Float Trays as an Alternative to Methyl Bromide in Tobacco Production in Hurungwe District, Zimbabwe

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ABSTRACT

The study was carried out in Hurungwe district in Zimbabwe to evaluate the feasibility as well as the challenges of using float trays as an alternative to the use of methyl bromide in tobacco production. The study made use of the qualitative and quantitative research design. Questionnaires, interviews, economic analysis and field observations were used as data collection instruments. Descriptive analysis was used in the research. The results of the study indicated that floating trays can effectively substitute the use of methyl bromide in tobacco seedling production. This is because of their accessibility, ability to produce excellent quality seedlings because of reduced insect pest, weeds and disease attack and also a reduction in labor requirement. The float trays maintain or improve productivity because the transplanting shock is reduced; when the seedlings are ready for transplanting, there is a reduction land required for seedling production as well as the cost effectiveness of the float trays. There are, however, challenges that affect the float tray system, although the challenges are outweighed by the advantages. The challenges include the technical knowhow that is associated with the float tray system. The unavailability of additional substrates, the distance to the float tray distributors where the trays are procured, high initial establishment costs and the need for farmer to stay on the farm until the seedlings are transplanted onto the field are also factors affecting the adoption of the float trays. From the results of the research, it can be concluded that float trays can substitute methyl bromide in insect pest, weeds and disease control while being environmentally friendly. It is recommended that there is need for farmer training on the use of float trays, government subsidies in initial establishment of the technique, ready supply of the float trays and decentralization of the manufacturers of float trays into tobacco growing areas.

Key words: alternative, float trays, methyl bromide, phase.

INTRODUCTION

Methyl bromide is a broad spectrum fumigant that has been in use in Zimbabwe for over half a century (Karavina and Mandumbu, 2012). The chemical is mainly used as a pre-plant soil sterilant and disinfectant in warehouses, ships and aeroplanes (Karavina and Mandumbu, 2012) which kills a broad spectrum of insect pests, weeds, soil pathogens (Stevens, 1993; Martin, 2003) and a single treatment before planting controls nematodes, diseases and weeds (Meadows, 2013). Between 70-80% of Methyl bromide is used for soil sterilization pre-planting. Soil fumigation of methyl bromide has traditionally been practiced in high-input, high-value production systems (Ristaino and Thomas, 1997). The chemical has been proven to be effective in the control of root knot nematodes (Meloidogyne sp) and Cyperus sp which are problematic in tropical and subtropical climates (Gilreath and Santos, 2008). In Zimbabwe, much of the Methyl bromide is used to sterilize soils in tobacco and horticultural nurseries, as well as grain fumigation (Karavina and Mandumbu, 2012).

Methyl bromide was identified as ozone depleting in 1985 (Ristaino and Thomas, 1997; Rosskopf et al, 2005). This toxic gas is so volatile that more than half of the amount injected into the soil can eventually end up in the air. When methyl bromide rises high in the atmosphere, it contributes to thinning of the ozone layer (the layer that shields us from ultraviolet radiation) (Meadows, 2013).The disruption of the ozone layer causes increased ultraviolet radiation to reach the earth's surface, with potential effects to human health, the environment and agricultural crops. According to Stevens (1993), the ozone layer has a concentrated band at 15-30km altitude and shields the earth from harmful ultra violet-B (UV-B) radiation. The excessive exposure to the radiation by human beings is linked to skin cancer, eye diseases in humans, suppression of the immune system in the living organisms, damage to protein and DNA.This phenomenon was supported by over 160 countries who are signatories to the Montreal Protocol of 1987 (Cunningham, 1990). In 1992, Methyl bromide was added to the list of ozone depletion substances under the same Montreal Protocol. By September 1997, controls on methyl bromide production and use had been agreed to under the Montreal Protocol whereby it was agreed that there was to be a 50% cut in production by 2001, a 70% reduction by 2003 and total phasing out by 1 January 2005 in developed countries. Developing countries were to reduce consumption in 2002 at a 1995-1998 average, reduce consumption from that baseline by 20% in 2005, and are to phase out Methyl Bromide by 2015 (USDA Economic Services Research, 2000). Despite the agreement Methyl bromide is still being produced in the developed countries (Zasada et al., 2010).

