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DETERMINING THE "SAFE" STORAGE MOISTURE CONTENT OF YOUR MAIZE ON THE FARM USING THE SALT GRANULE TECHNIQUE

(Technical Note prepared for the Post-harvest Development Unit, Crop Services Division, Ministry Of Agriculture, Ghana, As Part of the National Post-harvest Training Programme)

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SUMMARY

This technical note gives a procedure for determining the maximum moisture content for safe storage of maize grains by the Salt-granule technique.

It also contains simple procedures for drawing representative samples of maize grains for determining moisture content.

It is hoped that the procedures given as well as the comments made would be of tremendous value to agricultural extension officers in helping farmers in the proper management of their stored maize.

1. INTRODUCTION

Regular monitoring of moisture content levels during storage of maize grains is an essential feature of proper storage management. Usually farmers have their own methods for assessing the moisture content of the maize grain. These include pressing the grain with the thumb-nail, crushing the grains between fingers, etc. Though these techniques provide fairly reliable methods for determining grains suitability for storage, they are however too subjective for good estimation of safe storage moisture level. The best alternative should have been the use of moisture meters. However, these are seldom available when and where they are needed. Moreover, most of them are too complicated and\or expensive for farmers to use. A technique which makes use of "Cooking salt granule" has been suggested. (FAO, 1985).

2. THE PRINCIPLES OF THE TECHNIQUE

The underlying principle behind this technique is that, ordinary cooking salt is hygroscopic. This means that cooking salt will take up (or absorb) moisture when exposed to a humid air. Conversely, when the air is relatively drier than the salt, it will give up (desorb) water.

All stored durable commodities, such as foodgrains are similarly hygroscopic.

Whether the cooking salt or the food commodities would absorb or desorb moisture depends on the relative humidity of the air surrounding it. At a given ambient temperature, there is a specific relative humidity at which the food commodity (salt or maize) does not absorb or desorb moisture. That is, the moisture in the air is said to be in equilibrium with the moisture in the food commodities.

This relative humidity is referred to as the Equilibrium Relative Humidity (e.r h.) and the corresponding moisture content called the Equilibrium Moisture Content (e.m.c.)

At ambient temperature, that is around 30^{0}c, the equilibrium moisture content (e.m.c.) of most foodgrains is about 15%. Figure A (Appendix I) shows this relationship.

Dry salt creates an atmosphere which has an e.r.h. of about 70% of the air around it; the equivalent e.m.c. is 15%. This explains why dry salt can be used for estimating the m.c. of grain.

From the above principles, if a small amount of dry salt and a few maize grains are brought into close proximity - in, say, a small transparent glass container and allowed to equilibrate

for a few hours, one could determine whether the moisture content of the grains is more or less than 15%.

2.1 Explanation Of Equilibrium Moisture content (e.m.c.) And Equilibrium Relative Humidity (e. r. h.)

All stored durable commodities are hygroscopic. Thus, if grains are placed in a situation where the ambient air is humid the maize grains will take up (absorb) moisture. Conversely when the air is dry the produce will give (desorb) moisture.

If maize is placed in an enclosed container, the moisture content affects the RH of the air and this will fairly quickly come to equilibrium at a new value. The equilibrium value is constant at any given temperatures and is called the equilibrium relative humidity (e.r.h.). The moisture content of the maize, at this point, is referred to as the equilibrium moisture content (e.m.c.).

From the above explanation if the salt placed in the glass container together with maize grains become wet, it means the moisture content of the maize grain is more than 15%. If the salt is wet, it will stick to the base of the container and\or adhere to the walls as the glass container is gently whirled about.

2.2 The "Safe" Moisture content:

The moisture content of a commodity is commonly defined as the weight of water in the sample, expressed as a percentage of the total sample weight.

The safe level of moisture for storage is defined as the moisture content in equilibrium with 70% RH at the specified temperature. This humidity level is approximately the lower limit for development of fungi.

For the safe storage of maize, conditions of temperature and moisture must be kept at ranges at which they will not be favourable for the growth of stored-product insects and fungi. In Ghana, with the average ambient temperature around $30^{0}C$ in most places, a moisture content of 13.5% or less would have been the ideal moisture content. However, because of the high RH in most of the maize growing areas in Ghana, the stored maize grains is most likely to equilibrate to 15% e.m.c. Thus, the 15% m.c. should be considered as the maximum level of m.c. permissible for safe on-farm storage.

