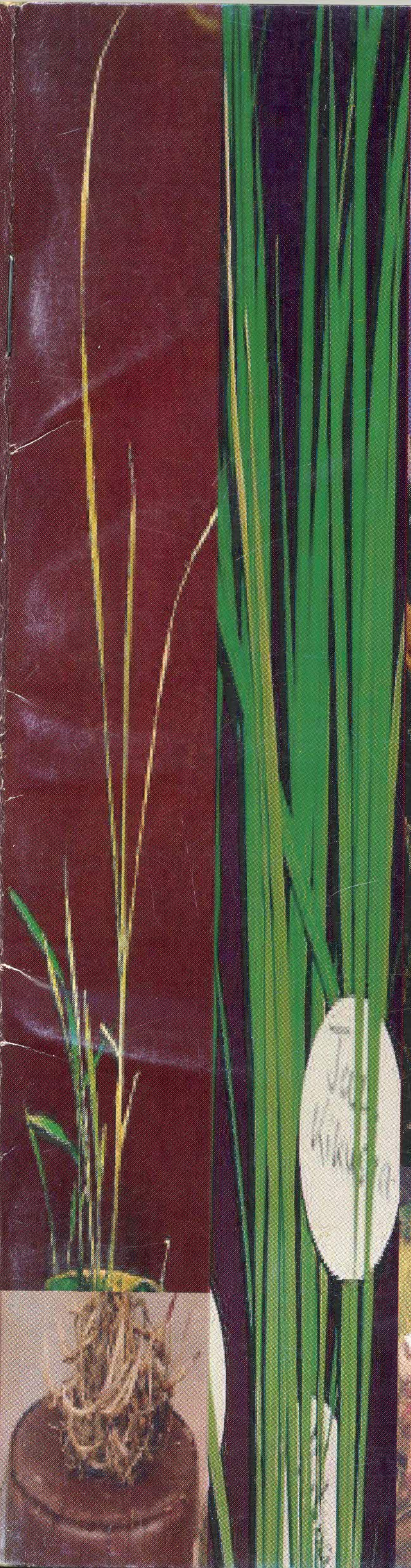
A GUIDE FOR THE MANAGEMENT OF

RICE YELLOW MOTTLE VIRUS DISEASE



TARP II SUA PROJECT

A Guide for the Management of Rice Yellow Mottle Virus Disease

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Preface

Rice (*Oryza sativa* L.) is considered the second most important cereal food crop after maize in Tanzania. It is consumed by about 60% of the countries population and grown mainly by smallholder farmers in almost all regions under different cropping systems. Production is still at subsistence level and far falls short of demand. The deficit is often complemented by rice imports. There is high potential for attaining self sufficiency and generating surpluses if the constraining factors, among them diseases were dealt with seriously. Rice Yellow Mottle Virus (RYMV) is currently the most threatening disease in most of the rice growing areas in the country and particularly in Kyela district where the highest production losses have been recorded. Sporadic epidemics prompted research on the disease in mid 1990s in most areas of the country. Being a relatively new disease in the country, little information on control has been generated. This booklet serves as a guide for control of the disease based on research studies conducted in Kyela for three years under the TARP II – SUA Project on Food Security and Household Income for Smallholder Farmers in Tanzania, implemented jointly by the Ministry of Agriculture and Food Security (MAFS), Sokoine University of Agriculture (SUA) and the Agricultural University of Norway (NLH). Hopefully it will provide useful messages for extension officers, and research farmer groups and other community development workers to share with the rice farming community in the war against RYMV disease.

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Acronyms

RYMV	-	Rice yellow Mottle Virus
MAFS	-	Ministry of Agriculture and Food Security
SUA	-	Sokoine University of Agriculture
NLH	-	Agricultural University of Norway
TARP II	-	Tanzania Agricultural Research project Phase two
m a.s.l.	-	Metres above Sea level
N.S.R.C.	-	National Seed Release Committee
IDM	-	Integrated Disease Management