Zimbabwe as one of the signatories to the Montreal Protocol has proposed a number of alternatives have been proposed and recommended for use to replace Methyl bromide. It is in the interest of Zimbabwe to phase off methyl bromide as soon as possible because the golden leaf which is largely exported is likely going to face consumer resistance

Alternative methods for soil pest control have resulted in some drawbacks such as uneven and inadequate coverage (Meadows, 2013), short stability in the soil, with microbial degradation responsible for chemical inactivation (Gan et al., 2000), inefficiency on fungi, weeds and insects (Gilreath et al., 2006). Other methods such as solarisation, seedling trays with overhead watering (microjet), composted pine bark (substrate) seedbeds and seedlings floating in the water, burn and ethylene dibromide (EDB), dichloropropene, ethyl dibromide, chloropicrin have been developed by TRB (Thompson, 2000). The evaluation of alternative methods in Zimbabwe started in 1994 by Tobacco Research Board and is still continuing (Thompson, 2000). Some studies indicated that the seedlings grown in seedling trays with overhead irrigation system were much smaller than those grown in pine bark as well as those of the float system.

Zimbabwe has set herself the deadline of 2011, four years in advance of the Montreal Protocol deadline, to phase out methyl bromide (Karavina and Mandumbu, 2012a). In Brazil, sixty percent of tobacco seedlings are raised using the float system (FAO, 2001). Tobacco Research Board has introduced the float tray system whose adoption by small-scale farmers is at between 30 and 40% (Karavina and Mandumbu, 2012a).

MATERIALS AND METHODS

The research was carried out in Hurungwe district that falls under Zimbabwe's agroecological region 2b. The region is characterized by intensive farming based on crop production. Rainfall amounts were in the range of 700-1050 mm with 16-18 pentads per season. Hail occasionally causes damage to leaf crops like tobacco. The first frost occurs around June. Most of the soils in the area are sandy to loamy sand that makes the area most suitable for tobacco production. Cereal and tobacco production is widespread in the study area.

RESEARCH DESIGN

The study used both the qualitative and the quantitative research design in evaluation of the use of float trays. The descriptive research approach was used. The qualitative and a quantitative approach allow the systematic collection of information about objects of the study in a setting (DeVaus, 1996). Field evaluation was important in this research to compare the performance of seedling between the seedlings grown under soil treated with methyl bromide, seedbeds without any soil treatment and the floating trays. This however, gave the researcher the correct information about what is happening on the ground. Qualitative design was used on the other hand, to bring out data on farmers experiences and feelings. For the questionnaire random sampling was done on a cluster of farmers in six operational zones who were into tobacco farming. Ten farmers were selected from each operational zone to come up with 60 farmers in all the six zones. In the operational zones, two farmers from each zone allowed the researcher to assess the various treatments on each treatment. The findings from the observations were triangulated with the questionnaires as well as the interviews to improve the validity of the research findings.

DATA COLLECTION AND ANALYSIS

Questionnaires, interviews and field observations were used as data collection techniques. The observations were made once after three weeks up to the twelfth week when the seedlings were said to be ready for transplanting. The quality of the seedlings was later coded for analysis. Descriptive analysis was used in the form of tables graphs and pie-charts. An economic analysis was also used to compare the cost of the float tray technology and the traditional (conventional) seedbed

RESULTS AND DISCUSSIONS

1. Gender and age of respondents

The results of the study show that the majority of tobacco farmers are males (75%) while women constitute 25% of the respondents. A higher number of tobacco farmers are in the above 40 age group for both the male and the female tobacco farmers. There were no farmers in the below 20 age group whereas only 15% and 25% constitutes farmers in the 21-30 age group and 31-40 age group respectively. The farmers who were above 40 age group constituted 60% of the respondents (Table I).

Table I: Gender and age of respondents

	Gender		
Age group (yrs)	Female	Male	Total
<20	0 (0%)	0(0%)	0%
21-30	3(5%)	6(10%)	15%
31-40	3(5%)	12(20%)	25%
>40	9(15%)	27(45%)	60%
Total	25%	75%	100%

N=60

The results of the study were in line with the research by Mazarura et al (2012) who observed that the majority of farmers in tobacco production are males in the adult age group which in this case are over the age of forty. The shift of women from the traditional non-cash food crops as evidenced by the fewer number of women who are into tobacco production could raise fears that the shift might lead to food insecurity in the households (Muwanga-Bayego, 1994). The research finding that the majority of growers were adult males conforms to the findings by Capehart (2004) who observed that there are fewer young farmers in tobacco production. In another study, in Bindura, it was found that the smallholder tobacco farmers in Bindura are males who constitute more than half of the farmers in the district (AREX, 2012). In this study most of the farmers were above the 40 age group similar to the work of (Manyumwa et al, 2013) who observed that the age group in the range of 40 years and above years is dominating smallholder tobacco farming in the district due to experience in tobacco farming.

