FARMER'S SELECTION OF LOCAL AND IMPROVED PEARL MILLET VARIETIES IN OVAMBOLAND, NORTHERN NAMIBIA

Daisuke UNO
Graduate School of Asian and African Area Studies, Kyoto University

ABSTRACT A new and improved cultivar of pearl millet (*Pennisetum glaucum*), Okashana-1, was released in Namibia in 1990 and was rapidly adopted in Ovamboland. However, as most farmers do not buy new seeds each year, any genetic trials of the cultivar on actual farms would be affected by cross-pollination. The present study clarified the characteristics of Okashana-1, as found on actual farms. In addition, this research also examined the interrelationships between the environmental status, traditions, livelihood, and subsistence activities in the study area and the cultivar characteristics.

Key Words: Okashana-1; Pearl millet; Namibia; Ovamboland.

INTRODUCTION

In semi-arid areas, crop plant breeding programs and various other trials are undertaken to develop cultivars that can withstand the harsh environmental conditions and produce a reliable harvest. Most trials, however, ignore the important differences between actual farms and pilot farms, e.g., plants are watered regularly on pilot farms, while on actual farms watering is weather-dependent. There are also many differences among farmers; wealthier farmers can afford chemical fertilizer, but others cannot. Research-led plant breeding at agricultural research stations often ignored such real conditions of farmers, and participatory breeding is strongly recommended (Monyo *et al.*, 2000). The present study focuses on a pearl millet program in Namibia as one of the successful example of crop breeding and extension.

A program introducing new varieties of pearl millet in Namibia started late 1980s, with the assistance of the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) at Hydrabad, India (Rohrbach *et al.* 1999). Local farmers were involved from the early stage of the program in selecting favorable varieties brought from India.

Early maturity and bold-seeded varieties were preferred, and they were mixed as a composite that was later called Okashana-1. It was introduced in the 1990 –1991 crop season in Namibia, and was rapidly adopted by farmers to the extent that it covered estimated 49% of the country's pearl millet field (Rohrbach *et al.* 1999).

It is important to note, however, that most farmers did not buy new seeds each year (personal observation). Rather, seeds were collected from former harvests because of the shortage of money or farmer's traditional way of thinking that they won't spend money for subsistence farming. Unlike a cross-

pollinated F1 hybrid, Okashana-1 is an open-pollinated variety whose germplasm is maintained as composite. As pearl millet is primarily open-pollinated, the genetic characteristics of the crop may change in each generation, if cross-pollination with local varieties is not carefully avoided. As a matter of fact, many farmers were not strictly cultivating genuine Okashana-1, but validating their own varieties through selecting desired characteristics for the next generation. This paper tried to find out the fate of an introduced Okashana-1 in farmer's field, and the multi-purpose use of pearl millet in the livelihood of the Owambo people was discussed.

STUDY AREA

The research was conducted from December 2002 to May 2003 in Onkani, a village located in Northern Central Namibia, commonly referred to as Ovamboland (Fig. 1). The village, situated approximately 80 km southwest of Oshakati, included 58 families and had a population of approximately 670 in December 2002. Most of the population belonged to the Kwambi ethnic group. Until the first settlement was built in 1968, the area had been used as cattle pastureland and was generally known as a cattle post (Shilunga, 1997). The mopane bush (*Colophospermum mopane*) grows throughout the village and is primarily limited to 1.0–1.5 m in height because of felling. The ground surface is sandy and therefore considered barren and unsuitable for crop cultivation. Annual precipitation from 1997 to 2003 ranged from 200 mm to 400 mm. The dry season lasts from May to October, and the rainy season extends from November to April. The dominant livelihood in the village is agriculture and most families have fields and cultivate pearl millet, locally known as *mahangu*. In addition, most families also have livestock, such as cattle and goats. Pearl millet porridge (*oshifima*) is a staple food and pearl millet beer (*ontaku*) is a common drink. The villagers' incomes consist of pensions or remittances from family members who work in town.

