATIs) visited all the districts listed in Fig. 3 (except Makete and Missenyi) to interview 927 farmers who had cultivated NERICA1 during the 2010 /2011, 2011 /2012, or 2012 /2013 cropping seasons. KF = key farmer, IF = intermediate farmer, OF = other farmer.

### Table 5. Number of NERICA1 growers, cultivated areas, and mean grain yields in the 2010 /2011, 2011 /2012, and 2012 /2013 cropping seasons.

| Training period | Farmer class | 2010 /2011 | 2011 /2012 | 2012 /2013 |
|-----------------|--------------|------------|------------|------------|
|                 |              | Number     | Area (ha)  | Yield (t ha\(^{-1}\)) | Number     | Area (ha)  | Yield (t ha\(^{-1}\)) | Number     | Area (ha)  | Yield (t ha\(^{-1}\)) |
| 2010 /2011      | KF           | 99\(^A\)   | 12.8       | 1.56       | 85\(^A\)   | 15.2       | 0.91       | 71\(^A\)   | 11.7       | 0.80       |
|                 | IF           | 227\(^B\)  | 32.0       | 1.16       | 194\(^B\)  | 31.7       | 0.97       | 152\(^B\)  | 25.2       | 1.30       |
|                 | OF           | 60\(^C\)   | 10.8       | 1.10       | 174\(^D\)  | 25.3       | 0.84       | 209\(^D\)  | 28.0       | 0.94       |
| 2011 /2012      | KF           | 5\(^E\)    | 0.5        | 1.86       | 62\(^H\)   | 8.1        | 0.38       | 38\(^H\)   | 7.6        | 1.62       |
|                 | IF           | 8\(^F\)    | 1.3        | 0.56       | 146\(^I\)  | 17.3       | 0.52       | 91\(^I\)   | 16.7       | 0.86       |
|                 | OF           | 7\(^G\)    | 1.2        | 0.85       | 12\(^G\)   | 1.9        | 0.66       | 61\(^G\)   | 14.0       | 0.76       |
| Total           |              | 408        | 58.5       | 1.25       | 676        | 99.4       | 0.79       | 626        | 102.9      | 0.94       |

Some superscripts (A, B, C, D, E, F, G, H, I and J) correspond to types of farmers in Table 4. KF = key farmer, IF = intermediate farmer, OF = other farmer.
plants during the dissemination period, appreciated NERICA1. Besides, relatively large percentages of OFs employed drilling or dibbling for sowing NERICA1 rather than traditional broad casting (Table 6), indicating that the cultivar was transferred from KFs and IFs to OFs along with cultivation techniques that the simplified KATC training course provided. These results suggest that the FTF extension from KFs and IFs to OFs increases over time even without guidance.

Therefore, the simplified KATC approach should involve intervention that further exploits the potential of FTF extension. For example, the nomination of OFs in the action plan may be one way to facilitate the FTF extension beyond KFs and IFs. During the two-year dissemination program, almost no interventions were made for OFs except teaching KFs the NERICA dissemination mechanism (Table 2). If OFs are nominated from the beginning, they may approach KFs and IFs for their shares even in the absence of VAEOs. Some KFs and IFs reported that the low rainfall in the 2011 / 2012 cropping season destroyed their plants and left no seeds available for the next season. The data in Table 5 support that report based on the reduction of mean yields in the same season. Those KFs and IFs suggested that the low yields greatly reduced their motivations to provide OFs with seeds. The farmers involved in our program are vulnerable to problems related to the extreme climates, such as rainfall scarcity, flooding, and other weather and temperature related variations. Therefore, a seed supply system may be necessary to support vulnerable farmers who would otherwise have no seeds available for the next season. The large-scale program was made possible by the nationwide network of MATIs and their close relationships with local governments.

**Table 6. Percentages of farmers who employed random transplanting, line transplanting, broadcasting, drilling or dibbling for the cultivation of NERICA1.**

| Farmer class | Transplanting | Sowing |
|--------------|---------------|--------|
|              | Random | Line | Broadcasting | Drilling | Dibbling |
| KF           | 0.6    | 12.6 | 4.2          | 48.5     | 80.8     |
| IF           | 1.4    | 11.0 | 6.4          | 45.1     | 76.8     |
| OF           | 8.4    | 18.9 | 21.0         | 34.1     | 66.8     |

Each value is the number of farmers who employed each method / the total number of farmers in each class × 100%. Since there were many cases where one farmer practiced more than two methods in his / her fields, the total percentage in each farmer class exceeds 100%. Although NERICA1 is the upland rice cultivar, some farmers grew it in rainfed lowland fields by transplanting its seedlings. KF = Key Farmers, IF = Intermediate Farmers, OF = Other Farmers.

Conclusions

The simplified KATC approach induced the FTF extension from KFs to IFs almost theoretically. However, some improvement is necessary for the FTF extension beyond KFs and IFs such as the nomination of OFs during the training course. Although NERICA1 performed very well under favorable conditions, the cultivar often failed during extreme climatic events and / or due to managerial problems (e.g., late sowing). Thus, some measures such as a seed supply system should be put in place to support vulnerable farmers who would otherwise have no seeds available for the next season. The large-scale program was made possible by the nationwide network of MATIs and their close relationships with local governments.

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