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THE INCIDENCE OF POST-HARVEST PROBLEMS AMONG SMALL FARMERS SURVEYED IN THREE REGIONS OF THE LIMPOPO PROVINCE

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Abstract

High yielding varieties and new production technology have vastly increased the world's agricultural production and provided rural incomes and affordable food for large parts of the population. While production research has received considerable attention, until recently, post harvest activities have not received much attention. Post harvest research has significant contribution towards the alleviation of poverty, food insecurity and the sustainable use of resources. The objective of the paper is to assess the post-harvest constraints affecting main staple grain crops in three regions of the Limpopo Province. Some of the most common post harvest constraints revealed by the study are, weevils, rodents and transport for produce from the field to home Chemical, biological and indigenous control measures are used by the smallholder farmers to alleviate some of the post harvest constraints. The results of the study seem to indicate that more research work should be done especially on the use of indigenous knowledge towards the alleviation of post harvest constraints.

1. INTRODUCTION

"For those who make their living by working the land, it is a great satisfaction to be able to observe a field of maize, sorghum or beans that is about to be harvested. But what a disappointment it is to discover that often, after the harvest, a large part of the grain produced has been lost, or has so badly deteriorated that it is unfit to eat or sell."

(De Lucia & Assennato, 1994:3)

Improving agricultural production is essential to achieve a sustainable development process that will contribute to reducing poverty and enhancing food security and income growth. High yielding varieties and new production

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technology have vastly increased the world's agricultural potential and provided rural incomes and affordable food for large parts of the population. While research on the improvement of agricultural production has received considerable attention, until recently post harvest activities have not attracted much attention (Goletti & Wolff, 1998). But it is important to realise that agricultural production does not end at harvest time; rather there is a production-consumption continuum, which includes a variety of post-harvest activities.

Limpopo Province small-scale grain producers in particular sustain significant post-harvest losses. Farmers are encouraged to grow high yielding varieties and little attempt has been made to introduce grain handling and storage facilities to cope with the increased insect damage associated with these varieties. In addition, extension workers in some areas have observed considerable rodent damage to household grain stocks. To produce as much grain as possible is an admirable objective but if a significant proportion of the grain is lost to the ravages of insects pests, it makes a mockery of the field situation.

The objective of the study is to assess the post-production constraints affecting main staple grain crops in the three regions of the Limpopo Province, with a view to identifying opportunities for their resolution. Understanding of post-harvest constraints helps to understand the importance of investment in post harvest research. To achieve this objective, the study kicks-off by introducing the methodology used for data gathering. This is followed by the impact of post harvest research on the national goals of the developing world. This is followed by the main crops grown in the surveyed areas. The study proceeds with the introduction of the post-production constraints of the major staple crops. The focus of the paper continues with post-harvest protection methods of stored grains. Conclusions and implications for future research follow in the final section.

2. METHODOLOGY

The project was conducted in two phases, namely the planning (phase 1) and the implementation phase (phase 2). The paper focuses on phase 2 that deals with the actual undertaking of the surveys. The study was carried out in three regions of the Limpopo Province, namely the Northern, Lowveld and the Southern region. Two villages in each region were randomly selected for participatory rural appraisal (PRA) and questionnaire work. Within each region, one village with good accessibility to large roads and trading centres, and one remote village were selected. The villages selected in the Northern region were Mapate and Vhurivhuri, and in the Lowveld region were Basani

and Nkomo-B, while in the Southern region it was Ga-Phaahla and Bloublometjieskloof (Bloublommetjieskloof). Within each village 30 households were randomly selected for interviews. As a consequence 180, mostly female, farmers were interviewed from all the 6 villages. Female farmers were targeted since they dominate the post-production sector.

The selected PRA tools, *inter alia*, focussed on crops grown and post-harvest related activities, the importance of post-harvest constraints among the general agricultural constraints and potential locally acceptable solutions. Information gathering with other actors in the post-production system was also done using a number of rapid appraisal technique including:

- informal group discussions with farmers, women farmers in particular;
- interviews with key informants at provincial, district and field level;
- direct observation of post production operations; and
- informal discussion with traders and millers.

Surveys were carried out by multi-disciplinary teams and the results of the survey were also confirmed with the surveyed communities through a number of feedback visits.

3. A BRIEF OVERVIEW OF THE IMPORTANCE OF POST-HARVEST RESEARCH

While research on the improvement of agricultural production has received considerable attention and funding, post-harvest activities have not attracted much attention particularly from research organizations. However, there seem to be an emerging consensus on the critical role that post-harvest can play in meeting the national goals of developing countries. This section provides an insight of the importance of post-harvest research and much of this work is well documented in Golletti & Wolf (1998).