2. Land area used in tobacco farming

The highest number of farmers (68.3%) use land area of between 1 and 3 hectares followed by 21.6% of the respondents who use 4-6 hectares for tobacco farming. The smallest number of farmers (10%) use more than six hectares of land for tobacco production (Table II). This means that most farmers use small portions of land for tobacco production.

Table II: Land area used in tobacco farming

Land area	Number of respondents	Frequency (%)
1-3ha	41	68.3
4-6ha	13	21.6
>6ha	6	10
Total	60	100

N=60

Small land areas are used for tobacco production because the tobacco industry is now dominated by farmers who have benefited from the fast track land reform programme the majority of whom are on six hectare plots (Karavina and Mandumbu, 2012b). The research results was also similar to the work of Jayne et al, 2003 who found that the majority of tobacco growers in the sub Saharan region were smallholder farmers working on land less than two hectares. The nature of smallholder farmers of characterized by mixed cropping where by maize is part of the production system means that the farmers could also have been involved in some activities such as maize and legume production on some of the land that they own. This means that growing only tobacco on their pieces of land could lead to food insecurity hence need for producing food crops on the other hand (Rahman, 2011).

3. Experience of farmers in tobacco farming

The results of the study indicates that the large proportion (46%) of farmers surveyed have between 4 and 6 years of tobacco production however while 35% had between 7 and 9 years of tobacco farming. Farmers with more than ten years of experience in producing the crop constituted 13.3% of the respondents (Table III). In brief 95% of the surveyed farmers have at least four years experience in tobacco farming.

Table III: Farmers experience in tobacco farming

Experience in tobacco farming	Number of respondents	Frequency (%)
1-3 years	3	5
4-6 years	28	46.7
7-9 years	21	35
>10 years	8	13.3
Total	60	100

N=60

The majority of farmers had at least four years experience in tobacco production because tobacco has become a major commercial crop of late, providing the farmer with a readily available, very sophisticated and well managed marketing system (Mazarura et al, 2012) therefore becoming a key crop in smallholder farming (Karavina and Mandumbu, 2012b). In the 2010-11 seasons, tobacco earnings totaled US$347.8 million (Karavina and Mandumbu, 2012) which was very attractive to most farmers and therefore this could further attract more farmers into the tobacco production industry (Chivuraise,2011).

4. Accessibility of float trays

The results of the study indicates that of the 60 respondents, 28 (43%) indicated that the float trays were easy to access, 24 (38%) indicated that the floating trays were not accessible while 12 (19%) indicated that the floating trays could not be accessed by many (Fig 1). This means that the highest number of farmers was able to access the float trays.

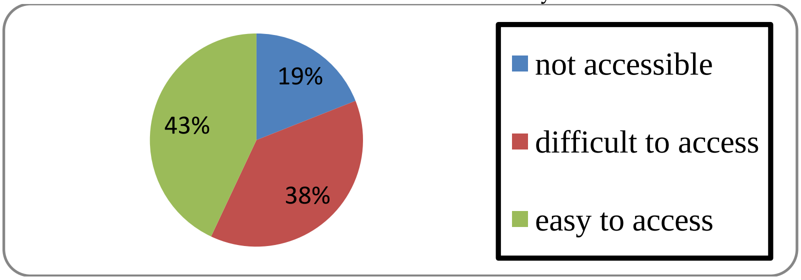

Fig1. Farmers accessibility of float trays

The highest number of respondents was able to access the float trays probably because they had vehicles that would enable them to go to Harare to buy the float trays from Harare. Some farmers have complained that it is not easy to secure the trays as well as the media and quarry to mix with seed for even seed distribution at planting because these trays sometimes are not available at the time they go to buy the trays. This was in line with the research by Karavina and Mandumbu, 2013 who indicated that sales records at the Tobacco Research Board (TRB) how that most of the trays are taken up by large scale commercial farmers leaving very few or no trays for the smallholder farmers who would want to buy the trays in smaller quantities as a result of the land area that they use for tobacco production.

5. Affordability of the float tray technology

The response of the farmers shows that the costs of the float trays were affordable to most farmers. Ninety three percent indicated that the float trays were affordable while 4% were not sure of the costs.

However only three percent have indicated that the float trays are not affordable (Fig 2.).