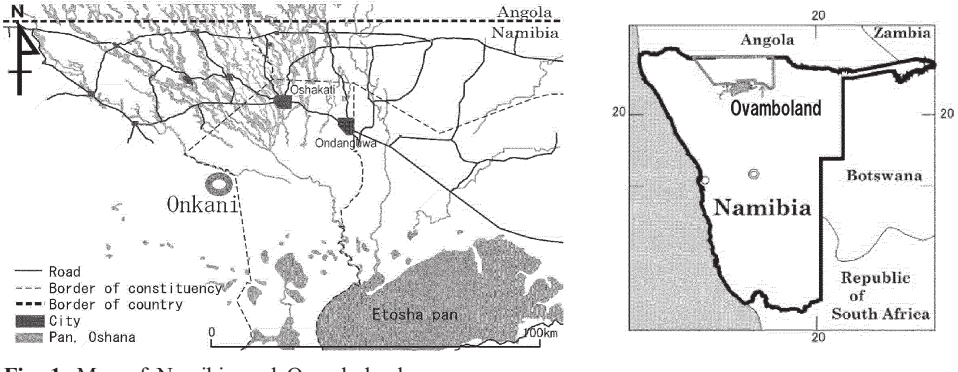

Fig. 1. Map of Namibia and Ovamboland.

FARMING

Most of the villagers have large fields, occupying over 4 ha on average, and over 90% of these fields are planted with pearl millet. Pearl millet is preferred over other cereals, because it is relatively drought resistant, tolerant of high temperatures, and can grow in sandy soils. There are many undulated hills of sand in the area and the upper parts of the hill slopes are used as pearl millet fields (Fig. 2), because the cereal is sensitive to flooding and the lower parts of the hill slopes are often flooded by heavy rains. All of the crops cultivated in the village are indicated in Table 1.

Plowing is generally started at the end of November, and sowing begins after the first heavy rainfall, and continues for several months. Weeding, the most labor-intensive aspect of the process, begins 2–3 weeks after sowing. Harvesting takes place between April and June. Threshing of the dried ears follows about one month after harvesting and the farmers store the harvests in large, traditional, granary baskets.

THE USE OF OKASHANA-1

Release of Okashana-1

Pearl millet is a food staple in Namibia, as it is the only cereal adapted to the low rainfall and high temperatures characteristic of most of the country.

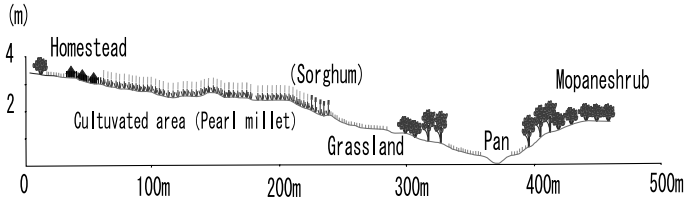

Fig. 2. Transect of cultivated area and pan in the study area.

Table 1. The variety of crops in the cultivated area.

English name	Scientific name	dialect name
pearl millet	*Pennisetum glaucum*	*mahangu*
sorghum	*Sorghum bicolor*	*oshijawara*
maize	*Zea mays*	*omapungu*
cowpea	*Vigna unguiculata*	*omakunde*
bambara nut	*Voandzeia subterranea*	*efukwa*
ground nut	*Arachis hypogaea*	*efungwa*
watermelon	*Citrullus lanatus*	*etanga*
calabash	*Lagenaria siceraria*	*omupanba*
pumpkin	*Cucurbita moschata*	*oshihenda*

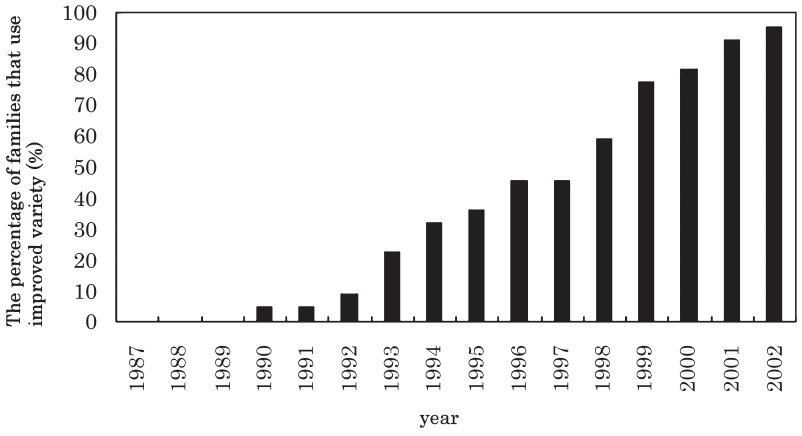

Fig. 3. The popularity of improved varieties of pearl millet in the study area (N=22).