1.0 Introduction

1.1 Kyela District Rice Culture

Kyela is one of the districts in Mbeya region occupying an area roughly between longitudes 33°40` and 30° 00' East and latitudes 9°25' and 9o40' South. Most of the district is lowlying within 478 and 600 masl on the floor of the great African rift valley at the tip of Lake Nyasa. It experiences a humid tropical climate with a mean daily temperature of 25 °C and monomodal rainfal of 2500mm. There are two district physiographic areas (Fig. 1): the flood plain considered as areas lower than 520 masl dominates the land scape and higher areas above 520 masl. Fluvisols and cambisols exist in the flood plain whereas Ferralsols and Luvisols dominate in the higher plateau. Based on cultivated areas, rice is the main food and cash crop in Kyela. Nearly 1800ha are cultivated annually by smallholder farmers in fields ranging from 0.13 to 4.1 ha.

Most rice is cultivated in the flood plain and river valleys of the upper plateau since 18th century when Arab traders introduced it in the district. Almost 99% of the crop is rainfed. Only a small proportion of innovative farmers practice dry season rice production under irrigation. Many new varieties have been introduced both formally and informally in the past twenty years but only two rice varieties, Kilombero and Zambia, have been universally grown for several decades and which have severely succumbed to RYMV infection since 1995. Farmers, however, claim to have seen symptoms of the disease as far back as 1980. Incidences and severity of RYMV are highest in the flood plain and farmers have noted occurrence of disease epidemics in seasons preceded by heavy rains and floods. The technologies recommended through this manual were tested at six different locations in the flood plain (Figure 1), after futile measures by farmers to contain the disease, *vis a vis* through application of nitrogenous fertilizers, fallowing, late planting and rouging of infected plants.

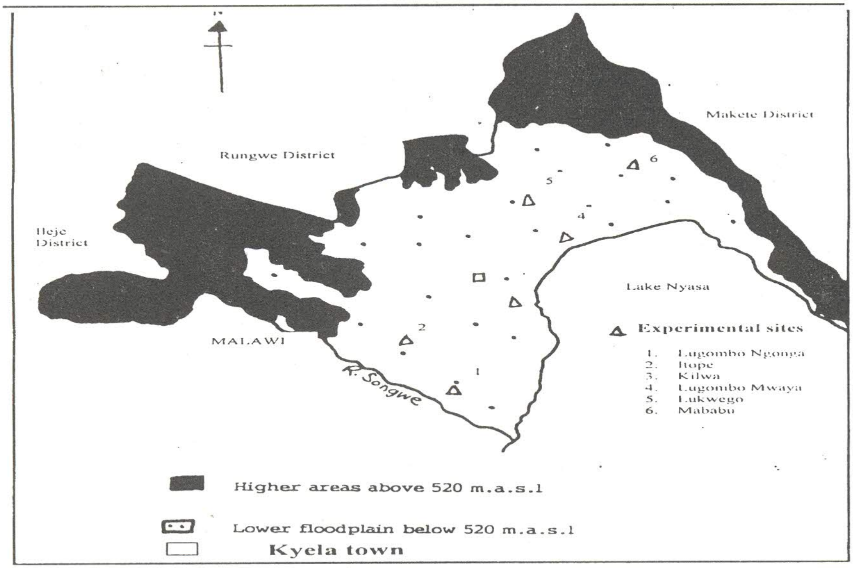

Figure 1: Physiographic map of Kyela District showing experimental sites

1.2 Rice Yellow Mottle Virus (RYMV)

Cause: Rice yellow mottle disease is caused by a virus of the genus sobemovirus, endemic in the African continent and surrounding islands. It is one of the most economically damaging diseases of rice in most of the lowland and irrigated rice production systems in sub-Saharan Africa. RYMV is considered the most important disease of rice in Tanzania especially in Kyela district in the Southern Highlands where high crop losses since 1994 have severely undermined household food security, income and the entire rice based economy. Insect vectors notably Chrysomelid beetles (*Chaetocnema pulla* Chapius and *Sesselia pusilla* Gerst), *Epilachna similis* Thunberg (Chrysomellidae), mites and the long horned grasshoppers (Oxya sp) have been implicated in disease transmission in different countries. The flea beetles *Chaetocnema pulla* and *Chaetocnema* sp. nov. prope *varicornis* Jacoby are cited as vectors of the disease in some parts of Tanzania. Most of the vectors are leaf-feeders with biting mouth parts and are abundantly present on rice and grasses in lowland fields. Transmission of RYMV is mechanical within rice plants as a result of feeding damage.

