Coming to Grips with Farmers' variety Selection - the Case of New Improved Rice Varieties under Irrigation in South East Tanzania

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Summary

In collaboration with farmers, rice varieties were evaluated under small-scale irrigation in two villages of south east Tanzania for two consecutive cropping seasons (1999/2000 –2000/2001). The objectives were to give farmers access to new improved rice varieties; to identify the selection criteria farmers consider important in irrigated rice production; and to come to grips with their arguments. Farmers were provided with eleven improved varieties, which they compared with their own ones. Farmers' preferred varieties with short to medium maturity period, which produce many tillers and mature uniformly; and with long translucent aromatic grains for their own use and marketing. This study identified qualitative and quantitative evaluation criteria which farmers are using for selecting rice varieties. The implication for further research on rice in south east Tanzania is that the breeding programme should incorporate these attributes to address farmers' preferences, rather than to go for absolute maximum yield levels.

Résumé

Comprendre la sélection de variétés par des fermiers: le cas de nouvelles variétés améliorées de riz sous irrigation dans le sud-est de la Tanzanie

En collaboration avec des fermiers, des variétés de riz ont été évaluées sous irrigation dans deux villages du sud-est de la Tanzanie pendant deux saisons culturales consécutives (1999-2001). Les objectifs étaient d'offrir de nouvelles variétés améliorées aux fermiers; d'identifier les critères de sélection que les fermiers considèrent comme importants pour la production du riz irrigué; et de comprendre leurs arguments. Les fermiers ont reçu onze variétés améliorées qu'ils ont comparé avec leurs propres variétés. Les fermiers préféraient, pour leur propre consommation aussi bien que pour le marché, les variétés de riz à maturation courte à moyenne, produisant de multiples talles avec une maturation uniforme; et produisant de longues graines translucides et aromatiques. Cette étude a permis d'identifier et de quantifier les critères d'évaluation des fermiers et de les comprendre. Les implications pour la recherche ultérieure sur le riz dans le sud-est de la Tanzanie, sont que des programmes de sélection devraient tenir compte de ces critères plutôt que de viser des rendements maximaux absolus.

Introduction

Rice, *Oryza sativa* L., is one of the most important food crops in Tanzania particularly among the rapidly expanding urban population. In south east Tanzania, it ranks third in importance for food security after maize and cassava (9). However, production is limited for lack of high yielding varieties with acceptable grain qualities and resistance to common pests and diseases. Except for a few varieties grown under small-scale irrigation, most of farmers' varieties are long maturing. They are popular because of their long and slender translucent semi-aromatic or aromatic grains.

Prior to the mid 1980s, focus on technologies such as variety development was based on station research where conditions (such as soils and slope) are uniform. These were different and unrepresentative of the edaphological conditions in most of the farmers' fields. Also, farmers' evaluation in technology performance was not given much attention and their initiated innovations most often were unanticipated by professionals. Later, the focus in technology development was on-farm research so that farmers are involved and have a bigger role in the process of agricultural research.

In spite of the shift in emphasis from on-station to on-farm research the conventional researchers are yet to appreciate the role of farmers in technology development. Because of the way in which they are trained, they look on a particular fragment of an agricultural problem instead of the entire production system (3). Farmers on the other hand, look on the production system in a totally different way and evaluate the suitability of a new technology by using a set of criteria that may be different from those of the professional researchers. In rice for

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example, reliable evaluations by farmers were made of traits such as grain breakage on dehusking, ease of dehusking, and market value and not just the limited set of characteristics measured in plant breeders' trials (6). Therefore, it is important to get insights into the kind of characteristics farmers desire by conducting evaluations with them.

The objectives of this study were, besides giving farmers access to new improved rice varieties, to see how farmers can be involved in the research process, to identify the selection criteria farmers consider important in irrigated rice production and to come to grips with their arguments.