The importance of post-harvest research lies heavily on its impact to the national goals of food security, poverty alleviation and sustainable agriculture particularly in developing countries. The conclusion drawn from the evaluation of post-harvest research by international research organization, firstly, revealed that post-harvest research contributes to poverty reduction by enhancing income generating opportunities for poor people and by providing time saving processed foods in the urban poor. Improved processing that leads to more convenient foods thus frees up time for other activities such as

wage work, contributing to poverty reduction. In addition, improved storage technology open up new market for product from developing countries and thus creates income opportunities and reduces poverty.

Secondly, post-harvest research contributes to food security. Improved storage technologies, such a biological pest control reduce post-harvest food losses. Reduced wastage during storage reduces food and income losses for the farmers. Reducing losses increases the amount of food available for consumption.

Finally, post-harvest research has positive effect on sustainable use of resources by finding alternatives to chemicals which have polluting effects on the environment and are usually hazardous for human health. Reducing waste of already produced food is more sustainable than increasing production to compensate for post-harvest losses. Increasing production leads to more intensive farming or to an expansion of the area under cultivation, which may have negative effects on the environment. Value adding opportunities that enhance the value of key commodities would also increase income generation for improving welfare and providing farmers with financial resources for investment in resource enhancing technology.

It is evident that post-harvest research complements the production research and the two should not be viewed as mutual exclusive processes. Food security has to be viewed as having both the production and post-production legs. Both these are of equal importance as only a well-managed post-production system allows the consumer to have access to the food produced. So far, relatively little has been invested in post-harvest research, there is potential for large impacts as constraints and bottlenecks are removed. It would thus be desirable to examine current funding priorities and to allocate a large proportion of resources to the post-harvest area.

4. MAJOR GRAIN CROPS GROWN AND THEIR USE

The major staple crops grown in the surveyed areas are shown in Figure 1 below. Maize is by far the most important and is the most favoured staple in both the Lowveld and the Northern region (see Figure 1). The minimum number of respondents growing only maize in the two regions is 70% in Vhurivhuri, while the maximum number of respondents is 97% in Mapate village. To a limited extent maize is also grown either with millet or sorghum in these two regions. In the Southern region, maize and sorghum are the major grown crops with sorghum being the dominant staple food. Climatic conditions, as well as, consumer preference seem to be the main factors influencing crops grown in the surveyed regions.

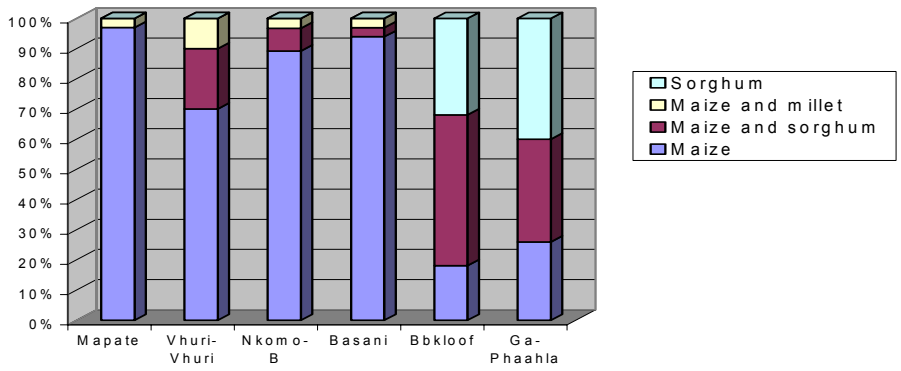

Figure 1: Main grain crops grown in the surveyed villages

Respondents were asked to use ten stones to show how they utilised their major staple crop harvested. The results of such production uses are shown in Figure 2. Because stones could not be divided into half stones *etc*. the figures below gives a rough representation of the utilisation of the staple crop. A larger proportion of production (53% on average) was utilised for household consumption . A larger proportion (59%) used for household consumption lies in the Lowveld region, followed by 55% and 46% in the Northern and Southern region, respectively (see Figure 2).