Status and distribution: The disease was reported for the first time near Lake Victoria in Kenya in 1966. During mid 1980s it was reported in many West African countries – Nigeria, Ghana, Ivory Coast, Niger, Mali and Burkina Faso. In Tanzania mainland the first incidence of the disease was reported at Mkindo irrigation scheme near Morogoro town in 1993. During the mid 1990s it was reported in Zanzibar, Madagascar, Eastern zone and in Kyela district in the Southern Highlands of Tanzania. To date the disease is prevalent in almost all rice growing areas of the country as well as in many other countries in Eastern, Southern, Central and West Africa. In most cases notice of the disease is taken at economic threshhold levels. It is said that the virus has spread fast along with the introduction of high yielding but susceptible cultivars from Asia and consequent intensification of rice culture.

Symptoms and damage: The disease is characterized by mottling and yellowing of the leaves, stunting, delayed flowering, poor panicle exertion and spikelet sterility. In Kyela district the disease is locally known as Ibangalala, Sanu and Panama according to symptoms expressed. RYMV incidences vary from year to year possibly due to variation in vector population and changes in environmental conditions that favour disease development and vector multiplication. Symptoms severity and yield losses are variable and depend on genotype and stage of crop growth at infection. With early infection a yield loss of nearly 100% has been reported. Yield losses ranging from 75 – 100% were recorded in Kyela lowland fields during epidemics.

Plate No 1: Symptoms of RYMV

2.0 Disease Management Options

Several control options have been developed in participatory manner and recommended by farmers who are already practicing in attempt to curb epidemics of the disease in Kyela.

2.1 Resistant varieties

It is unfortunate that no strong resistance is inherent in the most popular indica rice genotypes adapted to lowland conditions. Nevertheless there is considerable variation in resistance among the preferred rice genotypes. Varieties may also show differential resistance from one location to another due to existence of pathogen strain differences. Immunity to the disease is found in some indigenous *Oryza glaberrima* landraces but sterility barriers commonly associated with wide crosses hamper the transfer to indica rices of such traits for resistance.

The most popular local rice cultivars grown in the most fertile flood plain namely Kilombero, Zambia, Rangimbili, Mwasungo are highly susceptible to the disease. The minor varieties including new introductions from neighbouring Malawi, namely Faya, supa, Mwangulu, Mbonela, Bluebonet, Singa were also susceptible in the flood plain. Disease is less severe in the upper plateau where sometimes varieties escape infection. Among 84 elite rice genotypes of diverse origin screened at six sites in the flood plain both under natural and field innoculum, about 12 genotypes tolerant to the disease were identified. Among these only 6 which widely satisfied farmers' preferences for market, agronomic and culinary characters were identified and recommended for commercial production. The varieties are 4H234-18-1-1 (Kalalu), SSD35, SSD-3 BG 380-2, Wahiwahi, and Tule na Bwana (Plate 1). Others which showed localized resistance but widely accepted were TXD 306 (SARO), SSD5 and Salama A15. IRAT 133 and 252 showed wide resistance but localized acceptance. Some of the general characteristics of the widely accepted and disease tolerant cultivars are described on Table 1. Farmers believe that the slightly scented cultivars will acquire strong aroma after continued interaction with their environment.

Table 1: Brief description of commended rice cultivars tolerant to RYMV.

Character	SSD-35	4H234-18-1-1	SSD-3	SARO (TxD306)	BG380-2	Wahiwahi	Tule na Bwana	IRAT 133
Potential yield (t/ha)*	3.0	3.5	3.0	4	7	3.5	4.5	4
Plant height (cm)	160	115	108	110	130	115	127	126
Growth period (days)	90.95	150	90-95	130	170	150	155	150
Grain color	Brown	White	White	White	White	Brown	White	White
Aroma (Scent compared with Kilombero local)	Slight aroma	Highly aromatic	Slight aroma	Aromatic Semi aromatic	Non aromatic	Highly aromatic	Slight aroma	None aromatic

* Yields from farmer managed on-farm trials without supplemental fertilizers.