Material and methods

The study area

The study was conducted in Kinyope and Kitere villages in south east Tanzania. Kitere village is located between latitudes 10°20'28" south and longitudes 39°41'33" east in Mtwara region. Kinyope village is located between latitudes 9°58'57" south and longitudes 39°23'50" east in Lindi region. Soils of Kitere are dominated by *Vertisols* (7) and those of Kinyope are mainly *Fluvisols* (4). Annual average rainfall of the two areas ranges from 810 and 1090 mm. Temperature ranges from 21.7 °C to 30.5 °C. These villages were selected to represent two typical water systems: a seasonal stream in Kitere and a perennial stream in Kinyope, which can serve as a model for larger valleys in south east Tanzania where either *Vertisols* or *Fluvisols* are most common. Irrigated rice cultivation is common in these two watersheds.

Material

Eight cultivars (Agulha, Kihogo Red Selection No. 7, Naro fupi, Subarimati, Supa Utafiti, Rangimbili, TXD-85, TXD-88) and five lines (TXD-213, TXD-220, TXD-282, TXD-299, TXD-306) were provided by the Rice Research Institutes of Dakawa and Ifakara in Tanzania. Except Agulha originating from Mozambique and Subarimati from India, other materials were developed in Tanzania. Early maturity, long translucent aromatic grains and potential for high yielding were the desired characteristics behind their development. The materials were tested in participatory managed trials in which farmers provided the local varieties and were involved in planting and evaluation of the varieties. The new materials were compared with three local varieties in Kitere (Dakawa, Tunduru and Supa Kitere) and with one in Kinyope (Supa Kinyope).

Evaluation stages

In 1999/2000 and 2000/01 cropping seasons, farmers evaluated the varieties at maturity prior to harvest. At post-harvest stage, farmers evaluated un-milled rice, milled and cooked rice. Varieties of un-milled rice were displayed and evaluated by making visual observations. In each evaluation, farmers scored and ranked the materials against appreciated characteristics. Also, before the end of the evaluation exercise each year, farmers selected improved materials based on selection criteria in three categories: better, the same or worse than the local variety. Seventeen farmers (nine men aged between 30 - 52 years and eight women aged between 27 - 49 years) in Kinyope and nineteen (thirteen men with age between 24 - 60 years old and six women between 28 - 61 years old) in Kitere participated. A non-structured group interview was used.

Statistical analysis

A chi-square analysis was used to find out whether farmers were consistent in ranking of the materials against appreciated characteristics during the two seasons. Also, the percentage data of improved materials better, the same or worse than the local variety were analysed by analysis of variance using SAS statistical package (11). The data were first transformed to arcsine to get a normal distribution.

Results

Evaluation process

Farmers' methods of evaluation

Selection criteria were found by asking farmers to mention characteristics they use to choose a good variety from a bad one at maturity and post-harvest stages. Farmers then used these criteria as guidelines against which to select new varieties at each evaluation stage. In 2000/01 season, in addition to this procedure, farmers suggested that new improved materials and the local variety should be compared against important selection criteria to establish whether a different methodology may influence the outcome of the evaluation. After the group evaluation at maturity, farmers chose one of their colleagues to summarise the whole process and, after consultation with the others, selected the best varieties.

At post-harvest stage, farmers grouped the varieties into three categories of most liked, liked and not liked un-milled rice. The most liked varieties were further ranked by pair-wise comparison. Varieties were milled using farmers' practice and facilities (mortar), winnowed and evaluated. For evaluation of cooked rice, women farmers volunteered to cook. In-order to make an efficient assessment, six farmers (two men and four women) volunteered to taste the varieties on behalf of the others. The varieties were randomly divided into three groups. Farmers tasted each group separately, discussed and reached a consensus; then selected the best two varieties. From the three groups, farmers selected and evaluated six best varieties. At the end of each evaluation stage, farmers gave each variety a score of between 1 and 14 in Kinyope and 1 to 16 in Kitere; preferred materials being designated high scores.