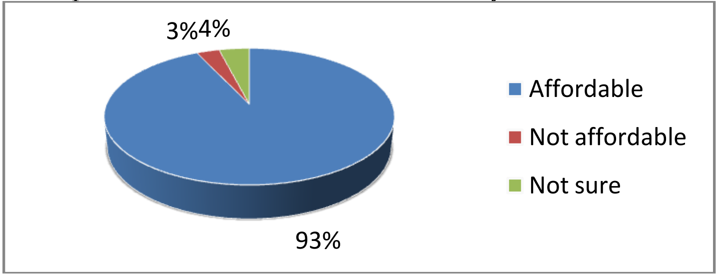

Fig 2: The response of farmers on the affordability of new technology

Most farmers have indicated that the technology is affordable probably because of the reduced labour needs that usually manifest itself in reduced labour costs since most of the farmers rely on hired labour in addition to the household labour. The labour requirements are reduced in the float tray system compared to the conventional seed bed because of the limited areas on the float trays that needed to be monitored, sprayed, weeded and ploughed.

Farmers have also indicated that the float tray technology is costly. This could be because of the requirements of additional inputs into the float tray system which are the growing media and the black plastic in addition to the float tray (Manyumwa et al, 2013).

6 Quality of seedlings in tobacco seedbeds

Quality of seedlings varied according to the treatment. The various codes that were used to describe the quality of the seedlings were excellent, good, fair and poor. According to Strahler (1988), excellent quality seedling that is ideal for transplanting should be 12-15cm from crown to bud, be size of a pencil in diameter, should be well hardened and have a vigorous and abundant root system. The quality of seedlings in the excellent category was almost similar between the methyl bromide treatment and the floating seedbed technology where it was 60% and 63.3% respectively. However for a treatment that had no either methyl bromide or float trays the majority of the seedlings were in the fair category. There was also slight difference in the quality of seeds between the methyl bromide and the floating seedbeds that were in the good category. Either methyl bromide or the float tray system had no poor seedlings while the poor seedlings were obtained in untreated seedbed (8.3%) (Table IV).

Table IV: The quality of seedlings in the seedbeds

	Treatments					
	Methyl bromide		Floating seedbed		No treatment	
	Number	Frequency(%)	Number	Frequency(%)	Number	Frequency(%)
Excellent	36	60	38	63.3	8	13.3
Good	22	36.7	20	33.3	20	33.3
Fair	2	3.3	2	3	27	45
Poor	0	0	0	0	5	8.3
Total	60	100	60	100	60	100

The results of the study indicate that the floating trays can equally compete with the methyl bromide that has been phased out. The trays can potentially reduce disease and pest incidences in the same manner as the methyl bromide treated seeds that in the end contribute to the quality of the seedlings.

7. Advantages of using float tray system

Farmers cited several advantages that are associated with the float tray system. The float trays were said to reduce labour (78%), reducethe effort that is required for pulling plants (93%), reduce risk of plant failure (85%), maintains yield (57%), controls weeds (80%), results in uniformity of seedlings (98%), reduce the use of pesticides (88%), saves land (100%) and reduce incidence of diseases (85%) (Table V).

Table V: Advantages of using the float tray system

Advantage	Number of respondents	Frequency(%)
Reduction of labour	47	78
Reduced task of pulling plants	56	93
Risk of plant failure from dry weather is eliminated	51	85
Yield is maintained	34	57

Weed control is eliminated	48	80
There is uniformity of seedlings	59	98
There is reduced use of pesticides	53	88
Land is saved	60	100
Reduction of disease	51	85

A reduction in labour requirements was said to be associated with the float tray system. This could be because, in the 'floating tray' system, seedlings are raised in trays that float in water. The system uses less space and therefore less labour required for watering compared to the traditional system. The float tray also requires less labour as watering also takes place less frequently (Mtonga and Mumba, 2010).

The benefits of using the float tray system were said to be associated with the reduction of disease incidences in the plants. This is attributed to the use of disease-free substrate (pine bark or vermiculite), nutrient solution, and containers. Irrigation pipes are also maintained clean as well as the workers or visitors production system interface. This gives the seedlings a good start and response to key production inputs (Upenyu and Asher, 2011).

There is also reduced labour required for pulling the plants because the practice produces better quality seedlings with intact dense root systems which result in more uniform crops. The plant uniformity, therefore reduces transplanting shock during the initial seedling establishment in the field (Upenyu and Asher, 2011).

Farmers indicated that there was a production of good quality seedlings in the float tray system. This could be because of the ideal proportion of air and nutrients on the substrate that ensures better root development of seeds that result in good quality seedlings (Pearce and Palmer, 1999) resulting in less disease which in turn have an effect on the reduction in the use of pesticides. The research results are in line with the work of Mazarura (2004) which indicated that the seedlings grown in float trays were more drought resistant (Mazarura, 2012). Mazarura, (2012) further attested that the farmers who practiced the float tray system found it easy and confirmed that the float tray system produced uniform seedlings The production of more uniform, drought resistant seedlings ensure easier field management of the crop (Karavina and Mandumbu, 2012).

