PN-AAR-769
ISN 38143

POSTHARVEST INSTITUTE FOR PERISHABLES

Recommendations for Onion Production, Drying and Storage in Panama

by

Archie M. Dessert

for the
U.S. Agency for International Development

and the
Postharvest Institute for Perishables

University of Idaho

in cooperation with
United States Agency for
International Development

GTS Report No.
PIP/Panama/Mar 84/No. 41

Recommendations for Onion Production, Drying and Storage in Panama

by
Archie M. Dessert
Consultant

for the

Postharvest Institute for Perishables
University of Idaho
Moscow, Idaho 83843
U.S.A.

March 1984

Table of Contents

Page

I. Introduction.....1
II. Production in the Mountain Area.....2
III. Cultural Practices in the Mountains.....3
IV. Cultural Practices in the Lowlands.....4
V. Drying in the Mountains.....6
VI. Drying in the Lowlands.....7
VII. Storage.....8
VIII. 1980-1981 Onion Production and Sales in Panama.....9
Appendix I Encuestas Sobre Cebolla.....10
Appendix II Informacion de Interes con Relacion al Secado de la Cebolla.....15
Appendix III Pictures of Dryers and Some of the Equipment used in the Dryers in Texas.....33
Appendix IV Split Burner Unit.....36
Appendix V Arco Seed Co. 20 Boxes Dryer.....40
Appendix VI Letter, John A. Calandri.....42
Appendix VII Onion Storage Building.....50
Appendix VIII Onion Storage Building.....51

RECOMMENDATIONS FOR ONION PRODUCTION, DRYING, & STORAGE IN PANAMA

I. INTRODUCTION

Onions are one of the most important vegetables in the diets of almost all people throughout the world. They are cooked in many different ways. They can be eaten raw, or mixed with the other vegetables to make sauces. There are many publications written about the value of the onion, and as cultural practices improve throughout the world, the total consumption of onions is constantly increasing. The onion used as a spice in dishes can add zest to a very bland diet. If produced properly, it can be a very inexpensive food.

Onions are basically classified as short-day or long-day varieties. There are some intermediate-day varieties. In Panama only the short-day varieties or the earliest of the intermediate varieties can be grown. As a general rule, the short-day varieties are very sweet, which means that they are low in solids, and do not store well. There are some exceptions to this, namely the Creole, which can be classified as a short-day onion. It is a little on the late side in maturing but is very high in solids. There are hybrids from this onion that should do well in Panama and that could be stored from three to five months.

There has been much done in the last forty years on breeding different genetic traits in onions. Solid contents in onions now run from around 6.2% to almost 25%. The varieties with high percent solids are used for dehydration. They are very good for cooking but are not good raw, such as in salads.

This report will be on the three different topics, production, drying, and storage. All figures are given in pounds and acres.

There are two distinct growing areas in Panama. The mountains, which are Boquete and Cerro Punta, where more than one crop can be grown a year. Onions can be produced there for a long period of time, even in the wet season.

The second area is the lowland. It would be advantageous to try to produce onions in that area after the rains begin. The main objective here is to grow a much healthier onion which can be stored better, and to increase the production considerably. It is believed that all these goals are very attainable.

II. PRODUCTION IN THE MOUNTAIN AREA

The mountain area is producing the best onions in Panama at this time. The growers are getting fair production; however, they could get higher production and more storable onions with better cultural practices. Two types of extension work is needed in this area. First, variety trials, which would include many varieties and different planting dates. The other is cultural practices.

I have shipped 25 varieties for trial all over Panama. These need to be planted and notes taken. The information gathered from these trials could then be evaluated with some recommendations being made. It is very important that a follow-up be conducted on these trials and readings taken. It is very probable that some of the later maturing onions can be found that will produce high yields, have higher solids, and be well matured for storage for a reasonable length of time.

An example of a good field trial was visited in Boquete. It would provide valuable information if all the data were obtained. At the time of the visit the following were evident:

1. There is a seed stem problem in this production area when the varieties are planted in the seed bed too early. This is why information from numerous planting dates is needed to determine when it would be possible to plant some of the better storing varieties that are available today and that do not have the seed stem problem. Breeding is going on that might solve this problem, and some new high-solid, short-day onions are becoming available that will not bolt the first year. There has been some very good new genetic work done on this.
2. One of the mid-season onions, New Mexico Yellow Grano, is starting to produce a bulb. This shows us that it may be possible to grow some later-maturing onions that are good for storage, if they can be planted early enough to be harvested in the dry period.
3. There were some Spanish varieties in the trial which were not forming any bulbs whatsoever. It shows that the late intermediate types cannot be used.

