THE MAINTENANCE OF SWEETPOTATO PLANTING MATERIALS IN NAMIBIA: OPTIONS FOR THE DEVELOPMENT OF A VINE PRODUCTION AND DISTRIBUTION SYSTEM*

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INTRODUCTION

Sweetpotato (*Ipomoea batatas* L; Convolvulaceae) is an important crop in Africa because it can withstand drought better than maize and relieves hardship caused by famines. It requires few inputs and can produce a crop within four months of establishment, with the production per unit area being among the highest of the major starch staple food crops (Karyeija *et al.*, 1998). It is therefore an attractive crop to farmers with little land and limited resources.

In the northern regions of Namibia an average annual rainfall of >400 mm allows mixed farming systems with livestock and seasonal crop production. The staple food crop is pearl millet, the only crop perceived to thrive well in the mainly sandy soils with relatively low and erratic rainfall. Due to the drought prone growing seasons, shortages of pearl millet are frequently experienced. A minority of farmers in the northern regions of Namibia currently produce sweetpotato (Namibia Agricultural Census 1994/1995). It is seen as an additional food, especially in dry years when pearl millet yields are poor. Development of sweetpotato production therefore has potential to impact significantly on food security in the northern regions of Namibia.

Sweetpotato is mainly produced under rain-fed conditions, except where water for irrigation is available. The loss of locally grown varieties during recent years of drought and a general lack of planting materials indicate the need for identification of varieties suitable to the harsh climatic conditions prevailing in northern Namibia. A system to maintain and distribute planting materials of suitable varieties needs to be established to ensure sustainable production of this crop.

The objective of this study, therefore, was to conduct research into methods to maintain a pest- and disease-free true-to-type stock of popular high-yielding sweetpotato varieties and to explore different options to establish constant availability of planting materials to producers in Namibia.

MATERIALS AND METHODS

Research into methods to maintain a pest- and disease-free true-to-type stock of planting materials of popular high-yielding sweetpotato varieties was conducted by means of literature studies. The requirements so established were matched to conditions in northern Namibia to find the most suitable options.

RESULTS

Propagation of sweetpotato planting materials

Sweetpotato is normally propagated vegetatively and part of the sweetpotato plant can be used for propagation purposes (Soenarjo, 1995). Sweetpotato is a hexaploid and plants from seeds are therefore genetically different from their parents and not desirable for agricultural production of sweetpotato. Seeds are used in breeding programs to obtain genetic variation for the development of new varieties (Thankamma Pillai & Easwari Amma, 1987).

(i) Vine cuttings

Unrooted freshly cut vine tip cuttings are generally best suited for the production of a sweetpotato crop (Amante, 1994). In frost areas nurseries can be established during the summer, first cuttings taken in autumn and the mother plants left to develop new sprouts, which are left through winter. In areas with light frost nurseries can be established in late summer so that storage root development is completed before the vines are damaged by frost. The tubers can winter in the soil without damage and will sprout in spring. Cuttings can be harvested in early summer and again in mid summer.

(ii) Sprouts from storage roots

In areas with cold winters and regular frost storage, roots can be used for propagation purposes. For the production of sprouts healthy, good quality storage roots are selected from the harvest and stored during winter at 10-15°C with 85% relative humidity. The storage roots are planted in spring to sprout and the first cuttings can be harvested in early summer (Coertze *et al.*, 1994).

(iii) In vitro propagation

Sweetpotato can be multiplied *in vitro* via explants of meristem tips, shoot pieces containing a node or root pieces (Schultheis & Cantliffe, 1994). In vitro propagation methods may, if the necessary facilities and expertise are available, be suited to multiply and internationally distribute virus— and disease free materials (Amante, 1994). It is, however, not suitable for the production of sweetpotato as all types of *in vitro* propagated planting materials produce lower yields than conventional vine cuttings (Schultheis & Cantliffe, 1994).

(iv) Rapid Multiplication Techniques

Large numbers of normal-size cuttings are needed for field nurseries, which normally have to be established stepwise as cuttings are taken from plants established first. To gain more plants from field mother plants, spouts grown from storage roots, leaf cuttings, seedlings and in vitro propagated materials, several rapid multiplication techniques (RMT) have been developed. The propagation rate is largely determined by the environmental conditions, varietal characteristics and cultural management practices followed (Amante, 1994).