The "safe" moisture content therefore means safe from mould growth. However, many insect pests can develop at lower humidities and these must be controlled in other ways.

2.3 Sampling of the Maize Grain

In simple terms, sampling may be described as a process of obtaining from a given quantity of maize, a small proportion of it which is such that it has all the physical, chemical and biological attributes of the main stock of grain.
it is always necessary to take a sample because it is impossible to determine the m.c. of the whole amount of maize. Sampling must always be carefully done in order to obtain the small amount needed for determining the m.c. This is because improper sampling can easily lead to errors.

2.3.1. Types Of Sample

i. Each probeful or handful of grain obtained from a bulk or sack is called a primary sample.

ii All the primary, samples combined together in a suitable container form a composite samples

iii Since the composite sample may be too large it is reduced in an appropriate manner to the submitted sample.

iv. Further reduction of the submitted sample gives the working sample on which the actual test is performed. The size of the working sample depends on the nature of the test. For the determination of the m.c. by the salt test technique, a few grains up to 50 in number can be considered as sufficient.

2.3.2. The Sampling Process

(a) Sampling equipment : - These include sampling spears, and bag samplers. Fig B and C show examples. (Appendix II).

The Sampling spear consists of a hollowhead attached to a shaft.
The shaft is often divided into two or three lengths for convenience of handling. The head remains closed whilst being pushed down into the grain, but opens when the spear is withdrawn, admitting a sample which is withdrawn with the spear.
The Bag sampler is a hollow tube with an inlet slot cut into the tube wall.

(b) Sampling by hand: - This is not a good method to use, but when it has to be resorted to care should be taken that the fistful of grain is held tightly so that, no grain escape. To sample from the bottom of a sack it may be necessary partly to empty the sack.

(c) A practical guide to sampling:

	Storage method	Sampling method
i.	Sacks: for up to 5 sacks, sample every sack. For 6-30 sacks, sample one in three randomly selected. For over 31 sacks, sample one in five, but not less than 10 sacks.	Take samples from the top, middle and bottom of each selected sacks by spear, sampler or by hand.
ii.	Bulk (ie. heaps, bins etc)	Take samples from a least ten different parts of the bulk and from various depths. Samples taken only from the surface are not representative of the whole bulk.

2.4 Sample Reduction (Coning and quartering) (Golob,1976)

The representative samples obtained, as above are pooled together as the composite sample and reduced to a working sample by the following.
The composite sample is poured onto a flat surface; and it takes a shape like a cone. The bulk is then divided into halves, and then quarters using a flat piece of wood or the side of the palm.

Bulk together two diagonal sub samples and then cone and quarter. If the sub-sample to obtained is still large, continue to "cone and quarter" until a reasonalbe working sample is obtained. The working sample is used for determining the moisture content.

3. INSTRUCTIONS ON THE SALT GRANULE TECHNIQUE

3.1 The Salt

- (a) Ordinary cooking salt (either granulated or coarse) is suitable. However, refined table salt is not suitable because it contains iodine.

- (b) The salt to be used must be dry. If the salt is slightly moist, drying of the salt can be

speeded up by adding a pinch of clean wood - ash, spreading it out in a cooking metallic pan and allowing it to sun-dry.

3.2 The Glass Container

- (a) Any small transparent glass bottle will be suitable. For example, the old "APC" tablet bottle can be used. Plate 1 shows examples of these bottles.

- (b) The bottle must be thoroughly cleaned and dried.

3.3 The Test:

- (a) Place about 2-3 teaspoonfuls of the dried salt into the clean bottle.
- (b) Add about 5-10 maize grains, from your representative sample, to the salt in the bottle.
- (c) Replace the lid firmly and shake gently. If the bottle does not have a lid, improvise one for it using a cork which must be firmly fitted.
- (d) Allow it to equilibrate for 6 hours or if possible overnight for best results.
- (e) Gently whirl the bottle in your hand, and observe.

3.4 The Observations

- (a) If the m.c. of the grain samples is more than 15%
- i. For the granulated salt:- The salt in the bottle appears slightly wet, usually sticking to the base and sides of the bottle. Occasionally, one or two maize grains may become covered with the salt particles.

- ii. For the coarse salt-granules: The surface of the crystals of the big granules of the salt become lightly shiny indicating that it is covered with water. The salt may also become stuck at the base and on the sides.

Note that the above observations become more pronounced, the higher the m.c. of the grain. You may even notice little droplets of water on the sides of the bottle.