However, because of shortages in the pearl millet harvest, the country depends heavily on cereal grain imports. Maize, wheat, and rice are commonly imported, particularly from South Africa. Improvements in pearl millet productivity are essential for both national and household food security. Namibia's pearl millet program provided farmers with the new cultivar, Okashana-1, developed by ICRISAT. Okashana-1 was released in 1990 and was notable for its early maturity and high grain yield (Monyo, 2002). Okashana-1 matures in 75–90 days, while the local varieties take an average of 120 days. According to Rohrbach *et al.* (1999), Okashana-1 provided Namibia with an estimated 21,000 tons of additional pearl millet grain during the average harvest. By the 1996–1997 cropping season, Okashana-1 was sown on an estimated 49% of the country's pearl millet area. Also, two additional pearl millet varieties, Kangara and Okashana-2, with characteristics similar to Okashana-1, were released in April 1998. These improved varieties were accepted by many farmers in Onkani. Fig. 3 indicates that the number of farmers who introduced new varieties increased steadily and that, eventually, all but one of the 22 families had introduced new varieties by 2002. Farmers bought new seeds every 3–4 years, and otherwise gathered seeds from former harvests. While, pearl millet is primarily open-pollinated, the farmers have tried to preserve desired types.

Characteristics of Improved and Local Varieties on Practicing Farms

As mentioned above, the "improved varieties" may change on practicing farms, and these varieties should be distinguished from the "original improved varieties". In this section, the characteristics of the improved and local varieties on practicing farms are described. The effects of improved varieties on the interrelationship between the farmers and crops are also examined.

Twenty-seven plots (5 × 5 m each) were established at numerous pearl millet farms of varying fertility and with varying densities of other plants. Plant height, number of ears, above-ground biomass and the yield after threshing

were measured. The harvest biomass was dried for about half a month after harvest and then weighed to calculate the efficiency of seed production. Fig. 4 shows the difference in the efficiency of seed production between local and improved varieties. It is clear from the figure that improved varieties, as a whole, are more efficient than local varieties in producing seeds whether they were fertilized or not. Considering the gradual change of seed production efficiency from improved to local varieties, the cross-pollination between the two varieties might have taken place in some extent. But it can be concluded that beneficial characteristics of improved varieties are preserved in farmers field. Perhaps this is because the practice of sowing was done by separating these two varieties. The local varieties were characterized by their above average height and biomass (Table 2). On the other hand, the improved varieties were characteristically shorter, produced less biomass, and had higher seed production efficiencies than local varieties. The short characteristic coincided with early maturation. No significant differences were found in the number of ears or the amount of yield. These findings differ from those of ICRISAT, who defined the original improved variety as an early maturing crop with high grain yields. In practice, while the characteristic of early maturity was seen in the improved varieties, superiority of yield was not. Presumably, these practical characteristics are related to the wide spread of Okashana-1.

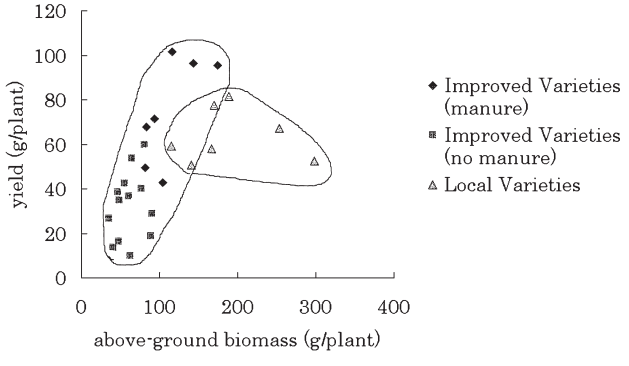

Fig. 4. The relationship between above-ground biomass and yield.