Maintenance of sweetpotato materials in a pest- and disease free state

Sweetpotato may host various pests and diseases in different production areas, which can potentially be transferred or spread by vegetative planting materials. Control measures are specific to the different pests and diseases and their dynamics.

(i) Insects pests

The only pests that cause substantial damage and that can be transferred by planting materials are the sweetpotato weevils *Cylas puncticollis, C. formicarius, C. brunneus* and *Blosyrus obliquatus* (Smit, 1997). In response to their damage the tubers produce a toxin that induces a sweet smell and bitter taste, reducing the tubers marketability. An approach of integrated pest management combining chemical and cultural control methods is necessary for effective sweetpotato weevil management (Smit, 1964; Martin & Leonard, 1967; Jansson *et al.*, 1987; Onwueme & Sinha, 1991; Daiber *et al.*, 1991; Skoglund & Smit, 1994; Fielding & van Crowder, 1995; Smit, 1997).

(ii) Virus Diseases

Of the five sweetpotato viruses detected and confirmed in Africa, Sweetpotato Feathery Mottle Virus (SPFMV) and Sweetpotato Chlorotic Stunt Virus (SPCSV) cause the most losses (Gibson *et al.*, 1998; Karyeija *et al.*, 1998). SPFMV is transmitted by various aphid species and spreads through vegetative planting materials taken from infected plants (Joubert *et al.*, 1995; Karyeija *et al.*, 1998). SPCSV is transmitted by the whitefly and infections are typically maintained in fields by the use of cuttings from infected plants. Sweetpotato Virus Disease (SPVD) is a range of severe symptoms in sweetpotato that is caused by the simultaneous infection of SPFMV and SPCSV (Gibson *et al.*, 1998). Until virus-resistant varieties become more widely spread, successful sweetpotato production is based on the use of virus-free planting materials so that the sources of virus infection are eliminated (Gibson *et al.*, 1997). Field nurseries cannot be grown under conditions that totally exclude vectors of sweetpotato viruses, but vector transmission can be minimized by various means. Regular visual inspections, rogueing of plants expressing viral symptoms and testing of mother plants for the presence of viruses have to be performed in field nurseries (Hammond, 1989).

(iii) Fungus diseases

Fusarium wilt is the most serious disease of sweetpotato and is caused by the fungus *Fusarium oxysporum* Schlecht. f. sp. *batatas* (Clark & Moyer, 1988). Although this disease occurs in all areas where the sweetpotato is grown, infections occur seldom in dry conditions. The fungus can survive in the soil for extended periods in the absence of a suitable host and is spread with the movement of soil, infected mother seed roots and infected vine cuttings. Control of Fusarium wilt is best achieved by host resistance in combination with chemical and cultural control methods (Clark & Moyer, 1998).

Maintenance of true-to-type core stock of popular sweetpotato varieties

(i) Reasons for decline in yield by recurrent use of planting materials

A gradual decline in yield occurs when previous crops and unmarketable tubers are used repeatedly as sources of planting material (Edmond, 1971). Sweetpotato also has an unusually high rate of somatic mutation (Clark & Moyer, 1998).

(ii) Methods to maintain varieties true to type

Vine traits in sweetpotato have high heritability estimates and can therefore be used confidently to monitor genetic changes in varieties and to identify off-types (Jones, 1969). The desired characteristics of varieties are maintained by hill selection and strict rogueing (Dangler, 1994; Mulkey & Hernandez, 1994; Sterret & Savage, 1994).

Physiological aspects determining the quality of planting materials

The quality of sweetpotato planting materials influences the performance of planting profoundly.

(i) Vine cuttings

Among factors influencing the performance of sweetpotato vine cuttings, the length of the cutting is most important. Cuttings of 30cm length or 10 nodes are most effective in early rooting without excessive moisture loss through transpiration (Holwerda & Ekanayake, 1991). Optimally cuttings should be taken from actively growing mother plants (Martin, 1984). Tip cuttings produce higher yields than basal or intermediate cuttings (Soenarjo, 1995).