4. There were two new experimental varieties already harvested before the visit on March 5, 1984. These onions were about two weeks ahead of any other varieties, particularly the two main varieties, Granex 33 and Standard Yellow Granex PRR. This shows that if the newer and earlier onions are planted at the same time, it will be possible to add up to a month more of harvest in the early part of the year, so total storage time can be reduced.
5. These trials did show that there was pink root and possibly Fusarium in the soil. Therefore, it is imperative to stay with the newest varieties that have the best pink root and other disease resistance, plus the use of some type of rotation in the mountain area.

III. CULTURAL PRACTICES IN THE MOUNTAINS

Cultural practices are fairly good in the mountain area but they definitely could be improved. The first improvement would be to work out a much better system on the growing of their transplants or putting in their seed beds. Onion seed is expensive and the growers are using too much seed when they are doing it on a transplant basis per acre of total production. There are two reasons why they are doing this.

1. They are not getting sufficient germination in their seed beds. Their seed beds are not formed and shaped firmly enough. Their seed is scattered around and covered by hand, causing irregular depth, thus they are not getting good germination.
2. The plants are being transplanted too thickly. They may be able to space their plants a little farther apart in the rows and between the rows on the beds.

The method of applying fertilizer could definitely be improved to obtain a more uniform rate. This is probably one of the reasons why some of the onions are big and some are little in some of the fields in the mountain area. To get more uniformity it would be better to spread the fertilizer by machine, particularly the initial fertilizer that is put on the ground before the beds are made. It might be possible to apply fertilizer in the water through the sprinkler systems, as most of the onions in the mountain areas are sprinkled.

As a whole, the farmers in the mountain areas are doing a good job in the use of fungicides and a fair job on the use of herbicides. Labor is very inexpensive and it is sometimes almost as economical to hand weed as it is to use herbicides. There is a lot of work that could be done by a good extension person on the use of different herbicides in that area and to find out how they react. All in all, the mountain area is turning out a fairly good onion; however, it is possible to get increases in yields from 30 to 70% just through better cultural practices.

Hormones or growth regulators could be tested for growing bulbs. This could involve the use of foliar fertilizers or sprout inhibitors, such as maleic hydrazide. This would inhibit sprouting and root growth on stored onions.

IV. CULTURAL PRACTICES IN THE LOWLANDS

The lowlands have the potential of producing a good crop of onions, but it is probably going to be a very difficult situation to completely convert most of the growers over to a different system. Their planting date has to be much earlier, particularly if they want to grow some of the earlier intermediate types and better storage types of onion. It seems to be very difficult for most of the people in the lowlands to get their plants started much before the very end of the rainy season. It would give them a big jump if they were started in late September, mid-October to the first of November. The growers could have a large transplant to put in the ground if they could get their ground worked up in December. This whole area has a low production record, and it is likely that double, maybe quadruple, total yield per acre could be obtained if they can get the right cultural practice system worked out. They rely on hand labor for almost everything. It appears that some equipment is going to be necessary, particularly where the growers go together and are growing big fields of onions.

It is important for the growers to get away from the system of growing onions in pans 6-7 ft wide and 12-20 ft long. They fill the pans with water once a week where it is over the tops of the onion bulbs. They are never going to be able to grow onions that will store if they run water over the tops.

It would be impractical to set up a lot of drying and storage warehousing in this particular growing area until they have a product coming out of the field. Somehow the onions must be gotten out of the water and up on a bed where they can grow a decent root system. Here agin, an extension service is needed to set up different systems and different ideas of growing onions. A good system could be to use a 20- or 40-inch bed, make the furrows, and irrigate, putting the water in the bottom of the furrows and bring it up the side of the bed to the onion. A bigger transplant will be needed, putting it in the soil on the side of the bed about an inch and a half to two inches deep. Turn the water in, and the water will be seen to sub up. Then a real good root system will be produced.

With the system described above, it is necessary to make sure that the original fertilizer is applied. This probably could be done mechanically, as most of the ground in these areas is quite flat and very irrigatable.

The growers were doing a fair job with their fungicide in keeping their leaves in good shape, but they could always improve. They can learn more on herbicide application, and growth regulators which can be used on the foliage for inhibiting sprouting and root growth in storage.

The following onions should be put in trial at both areas of Panama. Varieties are listed by company or origin.