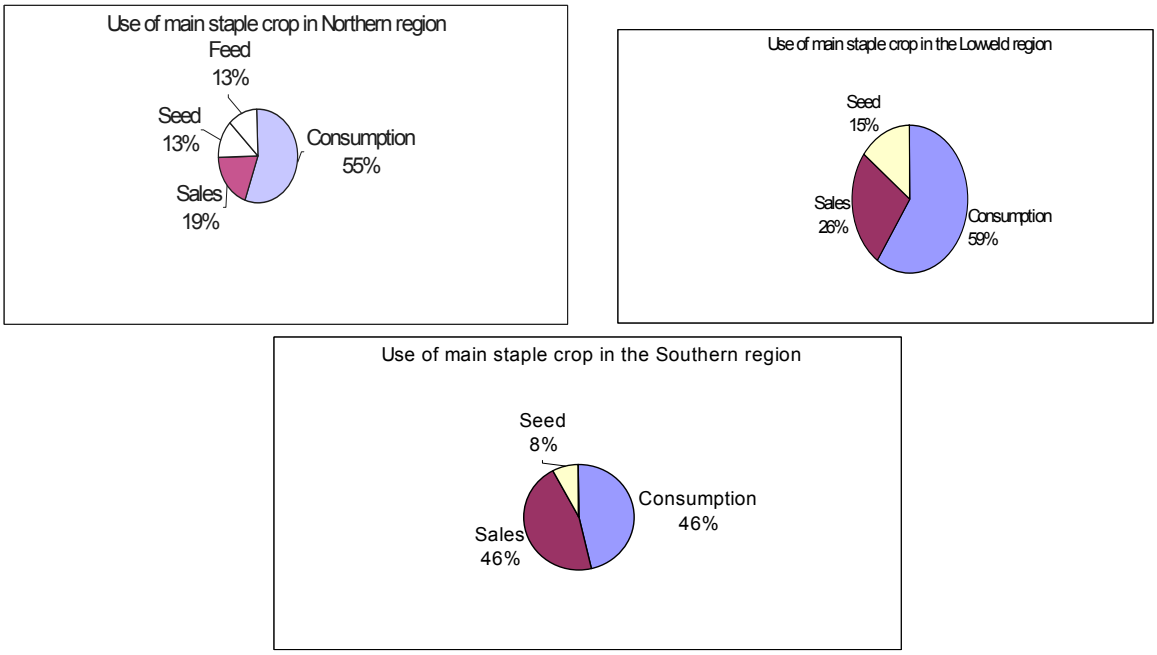

Figure 2: The use of Main Staple Crops grown in the Surveyed Regions

Apart from using the produced crop for their own consumption requirements, farmers also store grains for seed for the next season. The proportion of grain used for seed ranges from a minimum of 8% in the Southern region to a maximum of 15% in the Lowveld region. Sales are the second most important use of grain after household consumption. Interesting is that a much greater proportion of production (46%) in the Southern region was sold relative to 26% and 19% in the Lowveld and the Northern region respectively. Farmers often sell a proportion of their produce at harvest, when prices are low. This is frequently the case with deficit producers, who must satisfy immediate cash needs after harvest, only to buy in food later in the season.

A possible explanation for the higher sales in the Southern region lies partly in whether farmers can store their grains or not. The Southern region has the least number of farmers (86%) who store grains relative to 88 and 90% of surveyed farmers in the Northern and Lowveld region respectively. Higher sales are possible if farmers do not have financial resources to store grain for several months. Farmers sometimes have immediate cash needs (e.g. require school fees) and as such they are forced to sell part of their crop to pay these.

In addition, storage involves substantial costs and risks and farmers may avoid storage risks by selling the produce. As the English saying goes, "a bird in hand is worth two in the bush", which in this context can be rewritten as "money in the pocket is worth more than grain in store where grain can be attacked by insects. Finally, it is only in the Northern region where part of grains produced (13%) is used as a feed for the animals. It is apparent from Figure 2 that the dominant uses of grains in order of importance is household consumption, sales, seeds and to a limited extent feed.

5. POST-PRODUCTION CONSTRAINTS OF MAJOR STAPLE CROPS

This section focuses on the post-harvest constraints that farmers encounter in the post-production sector and are shown in Figure 3. The results are shown on regional basis. This has an added advantage of detecting the existence, if any, of regional differences.

5.1 Weevils

Weevils are one of the most important PHC particularly in the Northern region where 89% of the households expressed it as the major constraint. There are regional differences in the importance of grain weevil as a PHC as shown in Figure 3. According to FAO (1998) grain weevils have low status as pests of small grains primarily due to the limited grain size necessarily