Removal of leaves from cuttings is only recommended when cuttings are bound into bundles for transport (Amante, 1994). Cuttings should be planted as soon as possible after cutting to avoid moisture loss and root development before planting, they can, however, be stored in aerobic conditions for five to seven days (Mwinyi, 1991; Ocitti P'Obwoya & Mateeka, 1994).

(ii) Slips grown from storage roots

The size of the storage root influences the number of shoots as well as the quality of shoots produced. The number of plants produced by sweetpotato roots is increased by longitudinal cutting to reduce proximal dominance (Takatori *et al.,* 1960; Welch & Little, 1965), presprouting (Hall, 1986) and ethephon treatment of bedded storage roots (Hall, 1990).

Institutional organisation to facilitate availability of planting materials to producers

To ensure efficient distribution of planting materials to producers a system comprising all stakeholders has to be established. Sch systems are well established in developed countries and can serve as examples of systems for developing countries.

(i) Systems in countries with commercial agricultural production

The objective of sweetpotato foundation programs is to maintain eedstock quality through control of pests and pathogens and maintenance of varieties true-to-type (Dangler, 1994). Growers collectively benefit from the availability of high-quality planting materials from the foundation programs that also facilitate fast distribution of new improved varieties. Certification provides a program of planned production, limited generations, rigid standards and unbiased field and storage inspections for orderly increase, maintenance and distribution of sweetpotato varieties (Schultheiss *et al.*, 1994; Laurie & Stork, 1997).

(ii) Systems in countries with subsistence or developing commercial agricultural production

In countries with developing economies seed supply is in general absent or underdeveloped. Over the past decade sweetpotato, as one of the root crops, has become increasingly important in times of persistent drought and due to the rising cost of farm inputs caused by the devaluation of the local currency in Southern Africa (Roa, 1990; Minde *et al.*, 1997; Ngoma *et al.,* 1998; Mubiru & Ocitti P'Obwoya, 1998). Expanded and increased production has, however, been hampered by the unavailability of planting materials in general and of improved varieties in particular. Although improved varieties have been developed and selected by most of the National Agricultural Research Systems in SADC, these varieties have been unavailable to most farmers because their multiplication and marketing has not been organised and promoted. Contrary to normal seed, vegetative planting material production and distribution systems need to be localised within production areas due to the short shelf life and bulk of planting materials. In most of the SADC countries where normal seed production and distribution systems are still in the developing stage, the establishment of systems to multiply and distribute vegetative planting materials seems to be a great challenge. The strength of developing multiplication and distribution systems in Malawi and Zambia lay in the synergistic efforts and benefits carried by a wide range of partners who were fully integrated into the program. Although, traditionally, planting materials are often exchanged or obtained free of charge from relatives, the importance of commercialisation of the program has been recognised.

DISCUSSION

Planting material production methods suited for agro-ecological conditions in Northern Namibia

Optimal temperatures for sweetpotato growth are between 21 and 28°C with a minimum of 20°C (Henriksen, 1981; Coertze *et al.*, 1994). Although sweetpotato will survive at lower temperatures, its growth is considerably retarded. Average temperatures of > 20°C are already reached during August and September in the most northern parts of Namibia. Heavy frost does not occur in most areas in northern Namibia and total destruction of nurseries should not be of concern. Rainfall is generally low and erratic and during more than half of the year no rain is expected. Sweetpotato nurseries can therefore only be established where water for irrigation is available, which is limited to the border rivers and a few dams. Sweetpotato plantings are normally established in December/January with the onset of rains. These agro-ecological conditions dictate that sweetpotato multiplication nurseries should be established in the most northern areas of Namibia, mainly along the Okavango and Zambezi rivers, where water for irrigation is available, virtually no frost occurs and average temperatures rise to above 20°C earlier than in other areas. Nurseries in these areas should then be situated as such that they are able to supply planting materials to producers at the onset of rains.