1. Asgrow — Granex 33 F.
   Granex 429 F.
2. Texas A&M — 10-1 open
   10-15 open
   10-30 open
   11-10 open
3. Yate New Zealand Tropic Gold open type of Grano
4. Arco Seed Co. Gold Rush PRR F. Very early higher yielding than Y 33
   Special 38 PRR F. Globe shape very high yielding
   Early Premium PRR F. Globe shape very early small firm
   Dessex PRR F. Thick flat high yielding fair storage
   Early Supreme PRR F. Early white maybe for export

Robust PRR F. White for export very workable onion
Red Granex PRR F. Firm red onion, looks good in wet season also
Red Grano PRR open. High yielding red onion
Ringer Grano PRR open. Type of 502 Grano, more round
Colossal PRR PVP open. Very large, high yielding
Early Grand Grano PRR open. Very early, higher yield than Y 33
Yellow Granex PRR F. Later than Y33, higher yielding
Burgundy PRR open. High yield, very strong root system
Red Creole PRR PVP open. Very pungent, good keeper
Yellow Creole PRR open. Very pungent, good keeper
Golden PRR F. Pungent, good yield, good keeper
Tropicana PRR F. Pungent red, good yield, good keeper
Glory PRR PVP open. Medium late, good keeper
Regal PRR PVP open. Red medium late, good keeper
New Mexico Yellow Grano PRR open. Medium late high yielding, good eating
Texspan PRR PVP open. Medium late, good keeper, some Spanish blood in it

These varieties should be tried both in the mountains and in the low lands but in low lands the seed beds should be started in late September or early October. On these later maturing varieties it is necessary to get the extra growing time.

V. DRYING IN THE MOUNTAINS

The growers do not seem to have any trouble drying and curing their onions in the mountain area during the dry season. It is recommended, with their inexpensive labor, that they pull their onions and windrow them like they do in the Southwestern United States. Put one onion over the top of the other so that the tops are shading the bulbs. Leave them for three to five days so

that the necks go down real tight and the tops go into the bulbs. This will produce a little harder bulb, a little higher in solids, and one that will definitely store better.

If the onions are going to go into storage, and they are dried down almost completely before they are clipped, it would be a good idea not to be completely packed or finished packed after they have been topped and bagged. Use burlap bags, bring them into the warehouses, which most growers have, and set up some way to blow air over them for three or four days during the hot part of the day. Either bring the air in up underneath the wooden sheds that are in the area, or build some kind of storage and curing shed system. There are diagrams of a dryer attached to this report that is being used in Texas and California. A pamphlet describing the system has been distributed in Panama already. Some work is being done by Dr. Mark Gaskell, whose ideas should be considered.

This forced drying system would definitely have to be used on the onions in the mountain area if they are able to grow them during the wet season. They would have to get them out of the field the best way possible, definitely be force dried, and then probably be shipped to market. Some experimental work will have to be done to determine whether onions harvested in the wet season would be suitable to be put in storage even if they were force dried and cured.

VI. DRYING IN THE LOWLANDS

For the present it does not appear to be feasible in only the lowlands to try to produce onions that would only be harvested during the dry period of the year. It would be mandatory to make sure that practically all onions were out of the ground before the wet season began. That is why there is emphasis on getting the plant beds started as much as two months earlier, so that the growers could have big plants of intermediate-type onions that could be transplanted early in December to the fields and grow a much larger and better cured onion. There would probably be no trouble at all in drying and curing these onions during the dry season in the lowland area. Here again, if it is definitely still in the dry season, windrowing the onions, letting them sit three to five days, and then clipping them and putting them in burlap bags is

suggested. Let them sit in the fields another four or five days, take them in, put them over a grader and put them in storage. There is a large onion dryer and storage equipment in Chitre that could be used if they could get a cured, usable, firm onion. Running the very soft onions that are being produced there now through that equipment would almost do them more harm than no drying at all. Here again, the dryers can be worked out in the lowlands, particularly if some are built in the mountain area. The method could then be duplicated and brought into the Chitre area.

VII. STORAGE

Storage can be constructed in many ways. It depends on which is the most economical and best way to go about it for each location. There are good storage facilities in Boquete, Cerro Punta and at Chitre. They are typical, well insulated, refrigerated, air circulated type storage, and it was recommended earlier that storage in Boquete and Cerro Punta be increased.