Evaluation at maturity

During 1999/2000 season, farmers of both villages used total number of tillers per hill, number of productive tillers per hill, plant height, number of panicles per hill, grain filling and maturity days as the evaluation criteria at matu-

rity. Farmers in Kinyope selected and gave high scores to varieties with many panicles, long panicles and many tillers; relatively tall plant stature and uniform maturity (Table 1a).

Farmers in Kitere considered varieties, which have many tillers per hill, early maturity, uniform flowering; and long slender grains superior (Table 1b).

In 2000/2001 season, farmers considered the best varieties those with many tillers, short to medium maturity period, uniform maturity, long panicles, and long grains rather than short (Tables 1a and 1b). Farmers in Kinyope also preferred tall varieties. Table 5 presents statistical analysis of per cent improved materials better, the same or worse than the local variety as perceived by farmers. In Kinyope, there were significant differences ($P< 0.05$) between categories of rating improved materials compared with the local variety in plant stature. Farmers considered only 7.7% of improved materials better than the local variety in plant height while 62 % were regarded as inferior. On the other hand, farmers in Kitere selected 70% of improved materials tested for their superiority in tillering ability compared to the local variety ($P< 0.01$).

Evaluation at post-harvest stage

a) Evaluation of un-milled rice

In 1999/2000 season, farmers mentioned grain size, seed coat colour and grain filling as the most important selection criteria of un-milled rice varieties. Farmers in Kinyope preferred varieties with long and slender size and well filled grains (Table 2a).

Reasons for variety preference and ranking by farmers in Kitere are given in table 2b.

Table 1

Characteristics of varieties selected at maturity in 1999/2000 and 2000/2001 seasons

Appreciated characteristics	Varieties/Lines selected	Scores
a. Kinyope		
1999/2000 season		
Many and bigger panicles and many tillers	TXD-88	14
Relatively early maturing and produces many tillers	TXD-282	9
Bigger panicles, uniform maturity and grain filling is better	TXD-220	13
Taller plants, bigger panicles, slender grains and better grain filling	Supa Utafiti	10
Matures more uniformly, has slender grain size and many panicles	TXD-213	12
Relatively early maturing and is more aromatic	Rangimbili	11
2000/2001 season		
Many and bigger panicles, higher tillering ability	TXD-88	11
Relatively early maturing and higher tillering ability	TXD-282	13
Bigger panicles, uniform maturity and better grain filling	TXD-220	14
Taller plants, bigger panicles, slender grains and better grain filling	Supa Utafiti	12
Matures more uniformly, has medium slender and many panicles	TXD-213	10
Relatively early maturing and is more aromatic	Rangimbili	9
Chi-square = 1.69; df = 5; P = 0.89		
b. Kitere		
1999/2000 season		
Higher productive tillers and bigger panicles	TXD-220	16
Many tillers, slightly longer and medium grains	Subarimati	10
Shorter maturing period	TXD-306	9
Higher tillering ability and many productive tillers	Naro Fupi	14
Many tillers	TXD-85	11
Many tillers and is a short duration variety	TXD-299	8
Many and heavy panicles	Dakawa	15
Higher tillering ability	TXD-88	13
Higher tillering ability and is less susceptible to lodging	Kihogo Red Selection No.7	12
2000/2001 season		
Higher tillering ability and bigger panicles; early maturing	TXD-220	15
Many and heavy panicles	TXD-306	16
Many and more productive tillers	TXD-213	13
Many tillers and well grain filling	TXD-88	14
More productive tillers and heavy panicles	Tunduru	10
Many tillers and is early maturing	TXD-85	12
Many tillers, slightly longer and bold grains	Narofupi	11

Scores range 1-14 at Kinyope and 1-16 at Kitere; where 1 is the lowest and 14 or 16 is the highest score.