(b) If the m.c. of the grain samples is less than 15%

For both the granulated and coarse salt-granules, it will be observed that as the bottle is being gently swirled around in the hand, the salt and grains "flow" together.

3.5

ALTERNATIVE METHOD

An alternative method which requires the use of a piece of paper instead of a bottle is described below. This method though faster is not as efficient as the one described earlier.

The method:

(a) A dry salt is obtained as described above.
(b) A teaspoon full of the dried salt is spread on a sheet of paper which must be clean and dry.
(c) Add about 5-10 grains from the representative sample to the salt on the piece of paper.
(d) Gently shake and\or use your forefinger to stir the mixture of grains and salt.

THE OBSERVATION: If the moisture content of the grain is more than 15%, salt particles will collect around the grains. If however, the grain has a moisture content less than 15% there will be no apparent interaction between the salt and grains.

4. COMMENTS

This technical note forms part of work being carried out at the Food Research Institute on indirect methods of determining the moisture content of food-grains. Work so far carried out on seven different varieties of maize (Dobidi, Aburotia, Ableehe, Okomasa, Safita S)R), Dorke SR and GH 8363 SRC2) indicates no varietal influence on the efficiency of the salt - granule techniques.

The problem with the method however, would appear to be the availability of small transparent glass containers to be used for the test.

In the study, one common bottle that was found usable for this test is the "APC" tablet bottle. This is aside from the more scientific universal bottle. Polystyrene or plastic containers were found not to be suitable. Apart from the difficulty in getting very transparent containers, the wet salt does not stick to bottle or

sides apparently because of smooth surfaces of these containers. This means a clear positive test is difficult to obtain.
Results on other food grains ie.sorghum, millet, groundnut, etc will be made available later.

5. CONCLUSION

This salt-granule technique can be used to determine adequately that a given quantity grain has a moisture content of 15% or not. it is therefore an important technique which agricultural extension officers can safely use to help farmers in the proper management of their stored grain.

6. ACKNOWLEDGEMENTS

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My thanks are also due to the Director, Crop Research institute for giving samples of the seven new varieties of maize used for the study.

