**IMPACT OF PEARL MILLET RESEARCH AND DEVELOPMENT IN NAMIBIA – THE CASE OF OKASHANA 1**

**P. Anandajayasekeram, D.R. Martella, J. Sanders and B. Kupfuma**

**ABSTRACT**

*Pearl Millet is the most widely grown and utilized cereal in the northern Namibia especially in Ovambo and Kavango regions. A millet variety was identified in the late 1980s from the Sorghum and Millet Improvement Programme (SMIP) nursery in 1986 and officially released in 1990, under the name Okashama 1. This pearl millet variety is short maturing (85-90 days), and is responsive to moisture and inorganic fertilizer.An impact assessment study was undertaken to calculate the rate of return on investment for this technological intervention. The estimated ROR for the R&D investment (development, dissemination and adoption) for Okashana 1 was 13.28 percent, the estimated ROR was 4.25 percent when the cost of investment was increased by 10 percent indicating that the ROR is very sensitive to the R&D costs. The study also revealed Okashana 1 yielded the largest benefits during the dry seasons of 1994 and 1998. During normal rainfall seasons, the net benefits generated by the introduction of Okashana 1 are not likely to replace the current farmer practice of using mixed varieties, a strategy often followed to avoid risk.*

**INTRODUCTION**

The principal cereal consumed in Namibia is maize followed closely by millet. Crop production is concentrated in the far north and the main cereal there is pearl millet. About 54 percent of the population is located in this northern strip along the border with Angola, where the rainfall is higher than in the rest of the country. In a normal rainfall year, 1992/93, millet provided 92 percent of the cereals produced in Ovambo and 84 percent in Kavango. This region is predominantly a millet production zone with some of other crops and small animals (Keyler, 1994, 37).

A millet variety was identified in the late 1980s from a SMIP nursery and released in 1990 through the efforts of the Namibian NARS. The benefits from the introduction of this new cultivar and inorganic fertilizers are estimated. The rate of return for the combined research and extension efforts is then estimated. Finally, some constraints on the diffusion of new millet cultivars and inorganic fertilizer are identified.

**Cereal Production and Consumption**

In the drought year of 1991/92, when both maize and millet production collapsed in northern Namibia, there was a substantial increase in maize imports. In most of 1992/93, maize meal was cheaper than the millet meal; hence it is not surprising that maize was the main cereal consumed. However, rural consumers express a preference for pearl millet ("mahango"). In fact, only 3 percent prefer maize in the two predominant agricultural regions of the country, (Keyler 1994). Northern Namibians prefer millet meal, when it is available. The predominant region for Pearl Millet production is the Ovambo region in northern Namibia. In Ovambo, land is becoming increasingly scarce. Hence, shifting cultivation is no longer possible for many farmers. For additional fields farmers have to walk an increasing distances. (Keyler, 1994) The farmer response to increasing scarcity of land is to improve land quality through both organic and inorganic fertilizer.There is substantial variability in fertilizer use between regions resulting from differences in soil fertility, length of settlement, and the availability of different types of fertilizers.

Predominantly manure has been introduced into the system with only 9 percent of the farmers in the Ovambo region and 3 percent in the greater Kavango region utilizing inorganic fertilizers. But, organic fertilizer can not substitute for inorganic fertilizer unless very large quantities are utilized, i.e., 3 to 5 metric tons per hectare (Sanders et.al 1996) Farmers in northern Namibia do not have sufficient animals to provide these quantities of manure. Therefore, increasing utilization of inorganic fertilizers will be a necessary addition to these crop systems in order to substitute for the increasingly scarce land. Then the organic fertilizers can complement the inorganic fertilizers and improve the water retention capacity and the structure and texture of the soil.

**Introduction of Okashana 1**

In 1986 the Rossing Foundation, a NGO in Namibia, imported a regional millet variety nursery from SMIP. The farmers were asked to identify the cultivar that they liked. They selected a widely introduced cultivar in India, ICTP 8203. After further testing, this cultivar was pre-released in the 1988/89 season. Then in 1990 Okashana 1 was officially released. By this time it had been substituted for with ICMV 88908 by SMIP, a cultivar with the same characteristics as ICTP 8203 but with higher yields in field testing. The characteristics of both varieties are earliness (short season), high yielding ability, large round seeds, and resistance to downy mildew. Okashana 1 takes 85 to 90 days to maturity as compared to with 120 days for local varieties.

**Diffusion of Okashana 1**

In the 1989/90, 10.5 metric tons of Okashana 1 seed were produced by SMIP and made available to Namibian farmers for the 1990/91 crop year. Assuming that the seed was planted at a seed rate of 2 kilograms/hectare, there were then 5,250 hectares planted to Okashana 1 in the first year of release.

Unfortunately, after the initial year, seed sales are not very useful for estimating diffusion because farmers begin utilizing their Okashana 1 for seed. However, there was a major drought in 1991/92. Assuming farmers either lost their millet or had to eat all that was left of their Okashana 1, an estimate of diffusion from seed sales can be made for this year. Again, with 90 percent utilization and 2 kilograms per hectare seed rate, 14,400 hectare could be planted in the region. These two point estimates of diffusion from seed sales are complemented with survey estimates.