Table 2

Characteristics of most liked un-milled rice lines and varieties in 1999/2000 seasons

Appreciated characteristics	Varieties/Lines selected	Rank
a. Kinyope		
Medium, heavy and more translucent grains; and higher yielding	TXD-88	1
Well filled and heavy grains	TXD-282	2
Translucent, long and slender and well filled grains	Supa Utafiti	2
Long and slender, well filled and heavy grains; and higher yielding	TXD-220	2
Medium, poorly filled and brown seed coat	Agulha	5
Relatively short, poorly filled and brown seed coat	TXD-299	6
b. Kitere		
Light brown (attractive) seed coat well filled long and slender grains	Tunduru	1
Seed coat colour not as attractive, well filled long and slender grains	Supa Kitere	2
Relatively long and medium, seed coat colour brownish	Agulha	3
Relatively long and medium, seed coat colour whitish	Supa Utafiti	3
Relatively long and medium, less whitish grains	TXD-306	3

In 2000/2001 season, farmers of both sites mentioned seed coat colour, grain size and grain filling the most important selection criteria for un-milled rice. Varieties with long rather than short, slender rather than bold and well-filled grains with light brown seed coat colour were preferred. Farmers in Kinyope preferred and gave high scores to varieties with light brown, long and slender and well-filled grains. Farmers considered nearly 60% of improved materials better ($P< 0.05$) than the local variety due to their light brown husks (considered attractive compared to other colours). However, farmers considered over 60% of the improved materials worse than the local variety in aroma and plant height ($P< 0.001$); and 69% the same ($P< 0.001$) as the local variety in milling recovery (Table 5). Farmers in Kitere preferred and gave high scores to varieties with light brown, long, slender and well-filled grains. Varieties with long but relatively medium slender grains were rated second. Farmers selected less than 30% of improved materials due to better grain size, 47% because of better grain filling and only 20% for their light brown seed coat compared to the local variety. However, no significant differences were detected compared to those rated the same as or worse than the local variety in these attributes (Table 5).

b) Evaluation of milled rice

Farmers of both villages mentioned grain size and colour, aroma and milling quality the most important selection criteria in 1999/2000 season. The most preferred varieties were those with long, slender and translucent grains (Table 3).

In 2000/2001 season, farmers in both villages added easiness to mill as a criteria in evaluating milled rice varieties. Farmers in Kinyope, preferred and gave high scores to varieties with clear white colour, long and slender, strongly aromatic, easily milled and high milling recovery (Table 3a). Farmers in Kitere preferred and gave high scores to varieties with translucent, strongly aromatic, long and slender grains (Table 3b). In both villages, the improved materials were rated worse ($P< 0.001$) in aroma (77% in Kinyope and 53.4% in Kitere) than the local variety (Table 5). However, farmers in Kinyope considered 69% of improved materials the same as the local variety in milling recovery and 43% in Kitere.

c) Evaluation of cooked rice

In both seasons, farmers in the two villages mentioned the ability to absorb water during cooking, good expansion during cooking, aroma, tasty and stickiness; and softness of leftovers as the main rice variety selection criteria during and after cooking. Results of farmers' evaluation in both villages are presented in table 4a.

Discussion

Farmers' selection criteria and influence on variety preference

Farmers of both villages prefer varieties with respect to their ability to produce a high number of productive tillers per hill, bigger panicle size, grain filling, grain size, seed coat colour, eating qualities, aroma, and time to maturity. Number of tillers per hill, size of panicles, grain size and grain filling were considered important attributes because they affect overall grain weight thus contributing to the final crop yield (13). Farmers in Kinyope preferred tall varieties because they have high stover yield, which they use for thatching houses. On the other hand, farmers in Kitere preferred short to medium plant height varieties because they show resistance to lodging. Soils in Kitere are generally more fertile and farmers use fertilisers.