7. REFERENCES

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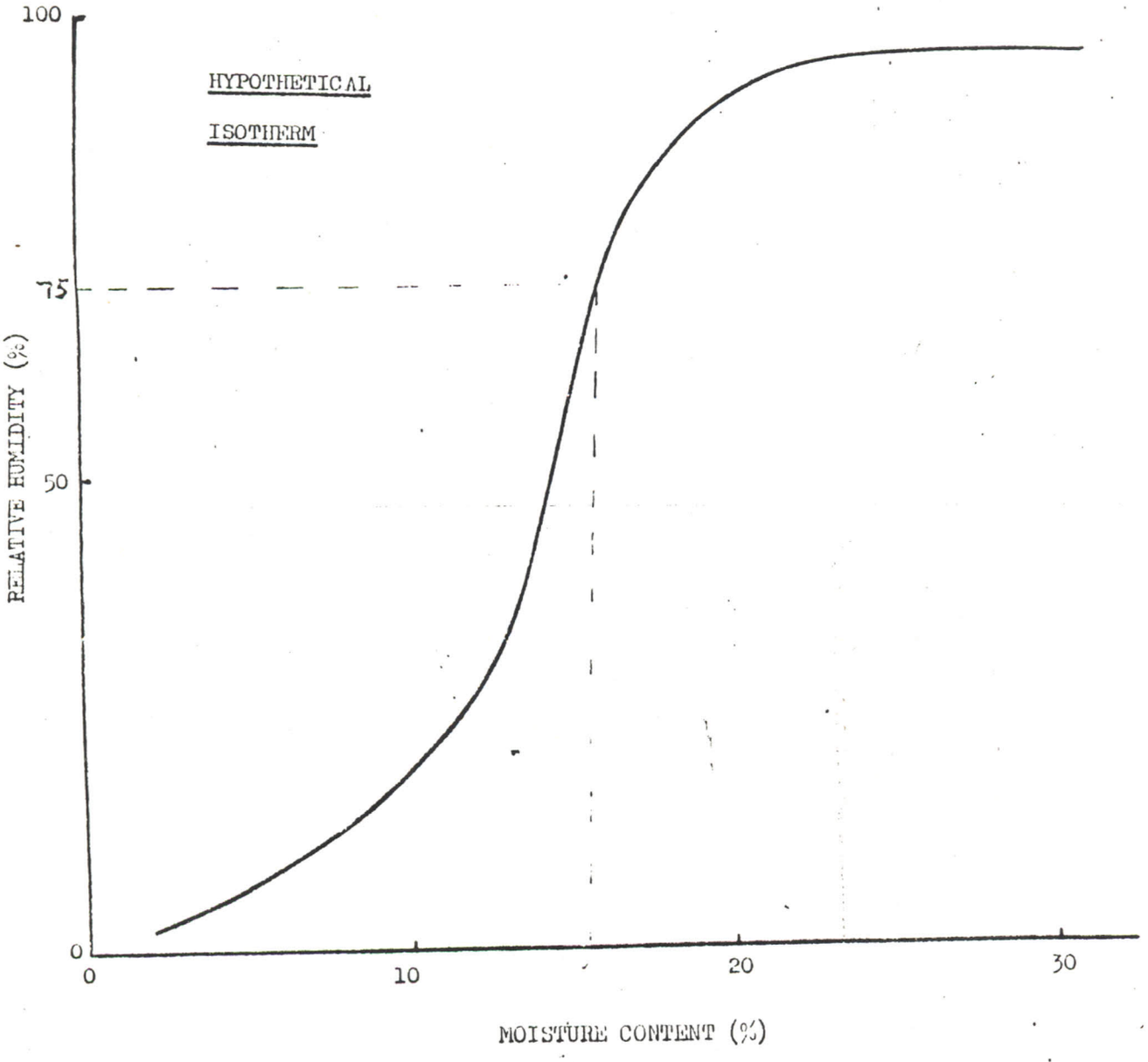
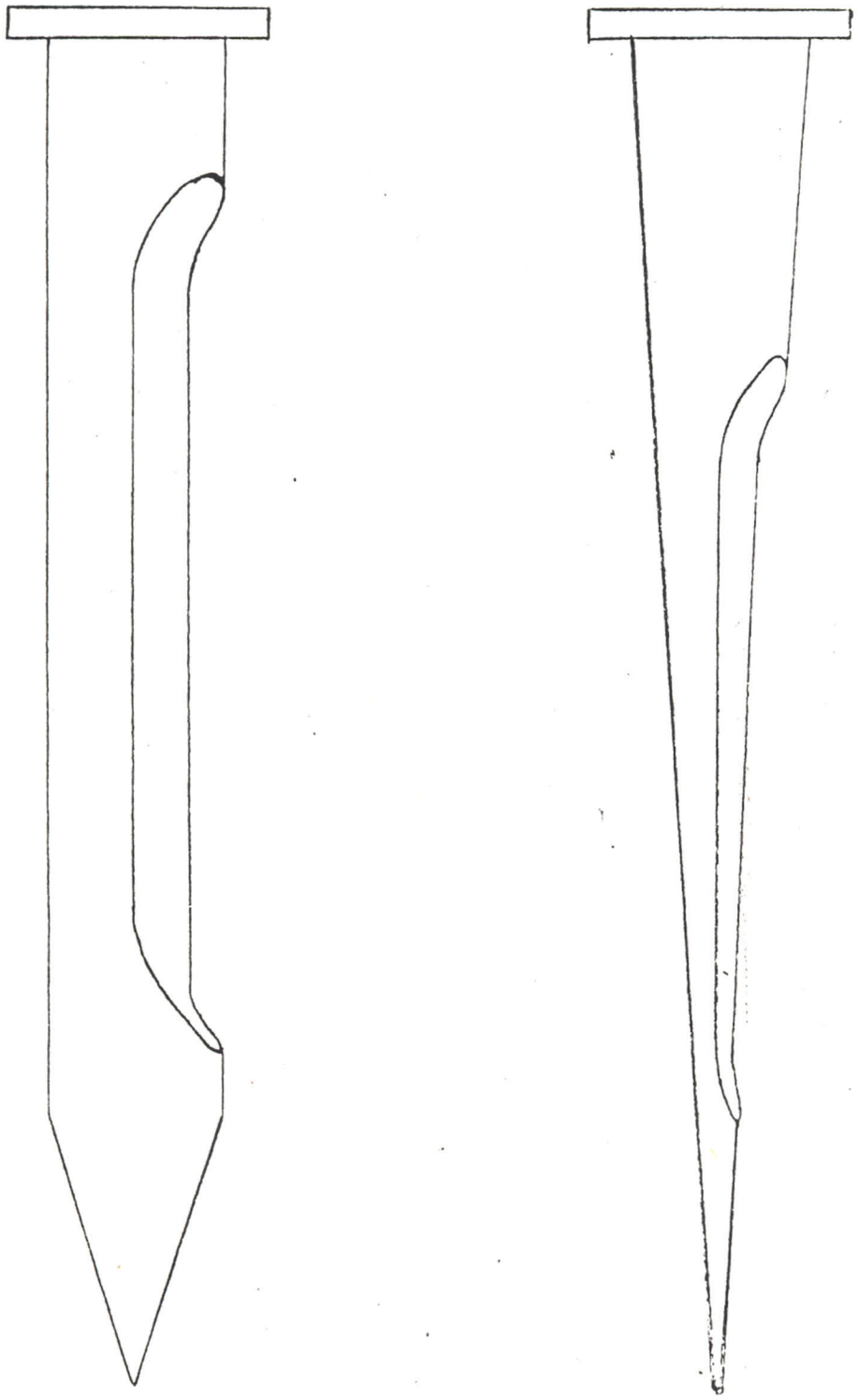
APPENDIX I