Table 2. Characteristics of local varieties and improved varieties from actual farms. The data presented are mean values (local variety, 7 plots; improved varieties, 20 plots).

	Plant height (cm)	Biomass (g/m^2)	Efficiency of seed production (yields/biomass)	Number of ear	Yields (g/m^2)
Local varieties	174	177	0.24	3.57	61.7
Improved varieties	151	90	0.33	3.67	51.8
	**	**	*	ns	ns

*, **, Significant at 5% and 1% levels of probability respectively.

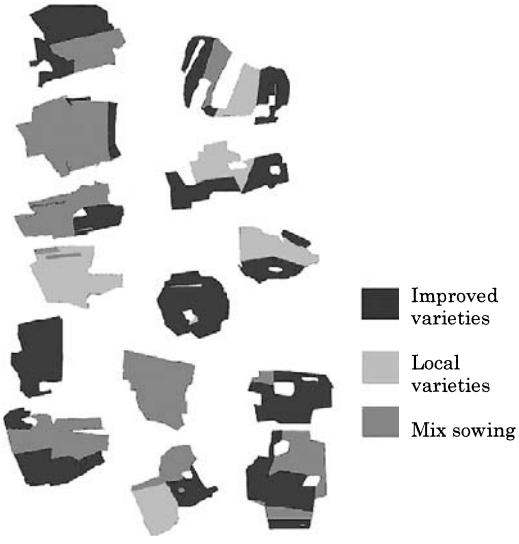

Fig. 5. The distribution of improved varieties, local varieties, and mixes on 14 farms.

Distribution of Improved Seeds in the Study Area

Twelve out of fourteen families were observed to use both the improved and the local pearl millet varieties. Furthermore, many families tended to sow these two varieties separately to prevent the cross-pollination (Fig. 5). But another opinion says that they are just doing their own "experiment" to find the difference between the two varieties. Their ordinal way of thinking is to sow them mixed which is also found extensively in the Fig. 5 either to breed a new variety or simply ignore the cross-pollination. Some farmers say that they don't mind cross-pollination because if the seed qualities became worse, they can buy new seeds then.

Reasons for Using Two Varieties Together

When asked their reasons for using both varieties of millet, farmers generally explained: "... we can harvest the improved variety if a particular year does not have enough rain. On the other hand, we can get more yield by the local variety when it rains enough ...", "... the improved variety is good because it matures early ...", and "... the local variety is good as building material ..." As stated above, most farmers saw the merits of both varieties.

Relationship between Rainfall Patterns and Adaptation of Varieties

When asked which year produced the best harvest, many of the 21 families queried answered 2000 or 2001 (Fig. 6). The 1999–2000 and 2000–2001 rainy seasons had had the highest rainfall for six years (Fig. 7). The 2000–2001 rainy

season was about two months shorter than that of 1999–2000 (Fig. 8). The local varieties required approximately four months from sowing to harvest, while the improved varieties needed only three months. Considering these differences, and that it takes at least one month to sow an entire field, the 2000–2001 rainy season was too short for growing the local varieties.

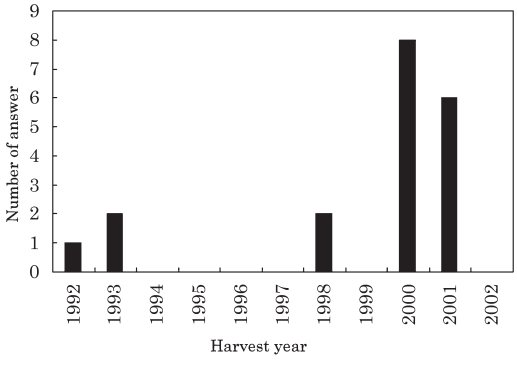

Fig. 6. The best harvest years.