Farmers of both villages also preferred varieties with long and slender grains and high milling quality. Further, there was preference to early and medium maturing varieties (100 - 130 days). These varieties if transplanted early January mature from end of April when there is rice shortage for both rural and urban dwellers thus commanding a better market price. For example during 2000 wet season, farmers in Kitere sold a bag of 80 kg un-milled rice up to TSH 24 000 (approximately USD 30) from end of April to the third week of May, falling by 50% thereafter. Apart from long translucent

Table 3

Characteristics of most preferred milled rice varieties in 1999/2000 and 2000/2001 seasons

Appreciated characteristics	Variety/Line selected	Rank
1999/2000 Season		
a. Kinyope		
Translucent, strong aromatic, long and slender grains	TXD-220	1
Less translucent, strong aromatic, long and slender grains	Kihogo Red Sel. No 7	2
Translucent, strong aromatic, long and medium slender grains	Rangimbili	3
Translucent, strong aromatic, long and medium slender grains	Supa Utafiti	3
b. Kitere		
Translucent, strong aromatic, long and slender grains	Supa Kitere	1
Translucent, aromatic, long and slender grains	TXD-220	2
Translucent, aromatic, long and medium slender grains	Agulha	3
Translucent, aromatic, long and medium slender grains	Tunduru	3
Translucent, aromatic, long and medium slender grains	TXD-306	3
2000/2001 Season		
a. Kinyope		
Translucent, strong aromatic, long and slender grains; no broken grains	TXD-220	1
Less translucent, strong aromatic, long and slender grains; no broken grains	Supa Utafiti	2
Translucent, strong aromatic, long and medium slender grains; and few broken grains	Rangimbili	3
Translucent, strong aromatic, long and medium slender grains; few broken grains	Kihogo Red Sel. No 7	3
b. Kitere		
Translucent, strong aromatic, long and slender grains, and easy to mill	TXD-306	1
Translucent, aromatic, long and slender grains and easy to mill	TXD-220	2
Translucent, aromatic, long but medium slender grains; and relatively hard to mill	Supa Utafiti	3
Translucent, aromatic, long but medium slender and relatively hard to mill	Tunduru	3
Grain colour cream/milky, aromatic, long but less bold grains and relatively hard to mill	Agulha	3

Table 4

Ranking of most liked cooked rice varieties

1999/2000 season		2000/01 season	
a. Kinyope			
TXD 220	1	TXD-306	1
Supa Utafiti	2	Supa Utafiti	2
Subarimati	3	Rangimbili	3
Kihogo Red Selection N°. 7	4	Kihogo Red Selection N°. 7	4
Rangimbili	5	TXD-88	5
TXD 306	6	Supa Kinyope	6
Supa Kinyope	7	TXD-220	7
TXD 88	8	Subarimati	8
Chi-square= 11.6; df= 9; P= 0.11			
b. Kitere			
Supa Kitere	1	Kihogo Red Selection N°. 7	1
Supa Utafiti	2	Supa Kitere	2
Tunduru	3	Rangimbili	3
Subarimati	4	Tunduru	4
TXD 306	5	TXD-306	5
TXD 88	6	TXD-85	6
TXD 220	7	TXD-220	7
Kihogo Red Selection N°. 7	8	Supa Utafiti	8
Rangimbili	9	Subarimati	9
TXD 85	10	TXD-88	10
Chi-square= 16.44; df= 9; P= 0.058			

Table 5

Statistical analysis of improved materials (%) better, the same or worse than the local variety as perceived by farmers

Selection criteria	% Improved materials				Significance between categories
	Better	Same	Worse	SD	
a. Kinyope					
Many tillers	61.6	19.3	19.2	20.6	ns
Long panicles	27.0	30.8	42.4	7.4	ns
Plant height	7.7	30.8	61.6	15.9	***
Uniform maturity	46.2	0.0	53.8	23.3	***
Early maturity	69.2	0.0	30.8	25.3	***
Slender grains	23.1	30.7	46.2	19.3	ns
Long grains	23.1	26.9	50.0	19.3	ns
Light brown husks	57.7	11.5	30.8	14.6	*
Well filled grains	45.9	19.2	34.6	10.6	ns
Aroma	7.7	15.4	77.0	21.8	***
Milling recovery	15.3	69.4	15.3	17.2	***
b. Kitere					
Many tillers	70.0	30.0	0.0	25.6	**
Long panicles	33.2	30.0	36.7	5.3	ns
Slender grains	23.3	33.3	43.4	11.3	ns
Long grains	13.3	26.6	60.1	13.9	*
Early maturity	53.1	40.0	6.7	18.5	ns
Light brown husks	20.0	46.6	33.4	9.8	ns
Well filled grains	46.7	20.0	33.3	10.0	ns
Aroma	13.3	33.3	53.4	11.4	***
Milling recovery	10.0	43.3	46.7	12.6	*