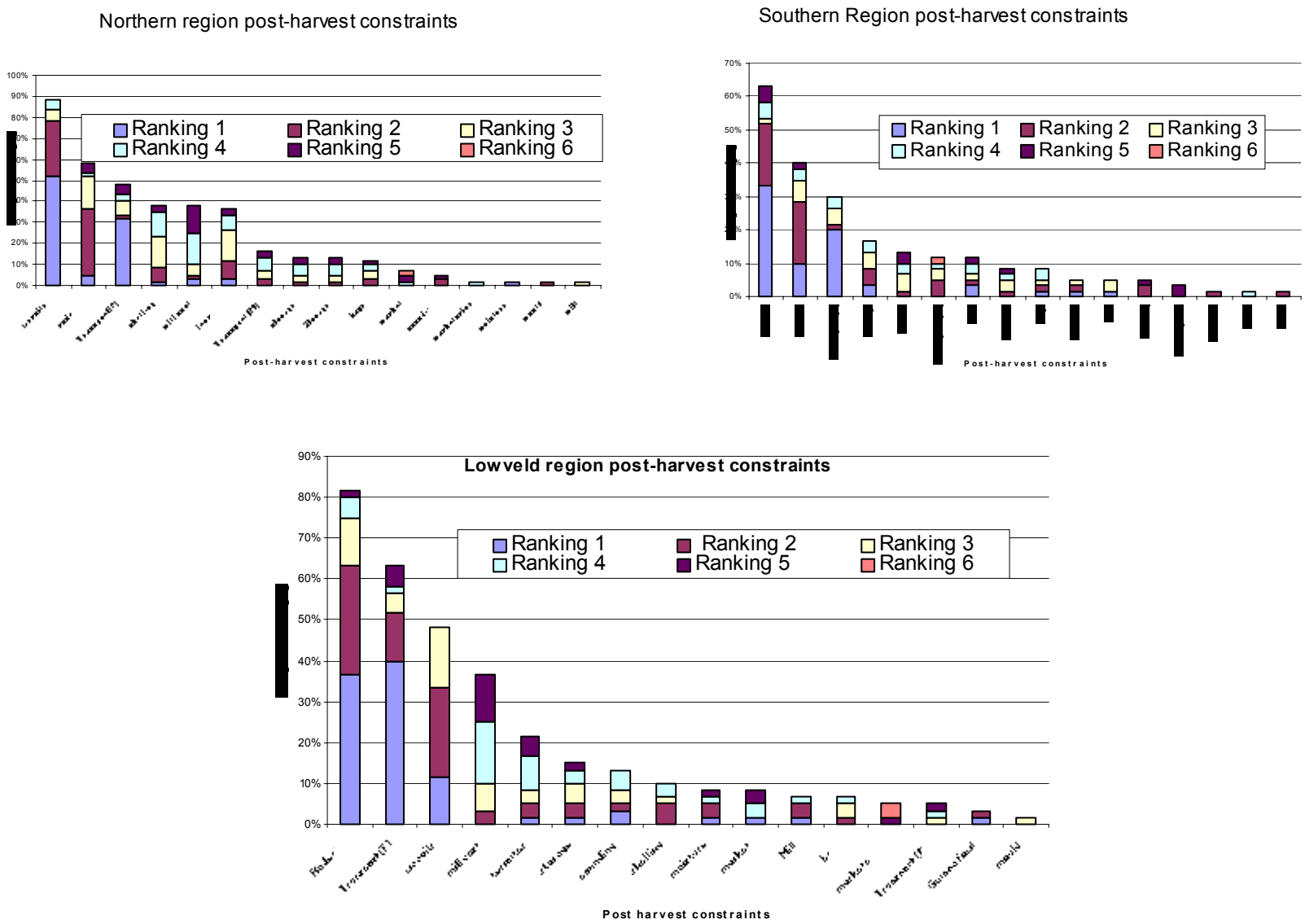

Figure 3: Ranked post-harvest constraints of major staple crops grown in the surveyed regions

needed for a complete larval development. Surprisingly, grain weevils is also the most important PHC in the Southern region where sorghum is grown mainly as a staple food.

5.2 Rodents

Rodent pests is one of the major PHC as expressed by 60% respondents in the surveyed regions. It appears to be of a major importance in the Lowveld region (82% of the respondents) followed by 58% in the Northern region and 40% of the respondents in the Southern region. FAO (1994) advances three major reasons why rodents are considered pests of major economic importance:

- they consume and damage human foods in the stores. In addition they spoil it by urine and droppings reducing the sales value. It is estimated that a hundred rats are capable of eating 200 kilograms of stored grains every year (Griggs, undated);
- through their gnawing and burrowing habit they destroy many articles (e.g packaging) and structures; and
- they are responsible for transmitting diseases dangerous to man.

5.3 Mould

There is some risk of mould damage to cobs during drying, especially if maize is harvested early and kept in poorly ventilated structures that do not facilitate rapid drying. In the surveyed regions mould seem to be a relatively insignificant PHC as equally expressed by at least 2% of the sampled households in each region.