To support the above result, I researched the percentage of the whole pearl millet area sown with the local varieties (Fig. 9). The families who had considered 1999–2000 as the best harvest year had largely planted local varieties. On the other hand, the families who had identified 2000–2001 as the best harvest had largely planted improved varieties. This observation further suggests that the rainfall pattern of the 2001 harvest year

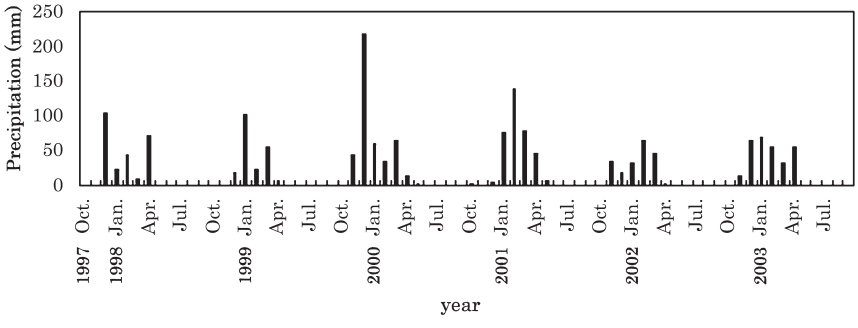

Fig. 7. Precipitation in Onkani village (1997–2003).

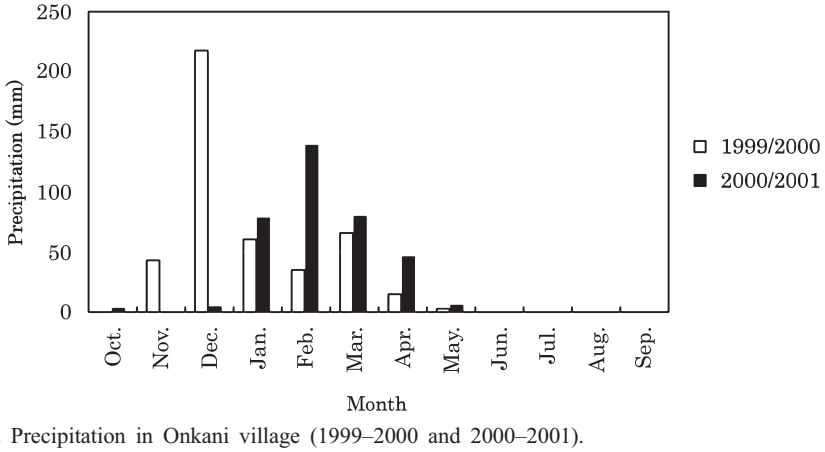

Fig. 8. Precipitation in Onkani village (1999–2000 and 2000–2001).

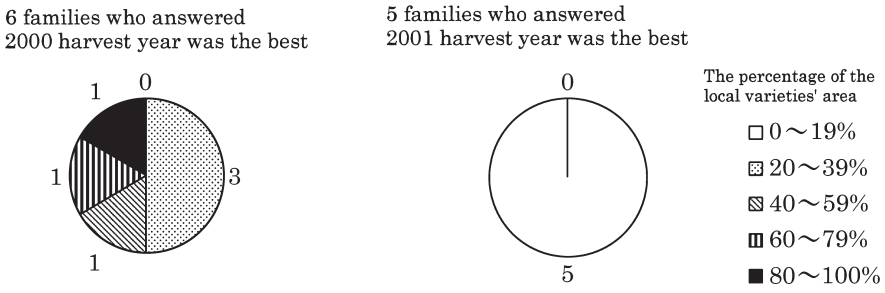

Fig. 9. The percentage of area cultivated with the local varieties, in whole fields of pearl millet, for six families who considered 2000 as the best harvest year (left) and for five families who considered 2001 as the best harvest year (right). The numerals indicate the number of families.

was more suitable for growing the improved varieties, and that the rainfall pattern of the 2000 harvest year was more suitable for the local varieties. As Fig. 7 shows, the pattern of rainfall changes very much from year to year, making it difficult for farmers to predict which variety will produce the greater yield. Therefore, many farmers find it important to use two varieties.