The farmers have also indicated a yield maintenance using the float tray method. Research has consistently shown that yields are the same or tend to be better than from the conventional system of using methyl bromide in seedbeds (Upenyu and Asher, 2012). This could be as a result of the production of uniform, disease free and drought resistant seedlings that can survive even harsher conditions. Float tray raised seedlings also allows easier and more efficient transplanting which means farmers do not spend time in sorting the better young plants from the rest, which greatly shortens the procedure of transplanting and have a positive results on the yield.

Farmers have indicated that the float tray technique saves land. Optimal use of land lies in the fact that approximately 20 m2 of the seedbed produces seedlings enough to cover a hectare after transplanting, something that is not possible with the seedbed applied with methyl bromide (Karavina and Mandumbu, 2012).

8. Challenges of using the float tray system

Farmers have indicated challenges associated with the float tray system. These are associated with labour constraints (25%), too technical (88%), high cost (28%), proneness to diseases (12%), need for additional substrate (22%), forces the farmer to stay on the farm (57%) and high initial establishment costs (67%) (Table VI).

Table VI: Challenges of using the float tray system

Challenge	Number of respondents	Frequency (%)
Labour intensive	15	25
Too technical	53	88
Costly	17	28
Forces the farmer to stay on the farm	34	57
Float trays are prone to diseases	7	12
Need for additional substrates	13	22
High initial establishment cost	40	67

Some smallholder farmers have indicated that they are still reluctant to use the float tray seedbed technology for tobacco seedlings arguing that the technique is labour intensive. This is caused by labour constraints that are rampant in the first year of using the technology in the sense that seed bed construction includes labour intensive tasks and heavy work for those physically challenged (Manyumwa et al, 2013).

The farmers cited the problem of high initial establishment costs. This is because, in the first season, the farmers need to secure the float trays first, establish a permanent source of water and then construct the pit that can hold the trays and the water (Karavina and Mandumbu, 2012). In a related study, in Bindura district in Zimbabwe, it was also observed that smallholder farmers are in shortage of initial capital to establish the float tray technology (Manyumwa et al, 2012). Some farmers also feel that the float tray technology is too technical. The technicality associated with the float tray technology could have been linked to the lack of knowledge, high entry costs of innovation, lack of training, input costs and lack of information (Manyumwa et al, 2013; Karavina and Mandumbu, 2012b) and lack of the required resources (Khanna, 2001). A little proportion of the respondents indicated that the use of float trays is costly. This could be because technologies that are capital intensive are only affordable by richer farmers and hence the adoption of such technologies is limited to larger farmers who are richer than the smallholder farmers (Khanna, 2001). The float tray system would forces the farmer to the farm always whereas the traditional method only needed regular watering and monitoring and gave the farmer room to do other chores. The float tray would need constant monitoring probably because of the need to maintain the water level in the tray such that the nutrient media would not become toxic to the growing seedlings.

Table VII: The partial budget analysis of using float tray seedbeds over methyl bromide

Losses (USD)		Gains (USD)	
Income lost	0.00	New Income	0.00
New Costs		Costs saved	
Pine bark	4.16	Water	9.36
River sand	0.82	Fumigation hire	2.55
Trays	3.86	Labour	21.35
Total Loss	8.84	Total gain	33.26
Net gain (33.26-8.84)	24.42		

Using float trays results in saving costs that are incur when using the traditional seedbed method. The partial budget (Table 7) shows that the farmers can save up to $24.42 through savings in irrigation water, fumigation hire when using methyl bromide, and the labour that is required for constructing the beds, insect pests and diseases control (Table VII). This means that the practice is a cheaper alternative compared to the use of methyl bromide.

CONCLUSIONS AND RECOMMENDATIONS

From the results of the study, it can be concluded that float trays can be used as an alternative to methyl bromide in tobacco seedlings production. This is as a result of the positive effects on the quality of the seedling, reduction of labour, saving of land that could be needed if the seedlings are produced in a seedbed and a reduction in the use of pesticides in the trays that have an in turn conservative effect on the environment. The study has shown that the use of float trays is relatively cheaper compared to the use of methyl bromide.

Government is urged to support the farmers through training in the technicalities of the float trays that are considered a challenge by farmers yet in fact it is the lack of knowhow and information on the use of the float tray.

The government should financially assist the farmers who are into tobacco production with initial capital such that the float trays become attractive to most of the farmers.

The float trays manufacturing and distribution should also be decentralized in the tobacco growing regions and the extension officers should be responsible for distribution of the float trays to smallholder farmers in their agricultural zones

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