The data used in the diffusion estimates were obtained from several sources. Seed sale data and area statistics came from the Ministry of Agriculture, Windhoek, Namibia, and the rest of the information came from two field surveys conducted during 1992/93 (Keyler, 1994) and 1994/95 (SMIP, 1995) crop year. The Keyler survey included 200 households from Ovambo and 120 from Kavango and was conducted in the 1992/93 crop year. The SMIP survey was undertaken in the 1994/95 crop year and utilized recall data for the earlier years to obtain the area estimates over time for Okashana. The column called "estimate" was from subjective judgments based upon the data from the various sources and field interviews. The future estimates for the next five years were deliberately conservative and included little further increase from the diffusion levels already attained in 1994/95.

The reported diffusion is more rapid in Kavango reaching 45 percent of the millet area in 1994/95 as compared with only 17 percent in the Ovambo region. Since the Ovambo region has less rainfall and Okashana 1 is an early maturing cultivar, this is a surprising result but both surveys report similar results. One explanation is that 1992/93 was also a poor rainfall year for the Kavango but a normal year for the Ovambo region. Hence, the increase in the demand for a short maturing cultivar would have been greater in Kavango than in Ovambo in 1994/95. Another potential explanation could be the differences in soil fertility.

In these higher rainfall conditions of Kavango, Okashana 1 needs to be planted later in the season. According to the SMIP survey, 65 percent of the farmers in both regions planted Okashana 1 later. Having a combination of cultivars or a portfolio mix then reduces the farmers' risk, especially that due to rainfall variability. Farmers also indicated that they will never replace the landraces completely with Okashana 1.

**Yields of Okashana 1 and Local Cultivars**

Yield data from trials in northern Namibia varies significantly with the region, seasonal rainfall, soil fertility, planting time and the incidence of bird problems. The 1992/93 crop season was a normal rainfall year. In the Ovambo region there was a strong response to Okashana 1 in two of the three trials. Moreover, there was an excellent response to inorganic fertilizer for both local cultivars and Okashana 1. On these Kalahari sands, the principal constraint on increasing cereal yields is low soil fertility. In 1993/94, the rains stopped early in the Ovambo region and there was a varietal response to Okashana 1 alone and an even larger effect when Okashana 1 was combined with inorganic fertilizer. In West Kavango there was a positive varietal effect for Okashana 1. In contrast in the Eastern Ovambo and East Kavango regions the local landraces performed better and where there was a good response to fertilizer. The poor response of Okashana 1 may be due to early planting in the higher rainfall zone. This later planting requirement is now well known by farmers and SMIP survey data show that almost two-thirds of the farmers planting Okashana 1 also plant it late.

All the yield trials that could be found on Namibia millet production were examined. There were many experiments lost due to birds or other factors. Moreover, the data reported were not very consistent. Nevertheless, a rapid diffusion process is reported for Okashana 1 especially in the Kavango region and to a lesser extent for Ovambo. Especially, if it is planted late in the higher rainfall region of Kavango, appears to be favorable.

The international price of millet (approximate mean value for 1992 and 1993) of $100 per metric ton and a freight, handling, and transportation charge of $30 per metric ton were used in this study. Given the fact that maize is usually imported to off-set shortfalls in millet production, the international reference price might alternatively be the maize price. Since the international prices for millet and maize are in the same range, this will not affect the analysis. Inorganic fertilizer is already being used in the region. The impact assessment team assumed that fertilizer use would gradually increase. The gross benefits to the above diffusion rates of Okashana 1 in the two regions with the increasing fertilization rate are presented in the same table. The Akino-Hayami pivotal supply shift was utilized for estimating the economic surplus.

In the two dry years after the introduction of Okashana 1, substantial benefits to the introduction of the early cultivar and fertilization were realized. In these two years the benefits were 341 thousand and 320 thousand US dollars (1993). The key to diffusion will be the availability of seed and inorganic fertilizer. With the frequency of dry years increasing adoption of Okashana 1 and other similar but higher yielding varieties is going to increase.

The costs of technology development and transfer are made up of adoption costs, research costs and transfer costs. Adoption costs for Okashana 1 are comprised of seed and fertilizer costs. The Zimbabwe prices of seed and fertilizer are used to estimate the adoption costs for Okashana 1 because the price data for Namibia was not available at the time when this analysis was done. The only data on research and transfer costs available were not in the form that allows the determination of the actual costs of the introduction of a specific variety such as Okashana 1. As a result, the costs of developing and transferring Okashana 1 had to be estimated.