Despite the long maturity period, scentlessness and difficult threshing, BG 280-2 was widely accepted by farmers as a food security crop (mpokanjala) because of its high yield and less attraction to bird damage. Likewise the early maturity varieties were selected for possibilities of double cropping and providing food early in the household. To start with the two varieties 4H234-18-1-1 (Kalalu) and SSD-35 have been tabled for official release by NSRC for commercial production. The variety TXD 306 has already being officially released for production in the eastern zone. Some cultivars showed localized infection suggesting the possibilities of existence of variant strains of the pathogen in some of the locations. The resistance of these varieties as with most cultivated I*ndica* rice genotypes is not considered strong but their use will widen the current very narrow genetic base and enhance resistance or slow down epidemics. Seeds of these varieties can be obtained from Ibangalala research farmer groups in the different locations as shown on Figure 1.

Plate No. 2: Grain type in recommended varieties

2.2 Weed control

Weeds, which compete with crops for light, nutrients and water, are among the most serious biological constraints to high yields in upland rice production ecosystems. Rice, more than any other crop shows the ravages of lack of proper weeding. Yield losses within the range of 28 – 100% have been reported due to uncontrolled weed growth in direct seeded lowland and upland systems in Africa. Apart from the direct losses weeds particularly grasses serve as alternate host of viral diseases like RYMV and insects, which affect the rice crop often enabling the pests to survive between rice crops.

Many perennial annual weeds and ratooned rice showed viral infections in the rice fields in Kyela both during the dry and main cropping seasons. Notable among them were wild rice (O*ryza longistaminata*), jungle rice (*Echinochloa colona*), wild fingermillet (E*leusine* sp) and sweet basil (*Ocimum* sp). The perennial wild rice is considered the main carrier of RYMV and together with jungle rice they proved to be infected with RYMV disease in cross inoculation tests. These stoloniferous and rhizomatous weeds thrive well and are found abundantly in the lower swampy areas, which remain moist throughout the year despite cattle grazing. They act as reservoirs of infection always available for the re-infection of the rice crop. Inoculum is reserved in the underground rhizomes, which sprout well as weeds in the rice crop after onset of rains. Disease inoculum is transmitted from these weeds to the healthy rice crop by the insect vectors or mechanically during hand weeding. Most troublesome weeds in Kyela rice production system are shown on Table 2.

Table 2: Categories of troublesome weeds in rice production

	Category	English name	Swahili name	Local name
A	Perrenial grasses that harbour viral disease infections.	Wild rice Fox tail grass Jungle rice Wild finger millet Crow's foot grass	Mpunga Pori Majani ya Setaria Mpunga mwitu Ulezi pori au Malulu Kifunga mbuzi	Jele Matekenyefu Mafundo Ndulwe Ndulwe
B	Resprouting grass weeds that are difficult to weed by hand and don't respond easily to herbicides	Swamp rice grass African star grass African star grass Nile grass	Mpunga bondemaji Ukoka/Thangari Ukoka/Lugowi Majani Naili	Rwiba Kasangani Lusangani Mbwiga
C	Annual fast growing broad leaves weeds	Crow's foot grass Sensitive plant Goat weed Umbrella plant	Kifunga mbuzi/malulu Kifauongo Kundambara Ndago au mfujo	Ndulwe Nyalu Kimonga Ndago

Elimination of the host weeds during off season or before the rice crop will break the disease cycle and reduce primary inoculum sources in the field. Hand hoe or oxen plough normally used in Kyela for land preparation are not efficient in removing all the numerous rhizomes in the fields especially during the dry season when the soil is hardened.

Plate 3: Wild rice plant infected by RYMV

2.2.1 Weed control strategies

A. Hand weeding

The most usual form of weeding rice is still by direct hand labour. In many cases effective weed control is impossible due to shortage of or competing demands for labour at critical stages. Weeding takes hours of backbreaking labour provided mostly by women in Kyela. About 93 mandays/ha costing Tshs 111,600/= (Tshs 1200/manday) are used by women in weeding. Men take slightly longer time. Staggered planting of small plots is practiced to cope with weeding load. Nevertheless in this area where seed is broadcast, manual weed control is very difficult and crop damage due to walking and pulling in the crop can be worse than losses from weed competition.