5.4 Infrastructure

The majority of villages in rural areas are served by an inadequate and poorly maintained road network. The poor conditions of roads, which are often impassible especially during the rainy season, have adverse effect on the transportation of the produce. Transport generally marks the passage from one stage of the post-harvest system to the next. For the purpose of the study transport was divided into two categories. Transport needed to move agricultural commodities:

- from the harvest fields to farmers' storehouses, drying or store houses[2]; and
- from the farmers' storehouses to the processing industries[3].

Survey results reveal transport from the harvest fields to farmers' storehouses as relatively a major PHC. It is most problematic in the Lowveld region as expressed by 63% of the sampled farmers in that region, compared to 48% and at least 30% of the respondents in the Northern and Southern region respectively. As expected transport of produce from farmers' storehouses (home) to processing industries is, to a lesser degree, a PHC. It is relatively a major PHC in the Northern region as expressed by at least 17% of the sampled households in the Northern region, followed by 12% and 5% respondents in the Southern and Lowveld region respectively. Transport to the processing industries was never mentioned as a PHC in Vhurivhuri, Ga-Phaahla and Nkomo B. Interestingly, transport for the produce to the processing industries was never ranked as the most important PHC in any of the villages in all regions that mentioned it as problem (see Figure 3). Commercially, if the transport system is inadequate, the farmer may find it impossible to sell his/her product within the required time limits and in places where market prices are the most attractive. The fact of having to forgo a potential profit is beyond doubt a loss of money. Under this situation, then there is little incentive to produce for the market. In addition, surveyed households produce primarily for household consumption. This would then explain why road transport to processing industries is not regarded as a pressing problem.

Contrary to the above, however, is that 65% of the 85 farmers who mentioned transport from the harvest fields to home as PHC ranked it as the most important constraints. This is understandable taking into consideration that the transportation of produce from harvest fields to home is crucial towards the avoidance of the occurrence of other PHC. Weevil infestation builds up in the field when maize is left for a long period, and it then continues even during storage. Harvested grain left in the field can rot if late rains occur. In addition, delayed transportation of produce from harvest fields can bring about combined losses from attacks by birds (e.g. guinea fowl), rodents and termites. Though it is not rife, lack of transport in the Southern region also subjects harvested grains to social risk such as theft as mentioned by at least 2% of the sampled farmers in the region.

[2] *Herein referred to as transport (F).*
[3] *Herein referred to as transport (M).*

In most of the developing regions the road network is underdeveloped and agriculture is predominantly traditional. In the surveyed areas products are generally transported by head load as expressed by 37% of the respondents. The majority of these farmers (18%) are located in Vhurivhuri since most of their fields are situated along the hills. Products are often carried in small quantities over very bad roads and footpath. This to a certain extent does not encourage farmers to increase their production. Increasing production probably requires small farmers to readjust the local road network to the needs of product transport. To alleviate this disadvantage, the road network would have to be improved to permit development of a small-scale transport system to meet the needs of the farmers. As infrastructure improves, it opens up new markets and opportunities for farmers. The other widely used mode of transport in the surveyed regions include hired cart (21%) and hired tractor trailer (15%).

5.5 Grain processing

Some of the PHC shown in Figure 3 are experienced during processing. The processing of maize is slightly different from sorghum or millet processing. Processing of grains is a task performed almost exclusively by women. A summary of the gender of the person in charge of post-harvest activities is shown in Table 1 below. Of the sampled households, 68% of the post-harvest activities are performed by women whereas 31% of the activities are jointly performed by both men and women. Technological development initiatives geared towards the alleviation of post-harvest constraints must therefore be gender sensitive.

Table 1: A summary of the gender of the person in charge of post-harvest activities, 2001 (N=180)

Gender of person in charge	Northern region		Lowveld region		Southern region		Total
	Mapate	Vhuri-vhuri	Nkomo-B	Basani	Bloublomme-tjieskloof	Ga-Phaahla	
	%	%	%	%	%	%	%
Women	73	63	77	43	87	63	68
Men and women	27	37	23	57	10	33	31

The majority (57%) of the households store their produce shelled. The easiest traditional system for shelling maize is by pressing the thumbs on the grains in order to detach them from the ears. Beating of cobs placed inside a sack is another way of shelling maize. At Bloublommetjieskloof threshing of

sorghum is done on a swept threshing floor situated in the yard and is made from cattle dung, while at Ga-Phaahla threshing ponds are in the fields. Beating of sorghum heads by sticks is a commonly used way of threshing, but in some cases a tractor is sometimes driven over the sorghum to be threshed. Winnowing threshed sorghum can be an itchy task. Shelling or threshing is reportedly a laborious task. It appears to be a relatively significant constraint in the Northern region as indicated by 38% households relative to 10% and 5% households in the Lowveld and Southern region respectively. The introduction of small maize shelling tool by a researcher from Grain Crop Institute of the Agricultural Research Council during feedback visits was generally met with great enthusiasm. The main advantage of the tool is that it is fast and significantly reduces the pain felt on the thumbs. In addition, it can be made by local artisan and be available at an affordable price.