Pest control

Sweetpotato multiplication nurseries need to be well managed to control pests and diseases and to prevent their spread through planting materials. Crop rotation is essential to avoid population build-up of sweetpotato weevil and Fusarium. This practice should easily be possible where nurseries are established on larger cropping areas; growers with limited land, however, need to plan rotations carefully. Sweetpotato weevil should definitely be controlled by regular chemical applications to nursery blocks. Namibia has no own-developed improved varieties and those introduced from elsewhere can readily be obtained in virus-free form. It is important to regularly rogue nurseries to avoid the spread of viruses through planting materials. This practice is time-consuming and technical staff need to be trained in the skills required. The development and propagation of virus-resistant varieties is probably the most feasible option over the long term.

Characteristics of sweetpotato varieties suitable for production in Northern Namibia

The involvement of farmers in preliminary variety evaluation trials created awareness and ensured that yield and taste, the criteria most important to farmers, were used to select varieties for advanced variety evaluations. Advanced variety evaluations should be conducted for a number of seasons to select varieties that are most suitable for dryland production in northern Namibia. Early maturing varieties with high potential have shown the highest yields so far. Furthermore, on farm evaluations are necessary to identify varieties with high yield and taste preferred by consumers.

Experience gained from the establishment of a seed production system in Namibia

Until the first efforts were made to establish a seed production system for the staple food crop pearl millet, shortly after independence in 1990, Namibia had never had a seed production program of its own (Auino, 1998). Seed production has shifted from almost total seed production on Government of Namibia research stations in 1992, to almost total production by members of the Northern Namibia Farmers Seed Growers' Cooperative (NNFSGC) in 1996 (Lechner, 1997). Since the 1997/98 cropping season the Extension Service is also no longer responsible for seed distribution (Auino, 1998; Nghipondoka, 1998). This function has been taken over by the NNFSGC in collaboration with commercial seed companies and smaller wholesale and retail channels. It is generally perceived that this project has worked well and can serve as a model of a seed supply scheme in circumstances where the private sector is reluctant to make an investment. Donor and Government of Namibia intervention served mainly as risk absorption during the establishment of a self-sustaining seed producers co-operative. The four key factors influencing the success of small-scale seed projects are the availability of one or more attractive varieties, growers confidence in the seed business, government support in the development of such a system and policy of seed sales rather than free distribution. The maintenance of tight quality control during production and processing is also emphasised. High quality ensures that users will stay confident in the seed, which in turn ensures sustainability of the system.

The roles of various institutions in developing a sweet-potato vine production and distribution system

The identification and maintenance of improved sweetpotato varieties has been initiated by IITA/SADC/SARRNET through the Directorate of Agricultural Research and Training. Primary multiplication sites have been established at five Research Stations throughout the northern regions. The expanded evaluation and distribution of research materials is aided by the Extension service and a number of non-governmental organisations involved in rural development or farming systems research. Assistance to a sweetpotato vine distribution system by the Extension service will be vital in its initial phases and policy makers are aware of the situation. The establishment of secondary nursery sites at village level has started to be addressed. The main challenges faced are lack of irrigation facilities on farm plots and the sustainability of the system through commercialisation.

REFERENCES

AMANTE, V.D.R. 1994. Production and handling of sweetpotato planting materials for cultivar evaluation. In: Sweetpotato variety evaluation. Volume1. Training manual. Ed E.T. Rasco jr. & V.D. R. Amante, SAPPRAD, Manila, Philippines.

AUINO, E. 1998. Farmer-based pearl millet seed production systems in Namibia. In: Proceedings of the workshop on farmer participation in pearl millet breeding and farmer-based seed production systems in Namibia. 23-27 March 1998, Oshakati, Namibia.

CLARK, C.A. & J.W. MOYER. 1998. Compendium of sweet potato diseases APS press, USA.

COERTZE, A.F., A.A. VAN DEN BERG, P.O. STORK & D.C.A. HOFFMAN. 1994. Sweet potatoes. Leaflet by the vegetable and ornamental plant Institute, Agricultural Research Council, Pretoria, South Africa.

DAIBER, K.C., M.D.R. UYS & A.F. COERTZE. 1994. Insect pests and diseases in sweet potatoes. Leaflet by the vegetable and ornamental plant Institute, Agricultural Research Council, South Africa.