Of more concern is that hand weeding is considered the main vehicle of mechanical transmission of RYMV disease in Kyela. Farmers reported epidemics of the disease in fields one to two weeks after hand weeding.

B. Chemical weed control

- **Pre-plough application of Roundup (glyphosate):**

This herbicide is applied at least three to four weeks before ploughing at rates of 4 litres/ha or 150ml/15litres water spray pump. It is directed at destroying difficult grass weeds (categories A – B) especially the stoloniferous perrenial horsts of RYMV disease before sowing. Use of glyphosate (roundup) 4 litres/ha, at least three weeks before ploughing to well sprouted weeds has shown to dry all aerial and underground sections of the weed plants and consequently eased oxen ploughing and ensured good seed bed preparation. As a result disease incidences and severity were reduced by 82% and 12% respectively in the subsequent crop, and yields increased by 10%. Hence maintaining fields free from the reservoir plants is crucial to achieve control or eliminate RYMV disease

- **Post-emergence chemical weeding**

There are many inappropriate herbicides that are used haphazardly in Kyela which are ineffective and tend to scotch the rice crop leading to low yields. Some of the tested and recommended herbicides to use in rice are shown on Table 3.

Table 3: Recommended herbicides for rice

Herbicide name	Application rate	Remarks
Basagran PL2B and Satunil 60EC	5 litres/ha or 180mls/15litres sprayer pump.	Control broad leaved weeds and nut grasses (B – C)
Stam T-8	8l/ha or 300mls/15l water sprayer pump.	Control broadleaved weeds and sedges (category C.)
2, 4 – D amine	3l/ha or mls 300/15l water pump	Controls only some broad leaved weeds in category C. should be applied before heading to avoid damage to crop

These herbicides should be applied when rice is 2 – 3 leaves stage or when weeds are about 5cm high. For best result they should be also used before fields are flooded.

Chemical weeding was deemed advantageous as it encouraged cultivation of large fields, early planting and timely weeding. Weed control by post-emergence herbicides reduced disease incidences by 12%. A three weeks pre-plough application of round up coupled with appropriated post emergence rice herbicides Basagran PL 2B, Satunil 60EC, Stam T-8 or 2-4D amine controlled RYMV disease by reducing mechanical transmission within fields by almost 100%. In addition the four post-emergence herbicides tested reduced weeding labour input by about 67% per ha on average and gave gross margins of Tshs. 78,000/ha for Basagran PL 2B and Satunil 60EC, (61itres/ha), Shs. 68,000/ha for Stam T-8 (8litres/ha) and Shs 84,600/= ha for 2-4D amine (3litres/ha) compared to hand weeding. It can be concluded that chemical weed control appear to be quite a useful option in integrated weed and RYMV disease management systems and also for reducing women workload who are mostly involved in weeding.

A number of other herbicides available in shops and which farmers apply in different rates and combinations like Tordon 101 and Gesapax (Ametryne 500EC) are not appropriate herbicides for rice and should be avoided.

Tordon 101 is often used to destroy shrubs during road construction works or in rangelands. Likewise Gesapax is a herbicide used widely in sugarcane and coffee plantations. It often scotches and kills rice plants at high dozes and reduces yield by about 25%.

2.3 Time of planting

Surveys showed that many fields in Kyela are planted relatively late in attempts to avoid RYMV disease. Verification trials conducted showed that early planted rice (November – December) in the swampy areas tended to suffer more from disease infections due to high insect populations from reservoir plants at the begging of the season. However due to uncertainties in weather patterns late planting is considered more risky in crop loss due to early floods which can invade fields and prevent ploughing, planting or drown the young crop. The drought period (February/ March) can also hit the crop at critical stages and depending on locality disease infection can also seriously affect the late planted crop. Experimental results showed that the normal planting period (December to end of January depending on locality) was still most appropriate for the recommended disease tolerant varieties coupled with destruction of alternate hosts by chemicals before planting. No disease incidences were observed with this practice in any of the locations in Kyela.