The majority of the sampled households (58%) milled their staple crops particularly in the Northern region. Few sampled households (14%) only used manual processing (pestle and mortar or grinding stone), whereas 28% of the households used both the manual methods and the mills. These households often dehull the grain manually and then used mills to produce the fine flour or uses mills only when they have sufficient funds. Lack of mills and possibly the resultant high milling cost is a limiting factor in the processing of produce. Lack of mills was mentioned by 4% of the sampled households, whereas high milling cost was mentioned by 28% of the sampled households with a greater number of respondents situated at both the Lowveld and the Northern region (see Figure 3). Interesting to note is that, in all the surveyed regions, lack of mills has been mentioned by far much less households than those mentioning high milling cost as a constraint.

5.5 High milling cost

Based on priori expectation, one would have expected high milling cost to be closely related to an insufficient number of mills available in the surveyed regions. However, the results of the survey seem to be inconclusive with regard to the existence of such a correlation. Again, the response magnitude on the lack of mills seem to indicate that the lack of mills is not, in relative terms, a constraint that need immediate attention in the allocation of scarce resources. Therefore, it is important to note that other millers do provide their own transport to some of the households. In most cases the milling cost is inclusive of the transport cost provided. Transport cost is primarily a function of the distance travelled and therefore is subject to variation. For instance, Mapate household farmers use a nearby mill in Duthuni village (almost 5km away) and it costs each household R6.50 for the 25 litre bucket milled, but it

costs those household not using the transport provided by the miller R0.50 less per unit. It is probably for this reason that milling cost was expressed as a major constraint.

5.7 Lack of storage facilities

Lack of storage was also listed as a constraint by 15% of the surveyed households. This problem primarily rests on the high cost and labour required to build granaries as well as the limited building materials. The current use of plant materials (wood) to construct granary structures has serious degrading effect on the environment and unless an alternative is found this will have some catastrophic results with rural households being the most vulnerable. Closely related to this, is a lack of bags to store the major staple crops. Maize is stored on the cob by 43% of the households, while 45% stored their staple crop shelled or threshed in bags and the remainder stored them shelled but loose.

Respectively, lack of markets and low market prices were expressed by 9% and 3% of the sampled households as PHC. It can be argued that the lack of market as well as low market price for the produce is probably, *inter alia*, a lack of storage facilities. Harvest usually occurs at the same time for all the farmers leading to a glut of produce that cannot be consumed immediately. Part of the produce that cannot be stored may therefore have to be sold at a relatively lower price because the surveyed farmers operate in a perfectly competitive market economy. It is therefore sensible to suggest that, in essence, these twin markets related problems are a symptom indicating limited value adding strategies that disable farmers to profit by market prices when they are at their best. Missing a profit is an economic loss for the farmer. It is also worth noting that access to rewarding markets is a stimulus towards production increase.

The success of any food loss prevention strategy means the availability of large quantities of commodities for consumption, sale *etc*. In some cases a surplus will be created for the first time, in others it will be an enlargement of the marketable amount. This could put pressure on the marketing system. It is therefore important that the marketing chain operators be made aware of the increased supply, so that it can be absorbed. Equally important to the above, is that such strategies or initiatives must be preceded by the establishment of the output market.

6 POST-HARVEST PROTECTION METHODS OF STORED GRAINS

This section focuses on post-harvest protection methods of stored grains. For the same reasons as in the previous section, results are shown on regional basis. Surveyed households were asked about the methods that they use to protect their stored major staple crop. The results are shown in Table 2 below.