FIGURE A



NOTE: The isotherm does not represent precisely the behaviour of any particular commodity but shows the generalised form of the curve.

Figure B Simple Bag Sampling Spears



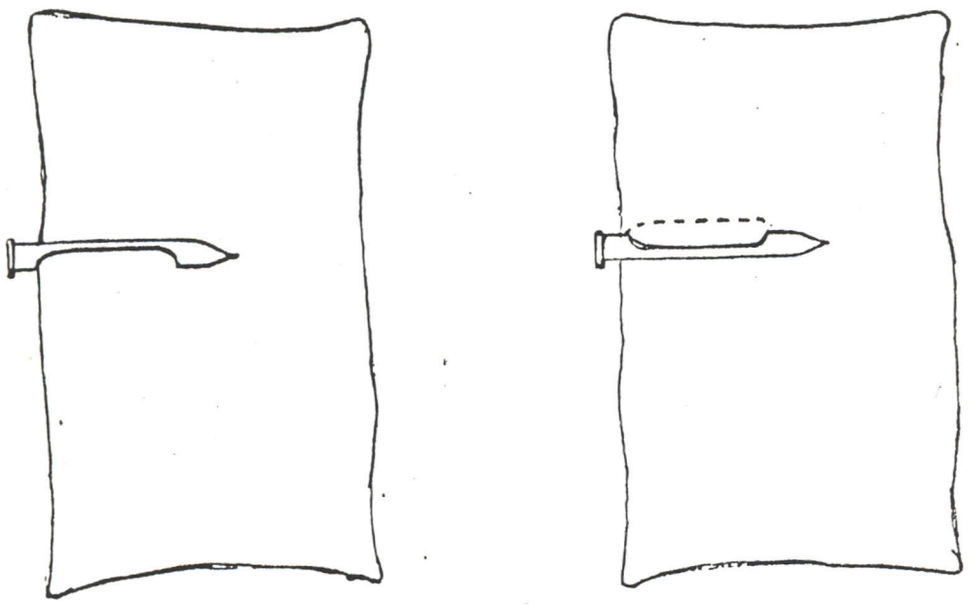
A. Cylindrical

B. Tapered

FIGURE B (ii)

Using The Simple Bag Sampling Spears.

Correct. A sampling spear inserted with its open side facing downwards and then turned through 180 degrees collects a more representative sample.



Incorrect. A sampling spear inserted with its open side facing upwards is filled with grain from the outer few centimetres only.