The difference between these two varieties with respect to the time of sowing should not be overlooked. Farmers in the study area tended to start sowing the improved varieties after they had finished sowing the local varieties. If farmers were to sow the improved variety, which matures early, at the beginning of the rainy season, they would be able to harvest by the end of the rainy season. In the study area, the ears of pearl millet are dried in the sun for about one month. Rain in this period would be problematic, as the moisture would trigger germination. Thus, farmers lacking roofed drying areas need to sow the improved varieties later, and effective use of the limited rainy season requires the sowing of both varieties.

The Value of Pearl Millet Stalks as Building Materials

The homesteads in the region include wonderfully designed wooden structures (Fig. 10). People use, primarily, mopane and the stalks of pearl millet for constructing the palisade fences that surround the homesteads and subdivide them into important areas, such as places to entertain visitors, sleep, cook, store grain, and a place to stamp grain. Approximately 4,000 poles would be used in a typical household (Marsh, 1994). The palisade fences must be taller than a person. The original function of the elaborate homestead fortification was to protect the inhabitants from both enemies and dangerous wild animals (Erkkila, 2001). Older residents reported that there used to be many big trees in the area in the past, but that they had been cut down for the construction of homesteads. The mopane bush, useless for palisade construction, covers most of the study area now, and therefore the stalks of pearl millet have become important substitutes for wood. The stalks of pearl millet are easy to carry and are in adequate supply, but need to be long to be suitable for the palisades. The local

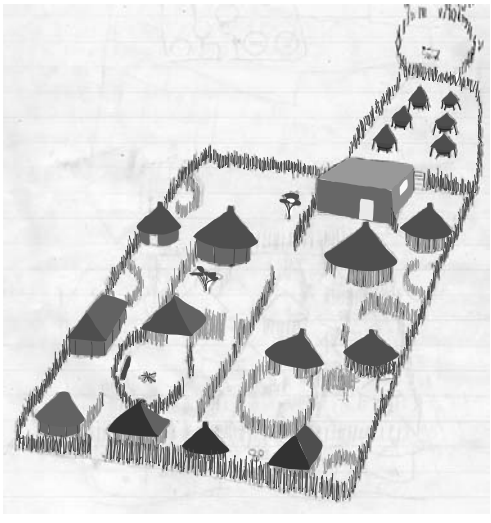

Fig. 10. A typical homestead structure in the study area.

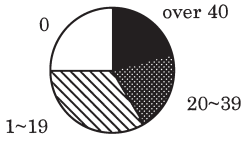

Fig. 11. The number of cattle owned by each family (N=24).

varieties are therefore preferred for building materials, as they grow tall. On the other hand, the stalks of the improved varieties are short and weak.

The Value of Pearl Millet Leaves and Stalks as Fodder

Livestock farming is also important in this area, and many families own cattle (Fig. 11). The seasonal cattle movement system is often practiced in Ovamboland (Mendelsohn & Roberts, 2000). There are four major movements each year in the study area. The first is in the rainy season, usually in February, when cattle are brought to densely populated areas where families live permanently. The cattle then feed on new pastures that have grown during the rainy season. In March, they are taken back to the cattle posts, located about 50 km from the village. The third movement occurs in June, after the pearl millet harvest. Cattle are then fed on the pearl millet stubble. Finally, they are taken back to the cattle posts. Goats are kept at home permanently. When cattle eat the stubble of pearl millet, they drop dung, an important fertilizer for the sandy, nutrient poor soil, especially given that most farmers cannot afford to buy chemical fertilizer. The larger biomass of the local pearl millet varieties was a significant source of fodder for the cattle. One family sowed about 2 ha with the local variety in the middle of February, too late to expect a successful harvest. It is conceivable that they sowed this variety at that time intentionally, not for grain production, but to provide fodder for their roughly 50 cattle. Fig. 12 displays the relationship between the number of cattle and the area of pearl millet fields for each of six families. No correlation