DANGLER, J.M. 1994 Alabama's foundation sweetpotato program maintains root quality. In: Compendium Sweetpotato foundation programs: the American Society for Horticultural Science, Alexandria, Virginia, USA.

EDMOND, J.B. 1971. Seedstock selection and plant production. In: Sweet potatoes: Production, processing and marketing. AVI Publishing, Connecticut, USA. Pp.81-105.

FIELDING W. J. & L. VAN CROWDER. 1995. Sweet potato weevils in Jamaica: acceptable pests? Journal of sustainable Agriculture 5(4): 105-117.

GIBSON, R.W., R.O.M. MWANGA, S.KASULE, I. MPEMBE AND E.E. CAREY. 1997. Apparent absence of viruses in most symptomless field-grown sweet potato virus in Uganda. Plant pathology 47: 95-102.

GIBSON, R.W., I.MPEMBE, T.ALICAI, E.E.CAREY, R.O.M. MWANGA, S.E. SEAL & H.J. VETTEN. 1998. Symptoms, aetiology and serological analysis of sweet potato virus disease in Uganda. Plant Pathology 47: 95-102.

HALL, M.R. 1986. Presprouting, root size, and cutting related to plant production by bedded sweet potato roots. HortScience 21(4): 985-987.

HALL, M.R. 1990. Short-duration presprouting, ethephon, and cutting increase plant production by sweetpotato roots. HortScience 25(4): 403-404.

HAMMOND, J. 1989. Virus Detection procedures for seed production. In: International Potato Center (CIP). Control of virus and virus like diseases of potato and sweet potato. Report of the 3. Planning conference, Lima, Peru, 20-22 Nov. 1989. Lima, CIP. pp.173-177.

HENRIKSEN, J. B. 1981. Processing of root and tuber planting material. In: Seeds proceedings on improved seed production. Food and Agriculture Organisation of the United Nations, Rome, 1982.

HOLWERDA, H.T. & I.J.EKANAYAKE. 1991. Establishment of sweet potato stem cuttings as influenced by size, depth of planting water stress, hormones and herbicide residues for two genotypes. Scientia Horticulturae 48: 193-203.

JANSSON, R.K., H.H. BRYAN & K.A. SORENSEN. 1987. Within-vine distribution and damage of sweetpotato weevil, Cylas formicarius elegantulus (Coleoptera: Curculionidae), on four cultivars of sweet potato in Southern Florida. The Florida Entomologist 70 (4): 523-526.

JONES, A. 1969. Quantative inheritance of ten vine traits in sweetpotatoes. Journal of the American Society for Horticultural Science 94 (4): 408-411.

JOUBERT, T.G. LA G., P. KLESSER & D.D.NEL. 1995. The value of virus-indexed sweet potato material. Leaflet by the vegetable and ornamental plant Institute, ARC-Roodeplaat , Pretoria, South Africa.

KARYEIJA, R.F., R.W. GIBSON & J.P.T. VALKONEN. 1998. The significance of sweet potato feathery mottle virus in subsistence sweet potato production in Africa. Plant Disease 82 (1): 4-15.

LAURIE, S.M. & P.O. STORK. 1997. A Scheme for the distribution of disease-free sweetpotato propagation material in South Africa. ARC-Roodeplaat, Pretoria, South Africa.

LECHNER W.R. 1997. Seed multiplication and distribution through a farmers' cooperative in Namibia. In: Alternative strategies for smallholder seed supply. Proceedings of an international conference on options for strengthening national and regional seed system in Africa and West Asia. 10-14 March 1997, Harare, Zimbabwe.

MARTIN, F.W. 1984. Effect of age of planting on yields of sweet potato from cuttings. Tropical Root and Tuber Crops Newsletter 15: 22-25.

MARTIN, J.H. & W.H. LEONARD. 1967. Principles of field crop production. The Macmillan Company, New York.

MINDE,I.J., J.M. TERI, V.W. SAKA, K. ROCKMAN & I.R.M. BENESI. 1997. Accelerated multiplication and distribution of cassava and sweet potato planting material in Malawi. In: Alternative Strategies for smallholder seed supply. Proceedings of an International conference on options for strengthening national and regional seed system in Africa and west Asia. 10-14 March 1997, Harare, Zimbabwe.