Attaached is a copy and some pictures of storage facilities. One of the most modern storage for onions is in California where the onions are graded before they are put in storage. They are put in a saleable bag and are shipped directly out of storage to the stores and other retail outlets. In Panama, the onions are put into storage, then when they are taken out and sold, they are graded and regraded and rebagged before leaving the storage area. Attached is some literature about storage and a letter from a gentleman that owns this fine storage. Also enclosed is a description of storage used in Idaho and Oregon where the onions are stored in crates in bins with false floors, and the air is moved through them. In this particular area they are more interested in keeping onions from freezing and air through them so they don't sprout. This is a less expensive type storage than the heavily refrigerated, air circulated type. The same kind of storage can be used in both areas of Panama.

VIII. 1980-81 - ONION PRODUCTION AND SALES IN PANAMA

Farm Units	Number Hectares Planted	Number Hectares Lost	Production In 100 Lbs.	Number Harvest Farm Units	100 Units Sold	No. Dollars
422	274.5	31.34	44,854	344	38,627	629,716
			COCLE			
118	75	12	9,948	108	8,688	145,283
			CHIRIQUI			
125	83.70	5.7	15,417	98	14,400	227,400
			HERRERA			
44	26.16	1.24	5,845	28	4,050	74,918
			LOS SANTOS			
107	61.25	9.5	12,854	97	10,789	172,615
			PANAMA			
10	3.75	2.5	625	5	550	7,150
			VERAGUAS			
17	23.70	.5	165	7	132	2,375

0410D

APPENDIX I

ENCUESTAS SOBRE CEBOLLA

Aspectos Generales

Se plantea la conveniencia de realizar cuatro encuestas sobre cebolla durante el año, de la sguiente manera:

1) Sobre siembra y pronóstico de cosecha, uno dirigida a recopilar información sobre la provincia de Chiriquí y la otra en la región de Azuero, cubriendo las provincias de Herrera y Los Santos y la Provincia de Coclé.

   Otras dos sobre cosecha y pronóstico de siembra, dirigidas en la misma forma que las anteriores, una hacia la provincia de Chiriquí y la otra requeriendo información de las provincias de Herrera, Los Santos y Coclé.

   El levantamiento de las investigaciones estaría a cargo de la Sección de Encuestas Contínuas y Especiales del Departamento de Estadística de la Dirección de Planificación. Se deberá contar con el apoyo del personal de las otras secciones del Departamento, si se estima necesario.

Las tareas a realizar para cada una de las encuestas estarían divididas en etapas así:

1a.- Programación y Ejecución de la Encuesta.

Esta etapa consiste en el ordenamiento de todo el material necesario y la organización de lo relativo a la recolección de la información, examinándose las posibilidades en cuanto a la forma de obtener los datos, ya sea mediante entrevistas

directas a los productores por parte de los funcionarios de la Sección de Encuestas o a través del uso de empadronadores del área, contratados con el propósito de levantar la investigación.

En caso de emplearse empadronadores, los funcionarios de la Sección de Encuesta deben efectuar la labor de Supervición de la investigación dirigida a lograr una cobertura completa de la encuesta así como de revisar la consistencia de la información recogida para asegurar la mejor calidad de los datos. Además su labor se encaminará la búsqueda de soluciones a cualquier tipo de problemas que se presenten en la realización de esta labor.

2.°- Tabulación de los Datos:

Con base en el formulario de cada encuesta se ha preparado un conjunto de formatos de tabulaciones que permiten el procesamiento de los datos recogidos.

3.°- Presentación de los Datos:

A partir de la información tabulada se procede a la elaboración de cuadros con los datos resumidos, y agrupados con miras a que puedan ser utilizados como datos válidos para las labores de planificación, toma de decisiones, así como para la divulgación estadística.

La Sección de Encuestas contínuas y Especiales debe mantenerse permanentemente informada sobre los programa de las distintas entidades del Sector

(MIDA, BDA), así como a través de las Agencias Regionales del IMA y las Cooperativas de Productores, a fin de conocer las acciones que se impulsan encaminadas a extender y ampliar los cultivos objetos de estas encuestas. En este sentido es necesario que previa a la ejecución para tratar de logar una cobertura adecuada.

Las informaciones deben ser analizadas, y evaluada con base en las experiencias y conocimientos de personas o funcionarios relacionados con las actividades de producción de los distintos cultivos, tales como las comisiones específicas, que existen, para diferentes productos.

Aspectos Específicos:

1.- Encuesta de siembra y pronóstico de cosecha dirigida a las tierras altae en la provincia de Chiriquí que abarca los distritos de Boquete y Bugaba.

Marco de la Encuesta:

Se investiga aproximadamente 140 productores en el área señalada.

Período de referencia:

El período que se hace referencia en la investigación comprende de Diciembre a Junio. Fecha de levantamiento de la investigación:

Una semana del mes de diciembre (lar o 2da. semana)

2.- Encuesta de Siembra y Pronóstico de Cosecha de las provincias de Herrera, Los Santos y Coclé.