Table 2: Method used by the surveyed farmers to protect staple crop against insect damage, 2001 (N=74)

Method used	Lowveld region		Northern region		Southern region		Total
	Basani	Nkomo B	Mapate	Vhuri-vhuri	Bloublomme-tjieskloof	Ga-Phaahla	
	%	%	%	%	%	%	%
Plant materials	17	13	3	3	73	50	27
Put on top of a tree	-	-	-	3			1
Smoke	17	-	-	-	-	-	3
Mud	-	-	-	3	-	-	1
Used plastic to avoid termites	-	3	-	-	-	-	1
Synthetic insecticides	3	3	3	-	-	-	2
Phostoxin tablets	-	-	27	10	-	-	6
Total	**37**	**19**	**33**	**19**	**73**	**50**	**41**

At least 41% of the surveyed households do apply preventative measures to reduce food losses. There are various methods of insect control for grains. The majority of post-harvest grain protection in the surveyed regions is evidently still based on traditional practices. The majority of the respondents (27%) use products of plant origin against storage insects, often ash. The use of plant material is rife in the Southern region where aloe ash in particular is used.

Another plant used particularly in Vhurivhuri village, unfortunately its scientific name have not been identified, is *monze*. The barks of *monze* are put with grains as a preventative measure. At least 17% of the surveyed households in Basani village used smoke from the kitchen fire often situated under the granary as protection against insect damage.

The use of these locally produced plant material has an advantage of creating local employment for the collection and transformation of raw materials. The

efficacy as well as the risk of toxicity of the use of these materials, however, still needs to be investigated.

Synthetic insecticides such as "blue death powder" (Carbaryl/gamma BHC) were also used. Interestingly, Phostoxin tablets are only used by farmers in the Northern region. This is possibly because farmers in this region has relatively easy access to the Northern Transvaal Farmers Co-operative. The granaries of the surveyed farmers are regrettably not completely airtight and as such the efficacy of the Phostoxin tablets used under this condition is questionable and doubtful.

Surveyed households were also asked whether they use any preventative methods against rodents damage to their stored major staple crop. In spite of the major food losses caused by rodents, at least 40% of the farmers surveyed use some preventative measures and are shown in Table 3.

The most commonly used method involves the use of chemical products such as rattex. This product (rattex) is used by the majority (24%) of the surveyed farmers in spite of the risk of rodents resistance associated with its use. According to FAO (1994) the increased tolerance to pesticides is a well-known pest management problem. FAO (1994) further argues that there is little doubt that much of the existing problem that affect many species of the storage insects and a wide range of insecticides stems from careless use.

Rodents are also controlled biologically using cats as expressed by 9% of the respondents. Biological control consists of introducing a natural predator specific to a pest with the objective of destroying it in a lasting manner. This type of control requires little effort on the part of the farmers. With the exception of Vhurivhuri, all other villages use traps to minimise post-harvest food losses. These traps, normally with bait, are placed where rats move regularly. In addition, sticky or glue traps are another way of catching rats. Glue traps are boards made of wood or cardboard covered with sticky material. This type of control is only applied in the Lowveld region as expressed by 3% of the respondents in Basani and Nkomo B villages. Finally flushing rodents out of their burrows by flooding them with water can be very effective and suitable in some situations (Meehan, 1984). This method is not a common practice in the surveyed regions.

Table 3: Rodent protection and control measures used, 2001 (N=72)

Control measures used	Lowveld region		Northern region		Southern region		Total
	Basani	Nkomo B	Mapate	Vhuri-vhuri	Bloublomme-tjieskloof	Ga-Phaahla	
	%	%	%	%	%	%	%
Cats	17	7	3	7	3	17	9
Traps	3	7	3	-	3	3	3
Sticky glue	3	3	-	-	-	-	1
Rattex (difethialone)	23	40	10	17	17	40	24
Cabaryl/ gamma- BHC	3	-	-	-	-	-	1
Pour water inside the rats hole	3	-	-	-	-	-	1
Mud	-	-	-	3	-	-	1
Total	**49**	**57**	**16**	**27**	**23**	**60**	**40**

Surveyed farmers were also asked about how they stored their seed as well as how they protect them against insect damage. Their responses are summarised in Table 4 and Table 5 below. In Table 4 the category "container" was used for those who did not specify what type of container. It is likely that there is an overlap amongst container, closed basket and a clay pot category. The majority of the farmers (43%) store their seeds in the house other than the kitchen, while 13% store their seeds in the kitchen. It is important to note that for a resource poor farmer, seed storage locations in most instances also act as a seed protection measure. For instance, some farmers argue that the fire smoke acts as a seed protectant particularly against weevils' damage, and hence the construction of granaries over the hearth or the kitchen as indicated by at least 4% of the respondents. In addition, it is for this reason why a distinction had to be made between the kitchen and an ordinary house. Table 5 on the other hand reveals that at least 8% of the surveyed households use smoke as a protection measure with the highest respondents' percentage (27%) in Basani.