2.4 Other cultural practices

Row planting:
It was observed by farmers that compared to broadcasting, row planting which ranged from 20-35cm between plants in farmers fields enhanced weeding by hand hoe, walking and doing other field operations without touching and damage to the rice plants which often induce mechanical transmission of RYMV disease. Although no deliberate measurements were taken it was noted that disease incidences were minimal in most row planted compared to broadcasted fields.

Cutting back:
This cultural practice of cutting back tall rice varieties before flowering (Plate) to avoid lodging as is done by some farmers is an assured way of mechanically transmitting the disease in the entire field by the cutting sickles and should be avoided. Shorter rice varieties adapted to the local environment should be adopted.

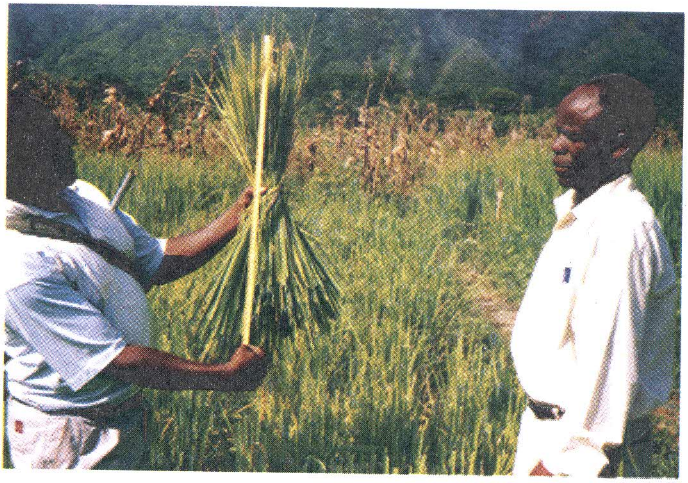

Plate No 4: A field where rice has been down sized to avoid lodging

Sequential cropping/Crop Rotation:

Planting dry season crops after rice harvest which is highly possible in the low-lying swampy plains is a good and profitable way of suppressing growth of reservoir host plants elimination of ratoon and volunteer rice crops and maintaining field sanitation between crops. Hence should be encouraged whenever possible.

2.5 Control of insect vectors

About six Homoptera and one Coleoptera insect species known to transmit viral diseases in rice fields in other countries were identified in Kyela. The Homopteras were *Nephotettix* after Ghauri, *Nephotettix* sp, *Exitianus distanti* Ross, *Cicadulina* sp, *Coffana unimaculata* (Signoret) and *Coffana spectra* Distant. The Coleoptera *Chaetocnema* sp. Indent was the only one implicated in literature as vector of the RYMV disease. The other insects have also been caught in rice fields where RYMV disease is not present. High populations and activity of the insect vectors were noted in abandoned rice fields and swampy areas where host plants were thriving well during off-season. As it may not be feasible for small scale farmers to spray large rice fields with insecticides to protect them from infected insect vectors destruction of infected wild hosts by chemicals or early ploughing after harvest cattle grazing, slashing will discourage insect feeding and hence help reduce the building up of sources of innoculum in fields before the season. Nevertheless, nursery beds which are established early in season can be protected by at least one insecticidal spray after germination for healthy insurance of the seedlings before transplanting in fields.

2.6 Exclusion

As the disease is not seed-borne it is not very clear how it is propagated in space. Hence efforts should be made to avoid moving planting materials, grazing animals and farm implements from infected to healthy areas to avoid exportation of infected vectors. Local quarantine regulations should be reinforced.

2.7 Integrated Disease management (IDM)

This is a strategy where essentially all or several available methods of control are integrated to achieve optimum economic benefit with minimal ecological impact on the environment. By this method the pathogen population is maintained at a level below that which would cause economic loss. Often host plant resistance as focal is combined with cultural, chemical and biological measures of control as no single control measure can stand alone for a long time. Hence for sustainable control of RYMV a combination of several or all options so far tested as a package which can be enriched gradually while in use according to varying ecological condition is recommended. Drawing example of the studies conducted in Kyela use of resistant varieties in conjunction with chemical weeding and pre-plough elimination of host plants controlled the RYMV by 100% and gave profits of Tsh. 223,800/= ha compared to local practices.

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