significant at 5%, ** significant at 1% and *** significant at 0.1%

and aromatic grains for which their popularity stands, farmers' varieties lack most of the preferred attributes such as early maturity and many tillers. This implies that improved varieties with qualities comparable or slightly lower than farmers' varieties have a higher chance for adoption.

During 1999/2000 season, farmers in Kinyope selected Line TXD-220 as overall the best mainly because of earliness and uniform maturity. Also, it resembles the farmers' variety in plant architecture and grain qualities. Farmers in Kitere selected variety TXD-88, Lines TXD-220 and TXD-306 as overall the best due to their higher tillering ability, bigger panicle size; well filled long and slender grains, aromatic and good grain quality. In 2000/2001 season, farmers in Kinyope on the other hand selected Line TXD-220 and variety Supa Utafiti as overall the best performers. They argued that it would be extremely difficult to get a variety with all desirable attributes but should rate highly in some and rank moderately in others. Line TXD-220 was among the highly rated at maturity stage. It featured well in evaluation of un-milled grains and moderately as milled and cooked rice. Farmers in Kitere selected Line TXD-306 followed by Line TXD-220 as the best. Line TXD-306 has similar but sometimes (according to some farmers) better eating qualities than the local variety. It produces more tillers per hill unlike the local variety. On the other hand, Line TXD-220 has the best milling and grain qualities.

Farmers' evaluation criteria and how they differ from scientists'

Farmers in Kinyope and Kitere involved many criteria including such ones as plant architecture, grain preferences, cooking characteristics and taste. Most of these entail qualitative data, which are subjective or difficult to measure. However, in this study an attempt was made to address farmers' preferences in a scientific way. Combining farmers' and researchers' evaluations is a powerful tool for crosschecking assumptions and coming to a more accurate assessment of a technology's usefulness and adoptability (12).

Farmers in Kinyope, preferred materials that resemble their local varieties in grain and eating qualities and plant architecture. Farmers in Kitere selected varieties with anticipated market preferences such as aroma and grain quality, and with early to medium maturity durations to minimise the risk of crop failure. By involving farmers in the evaluation, socio-economic aspects such as market preferences are implicitly covered. The overall evaluation involves weighing up the nature and size of the effects of a new technology in order to assess whether the technology is, on balance, worthwhile (12). Scientists' evaluations on the other hand, seek to provide hard quantitative data on a limited set of criteria, such as yield and yield components. In Kitere, variety Dakawa that has been growing there for a number of

years was given low preference despite its high yield performance. Line TXD-299 although had the highest average grain yield, was among the varieties farmers gave the lowest rating due to very poor grain and eating qualities.

There are many examples of farmers giving higher priority to other characteristics when evaluating or choosing to adopt new varieties (1, 2, 5, 8, 10).

Conclusions

Results from these evaluations have showed that farmers in Kitere and Kinyope were eager to adopt new improved varieties; but they preferred those with long and slender grain size, strong aroma and good milling qualities. However, the varieties were more accepted if in addition they had a short to medium maturity period, high tillering ability and uniform maturity. The implication for future work is that additional emphasis should be given to incorporate farmers' selection criteria in the breeding programme next to traditional criteria such as yield and disease resistance. The findings further underscored the importance of farmers' participation in variety development. It provided the necessary information to breeders and agronomists in their search for preferred traits. Farmers on the other hand were able to learn things they had not known before such as photosensitivity of some varieties. Also through this study, ways to identify and quantify evaluation criteria and getting to grips with farmers' criteria were unveiled.

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