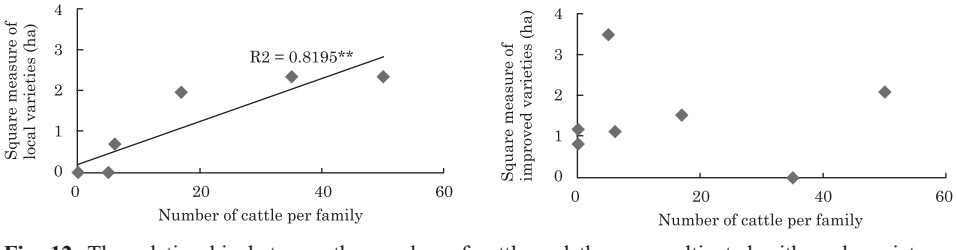

Fig. 12. The relationship between the number of cattle and the area cultivated with each variety.

was seen with the improved varieties, but the area cultivated with local varieties correlated closely with the number of cattle.

CONCLUSION

Comparison of growth characteristics of improved and traditional varieties of pearl millet in the farmers' fields revealed that despite continuous use of seeds from previous harvest, the characteristics attributed to improved varieties were preserved in the field, although cross-pollination with traditional varieties took place in some extent. This was ascribed to the fact that farmers grow the two varieties separately in the field. The improved varieties were short and were efficient seed producers. On the other hand, the local varieties were tall with greater biomass. Plant height was related to maturity period; improved varieties matured earlier than local varieties. Longer growing period of the local varieties increased the unreliability of the harvest because the pattern of rainfall was unpredictable, and the length of the rainy season was sometimes too short for the crop to mature. The improved varieties could compensate for the weak points of local varieties, and farmers accepted them easily and widely. On the other hand, the characteristics of the local varieties, i.e., the possibility of high yields, late maturity, long and strong stalks, and greater biomass, were also important to the traditional homestead and multi-subsistence strategies. In short, the rapid adoption of a new cultivar did not trigger the abandonment of the old cultivar in this study area. Farmers, taking into consideration the particular requirements of the climate and their lifestyle, largely selected to use both cultivars.

ACKNOWLEDGEMENTS This study was financially supported in part by a Grant-in-Aid for Scientific Research (Project No. 13371013 headed by Dr. Kazuharu Mizuno, Kyoto University) from the Ministry of Education, Science, Sports, Culture, and Technology of the Japanese Government.

REFERENCES

Erkkila, A. 2001. *Living on the Land: Change in Forest Cover in North-central Namibia 1943–1996. Silva Carelica, 37*. University of Joensuu. Joensuu.

Marsh, A. 1994. *Trees: Threatened Lifeline of Northern Namibia*. Gamsberg Macmillian Publishers, Windhoek.

Mendelsohn, J.S.O. & C. Roberts 2000. *A Profile of North-central Namibia*. Gamsberg Macmillian Publishers, Windhoek.

Monyo, E.S., S.C. Gupta, F. Muuka, S.A. Ipinge, H. Chambo, L. Mpofu, E. Chintu, M. Mogorosi & J. Mutaliano 2002. *Pearl Millet Cultivars Released in the SADC Region*. SADC/ICRISAT, Bulawayo.

Monyo, E.S., S.A. Ipinge, G.M. Heinrich & E. Chinhema 2000. Participatory Breeding: Does it make a difference? Lessons from Namibian Pearl Millet Farmers, In (Lilja, N., J.A.

Ashby & L. Sperling, *eds*.). *Assesing the impact of participatory research and gender analysis*. International Center for Tropical Agriculture, Cali.
Rohrbach, D.D., W.R. Lechner, S.A. Ipinge & E.S. Monyo 1999. *Impact from Investment in Crop Breeding: the Case of Okashana 1 in Namibia*. ICRISAT, Andhra Pradesh.
Shilunga, B. 1997. *Participatory Survey on Wood Consumption in Areas of Oshana and Ohangwena Regions: Onkani, Eenhana*. Teachers Resource Centre, Oshakati.

Accepted *January 22, 2005*

Author's Name and Address: Daisuke UNO, *6-2-15-403, Nishinakajima, Yodogawaku, Osaka, JAPAN*
E-mail: uno_daisuke513@yahoo.co.jp