Table 4: Seed storage location used by farmers surveyed in the Limpopo Province, 2001 (N=88)

Seed storage location used	Lowveld region		Northern region		Southern region		Total
	Basani	Nkomo B	Mapate	Vhuri-vhuri	Bloublomme-tjieskloof	Ga-Phaahla	
	%	%	%	%	%	%	%
Closed basket	-	1	27	-	-	-	5
Container	-	13	10	30	3	3	10
In clay pot sealed with mud	3	-	-	-	-	-	1
In bags	-	3	-	-	-	-	1
In drums	-	7	-	-	-	-	1
In granary	7	20	7	13	-	-	8
In granary situated over hearth/kitchen	17	-	-	-	3	3	4
In house (other than kitchen)	37	20	37	27	70	70	43
In the kitchen	30	17	13	3	7	7	13
Hang in tree on cob	-	3	-	3	-	-	1
Under a shelter	-	-	-	-	-	3	1

Another seed storage location method that is interesting to note is the one wherein cobs are hung on the tree with their sheath. This method as shown in Table 4 is applied only in remote areas of the Lowveld and the Northern region as equally expressed by 3% of the respondents in each region. The sheathing leaves that completely encloses the entire cob provides a considerable protection against weevils. Storage on the cob in the sheath, which does not significantly impair the grain-drying rate reduces the status of the grain weevil as a pest and is beneficial where weevils are the main threat. FAO (1994) argues that even without the sheath, grains on the cob are considerably less susceptible to weevil attack than the shelled grains. It is probably for this reason why 42% of the surveyed farmers store their staple crops on the cobs. Thus, the form and the location of storage play a crucial role in reducing post-harvest losses. From Table 5 it is evident that seed protection measures are not significantly different from staple food protection measures previously discussed.

Table 5: Seed protection methods used by the surveyed farmers in the Limpopo Province, 2001 (N=61)

Seed protection methods used	Lowveld region		Northern region		Southern region		Total
	Basani	Nkomo B	Mapate	Vhuri-vhuri	Bloublomme-tjieskloof	Ga-Phaahla	
	%	%	%	%	%	%	%
Plant materials	27	27	3	17	67	53	32
Paraffin	7	-	47	37	-	-	15
Smoke	27	7	7	7	3	-	8
Blue death (Cabaryl/ gamma-BHC)	-	-	-	3	-	3	1
Doom (dichlorvos/ d-phenothrin)	-	3	-	-	-	-	1
Cattle dip	-	-	-	-	3	-	1
Phostoxin tablets	-	-	10	-	-	-	1
Cement powder	-	-	-	3	-	-	1
Airtight container	-	3	-	3	-	-	1
Maize sheath	3	-	-	-	-	-	1
Mix with wet or dry manure	-	-	-	-	-	3	1

From the above discussions it is clear that farmers, *inter alia*, rely upon chemical, mechanical and biological control methods to alleviate post-harvest production losses. The minimisation of grain losses, particularly losses caused by rodents, relies largely upon the reactive strategy. It is crucial for any control strategies to aim at preventing losses and this require a pro-active rather than the more normal reactive approach. The maxim "prevention is better than cure" is just as true for post-harvest insects pests as it is for other pest and disease control.

7 CONCLUSION

The objective of the paper was to assess the PHC affecting main staple grain crops grown in some selected regions of the Limpopo Province. The PRA revealed a diverse number of PHC affecting the small-scale farmers in the province. The ranking of the constraints reveals also those constraints in need of urgent research development and technology transfer if the present aim of

small-scale farmers' development and commercialisation is to be realised. Importantly, to stay in business small scale farmers need to become more integrated with upstream processing of their produce.

Unfortunately, South Africa does not have a long history/experience of post-harvest research and extension activities. Previous research focused on production with very little emphasis on post-production sector. Thus, investment in post-harvest research and extension activities is imperative towards the achievement of food security, poverty reduction and the sustainable use of resources. Care should be taken into account not to aim at reducing food losses per se, but include institutional arrangements, processing industries and market information. Research results seem to indicate that more post-harvest research work should be done and should recognize and complement the indigenous knowledge possessed by the communities as shown by various methods used to prevent the post-harvest losses.

Lastly, from the control point of view chemical control is considered as the most effective technology for protection of stored products. More importantly, the employment of pesticides should be socio-economically acceptable. This can best be accomplished if farmers are actively involved throughout the technological development phases. Furthermore, there is a need for farmer training on safety and use of pesticides to avoid, *inter alia*, unnecessary resistance of pests to insecticides. This can partly be achieved through the improvement of the labelling of pesticides and such labelling should be in vernacular or local language.

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