To facilitate this estimation, several assumptions were made:

* The national agricultural research budget for 1990/91 and 1991/92 was obtained from ISNAR report. The budgets for the years before 1990/91 and after 1991/92 were extrapolated assuming a growth rate in the budget of 25 percent annually. This gave the annual research budgets. The data on staff establishments (total and millet research) allowed the estimation of the total expenditure per researcher that includes salaries (researcher and share of total support staff), capital costs, and operation costs.
* The time spent on millet research during the 1991/92 year was 1.3 researcher years out of a total of 21 researcher years. This study assumes that there were 1.3 researchers’ years for millet research.
* Based on the composition of the millet improvement program at Omahenene Research station during the 1993/94 season, 45 percent of the millet research budget is spent on the development and testing of non-hybrid varieties such as Okashana 1.
* Not more than a third of the non-hybrid pearl millet research budget was spent on the development and testing of Okashana 1. This was before it was released. After the release, the proportion fell to 10 percent as only maintenance research was required.
* The proportion of SMIP's material assistance to Namibia's NARS and time spent by SMIP millet scientists in Namibia that can be apportioned to the introduction of Okashana 1 is not more than 10 percent.
* The cost of cleaning, packing and distributing Okashana 1 seed during the 1992/93 emergency seed production and distribution activity is estimated at US$ 250 per metric ton.

**The Returns to the Introduction of Okashana 1**

The subtraction of the cost stream from the net benefit stream yields the incremental net benefits. These are the benefits over and above all the costs. The benefit stream is dependent on the quality of the season while the cost stream steadily increases throughout the period. Okashana 1 yielded the largest benefits during the dry seasons of 1994 and 1998 (the only years with positive incremental net benefits). This assumes that Okashana 1 is planted late and is fertilized. During normal rainfall seasons, the net benefits generated by the introduction of Okashana 1 are modest. During normal seasons the incremental net benefits are negative. This confirms the previous assertion that Okashana 1 is not likely to replace current farmer varieties, but will be a valuable source for variety mixing, a strategy often followed by farmers to avoid risk.

The incremental net benefit stream permits the calculation of the net present value (NPV) and internal rate of return (IRR) of introducing Okashana 1 in northern Namibia. If the social discount rate (real) is assumed to be below 13.28 percent then the introduction of Okashana 1 had a positive net present value. The NPVs for discount rates below 13.28 percent are all positive, and hence if the social discount rate is above 13.28 percent then investments made in Okashana 1 could have been better elsewhere. In addition the returns to Okashana 1 research and transfer would be different if we change the time period. Clearly the twelve years used in this study does not sufficiently capture the life span of Okashana 1. Although it is acknowledged that the variety is not going to replace the existing ones completely, the benefits derived from Okashana 1 will not disappear.

**Sensitivity Analysis**

The aim of this sensitivity analysis is two-fold. First is the examination of the effect of increasing research and transfer costs by 10 percent on the rate of return to account for any underestimation of research and extension costs. The second is to examine the effect of increasing the time period by six more years on the estimated rate of return.

When costs are increased by 10 percent, the rate of return falls from 13.2 percent to 4.2 percent during a 12 year period of analysis. The increase in research and extension costs would reduce the rate of return significantly, even when the period is increased. For the longer time frame, the rate of return is 20.13 percent with the estimated costs. But when the research and extension costs are increased by 10 percent, the rate of return falls to 13.89 percent.

**Lessons Learned**

Okashana 1 was rapidly adopted in the Kavango region because of two consecutive dry years of 1991/92 and 1992/93 the higher fertility of the soils and later planting. These factors are encouraging farmers to implement a more rapid diffusion process of Okashana 1 than in the drier and less fertile Ovambo region. The enabling environment to facilitate the adoption of Okashana 1 is good because the extension service is promoting I along with inorganic fertilizer. In 1994/95, credit was made available to farmers for fertilizer, seeds and other related activities in the northern Namibia. Moreover, processing of millet flour in small (one to two kilograms) packets has been undertaken by a local manufacturer.

The development of new cultivars is a continual process in order to respond to farmer requests and to the emerging biotic problems as the agricultural system evolves. Farmers' interviewed expressed several complaints about the characteristics of Okashana 1. Poor storability and short stalks are major issues raised by the farmers with respect to this variety. These issues are currently being addressed by the NARS researchers. The eventual substitution of Okashana 1 and successors to Okashana 1 with greater height and longer length of season varieties is expected to accelerate the diffusion rate of the new cultivars.

**Conclusions**

The introduction of Okashana 1 has largely been an outcome of the efforts of the Namibian NARS. The seed was obtained from SMIP in 1986, and tested by the Rossing Foundation in Namibia. Initial bulking of seed was done by the Foundation and pre-released to farmers during the 1989/90 season. SMIP helped with seed production especially after the drought year of 1991/92. The benefits generated by the introduction of Okashana 1 have proved difficult to estimate because of the lack of appropriate data. Particularly crucial was data to estimate research and transfer costs for both the NARS and SMIP. Underestimation of costs results in an upward bias in the estimation of net benefits. The results of the analysis provide a range within which the actual rate of return falls. The estimated rate of return is around 13 percent. Moreover, the return to Okashana 1 is reasonable for a difficult low income farm sector where equity objectives would probably also be very important to the government. More research is required on millet production in Namibia. **References**

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