MUBIRU, F. & C. OCCITTI P'OBWOYA. 1998. Multiplication and dissemination of new and improved sweetpotato varieties in Kumi and Soriti districts of Uganda. A pre-proposal submitted to the ASARECA/ USAID Technology Transfer Program by Soroti Catholic Diocese Integrated Development Organization (SOCADIDO) in collaboration with the National Agricultural Research (NARO), 31 March 1998.

MULKEY, W.A. & J.H. HERNANDEZ. 1994. Louisana s sweetpotato foundation seed program. In: Compendium Sweetpotato foundation programs. The American society for Horticultural Science, Alexandria, Virginia, USA

MWINYI, S.C.O. 1991 Pre-planting method and duration of storing sweet potato (*Ipomoea batatas* (L) Lam) shoot cutting planting materials for increased tuber yield. Tropical Science 13: 1-7.

NAMIBIA AGRICULTURAL CENSUS 1994/95. Basic analysis of communal agriculture. Central Statistics Office, National Planning Commission of Namibia, 1995.

NGHIPONDIKA, V.K. 1998. The role of extension in seed marketing. In: Proceedings of the workshop on farmer participation in pearl millet breeding and farmer-based seed production systems in Namibia. 23-27 March 1998, Oshakati, Namibia.

NGOMA, H.W., F. MITI & M. MBUNJI. 1998. Multiplication and distribution of improved cassava and sweet potato planting materials. Paper presented at the International conference on improvement of food security through root crop in Southern Africa held by SADC/ IITA/ SARRNET, 24-26 August 1998, Lusaka, Zambia.

OCITTI P'OBWOYA, C. N. & B. MATEEKA. 1994. Effect of length of storage of vine cuttings on yield and quality of sweet potato. African Crop Science Conference Proceedings (1): 169-170.

ONWUEWE, I.C. & T.D. SINHA. 1991. Field crop production in tropical Africa. Principles and practice. Technical Centre for Agricultural and Rural Co-operation.

ROA, J.R. 1990. Sweet potato seed systems in the Philippines. In: Seed — production mechanisms. Proceedings of a workshop held in Singapore, 5-9 November 1990, International Development Research Centre, Singapore.

SCHULTHEIS, J.R. & D.J. CANTLIFFE. 1994. Early plant growth from seed, vegetative cuttings and somatic embryos. Journal of the American Society of Horticultural Science 119(5): 1104-1111.

SCHULTHEIS, J.R., C.E. COLLINS & C.W. AVERRE. 1994. The certified sweetpotato in seed program in North Carolina. In: Compendium Sweetpotato foundation programs. The American Society for Horticultural Science, Alexandria, Virginia, USA.

SKOGLUND, L.G. & N.E.J.M. SMIT. 1994. Major diseases and pests of sweetpotato in Eastern Africa. International potato Center, Lima, Peru.

SMIT, B. 1964. Insects in Southern Africa. How to control them. Oxford University Press, Cape Town.

SMIT, N. 1997. Integrated pest management for sweetpotato weevil. CIP Uganda & SARRNET Zambia.

SOENARJO, R. 1995. Standard, rule and regulations for the production of healthy plant propagation material for cassava and sweet potato. Root and Tuber improvement program, Mansa, Zambia.

STERRETT, S.B. & C.P. SAVAGE. 1994. Foundation sweetpotato seed program in Virginia. In: Compendium Sweetpotato foundation programs. The American Society for Horticultural Science, Alexandria, Virginia, USA.

TAKATORI, F.H., D.C. PURNELL & J.I. STILLMAN. 1960. Influence of seed piece size and cutting on the production of sweet potato shoots. American Society for Horticultural Science 77: 473-478.

THANKANMA PILLAI, P.K. & C.S. EASWARI AMMA. 1987. Effect of water soaking on seed germination in sweet potato *Ipomoea batatas* L. Journal of root crops 13 (2): 117-119.

WELCH, N.C. & T.M. LITTLE. 1965. Effects of heating and cutting roots on sweet potato sprout production. American Society for Horticultural Science 88: 477-480.