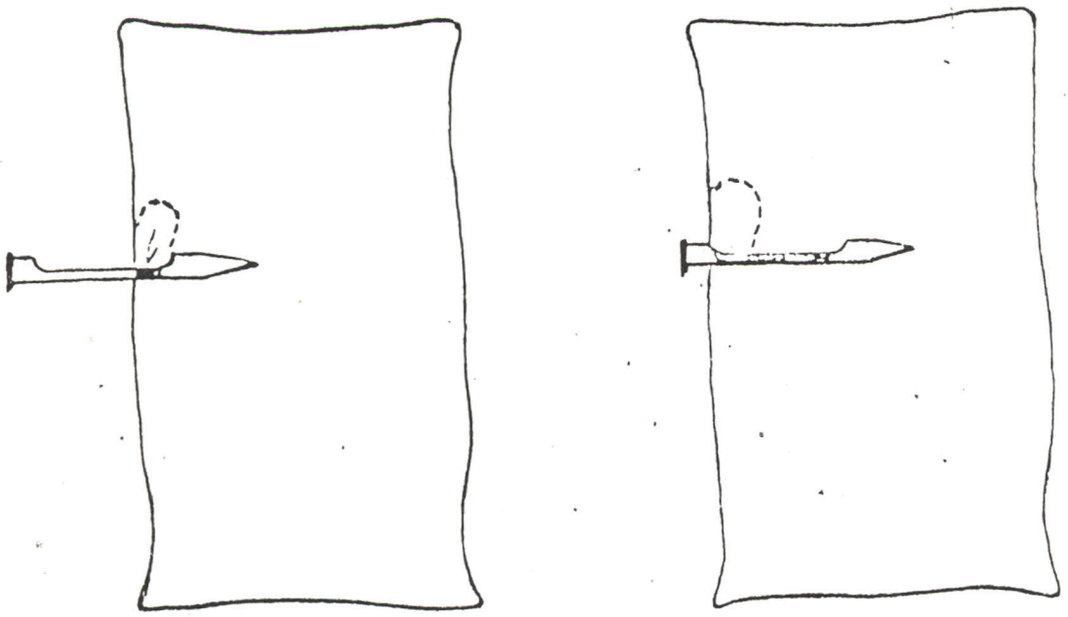


FIGURE C

Double Tube Sampling Spear.

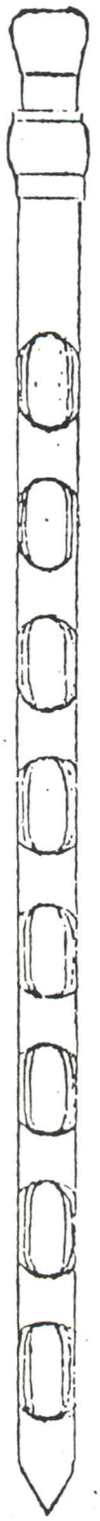
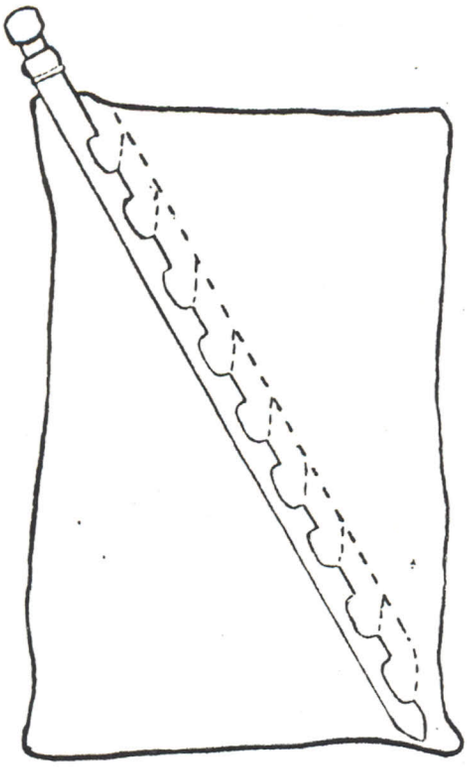
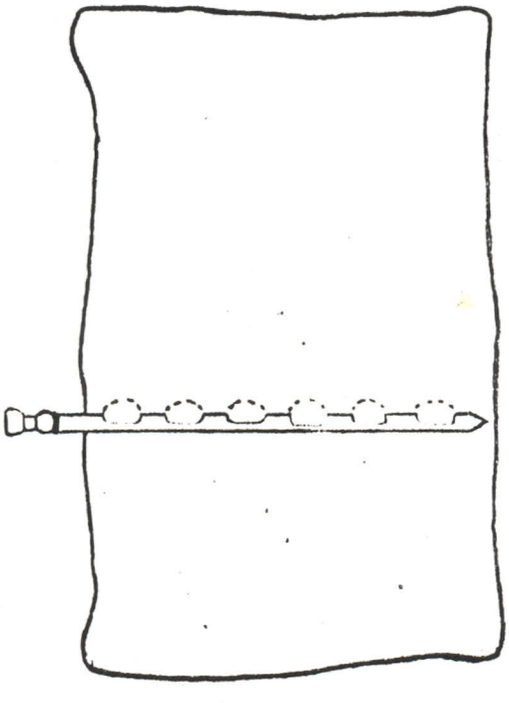


FIGURE C(ii)

Using The Double Tube



A. Diagonal insertion through mouth of bag



B. Horizontal insertion through side of bag