Los distritos de estas provincias que desarrollan estos cultivos son básicamente Chitré, Los Santos. Natá y Antón

(El Valle).

Marco de la Encuesta:

Se estima que la investigación cubrirá unos 135 productores aproximadamente, distribuídos más o menos así:

Distrito de Natá:	19
Distrito de Antón (El Valle) :	26
Area de Herrera :	25
Area de Los Santos	65

Período de Referencia:

De Enero a Junio

Fecha de levantamiento de la investigación:

Una semana del mes de Enero.

3.- Encuesta de Cosecha y Pronóstico de Siembra en la provincia de Chiriquí, distritos de Boquete y Bugaba.

Marco de la Encuesta:

Se abarca en esta investigación aproximadamente a 140 productores del área señalada.

Período de referencia:

Encuesta a la cosecha se investiga la realización para el período de diciembre a junio.

En lo referente al pronóstico de siembra interesa los planes de siembra para el año siguiente:

Fecha de levantamiento de la investigación:

Una semana del mes de junio (1ra. ó 2da. semana).

4.- Encuesta de Cosecha y Pronóstico de Siembra para las Provincias de Herrera, Los Santos y Coclé.

Marco de la Encuesta

Se investiga las mismas áreas que en la encuesta de siembra. Igualmente se cubren los productores (135 aproximadamente) señalados antes.

Período de referencia:

En lo relativo a la cosecha la encuesta pretende obtener la información sobre los logros alcanzados en el período de Enero a Junio.

En cuanto al pronóstico de siembra éste de ser referido a los planes de la próxima siembra.

Fecha de levantamiento de la investigación:

Una semana del mes de junio (3a. o 4a. semana).

APPENDIX II

INFORMACION DE INTERES CON RELACION AL SECADO DE LA CEBOLLA

Esta información se refiere a las facilidades (construcciones) requeridas para el secado, almacenaje y clasificación de las cebollas. Tradicionalmente, la cebolla se deposita en edificios con ventilación adecuada y depositada sobre una tarima entablillada sobre el piso en un cobertizo abierto al frente.

Otra forma de secado consiste en dejar secar la cebolla en estantes protegidos de la lluvia y a través de los cuales el aire pueda soplar y circular libremente.

Los métodos modernos de cultivos y cosecha, con frecuencia a gran escala requieren diferentes formas de secado.

Las cebollas cosechadas son traídas dentro de los almacenes o edificios después de estar algún tiempo puestos a secar en montones o hileras en el campo.

El espacio de tiempo que sigue a la cosecha variará de acuerdo a varios factores como son: las condiciones de la propia cosecha, época, tiempo de levantada y otros, pero es importante que la cosecha entre tan limpia y sana como sea posible.

Antes que cualquier forma de almacenaje sea intentada, la cebolla debe ser secada y para eso la <u>ventilación forzada</u> será necesaria. Los principios del secado estan descritos e ilustrados conjuntamente con algunas alternativas en los planos en uso actualmente.

En la mayoría de los casos, el almacenaje continúa en el mismo lugar donde

la cosecha ha sido secada sin futuro movimiento hasta el momento de su venta. En otros casos no obstante, se puede proveer almacenaje aparte si esta condición existe.

Aún cuando se ilustran varios diseños de construcciones para almacenaje, debe recordarse que el método seleccionado deberá estar relacionado con el sistema de secado empleado, el período de tiempo en que la cosecha es mantenida en la finca, el número de lotes diferentes y métodos de distribución.

Los edificios para propósitos separados de secado y almacenaje son tratados individualmente por razones de claridad y se ven algunos ejemplos de planos completos en relación con la materia de clasificación y despacho. Varias alternativas se dan a los diseñadores y pueden ser modificados o seleccionados a conveniencia.

El aspecto económico de los edificios o facilidades para la cebolla no se discute en esta información pues se asume que antes que se tome una decisión para su construcción se haga un estudio de factibilidad previo para asegurar el mejor uso de todos los recursos.

Secado: Esta bien establecido que si las cebollas se han secado bien en el campo, antes de depositarla en el edificio, el proceso inicial de secado puede ser completado en tres días ventilando la cosecha a razón de 250 pies cúbicos de aire por minuto por tonelada, tomando más tiempo cuando la cosecha es húmeda. Durante el secado será normalmente necesario calentar el aire ventilado y en fases posteriores la recirculaciónes también necesaria.

Secado a granel:

Se pueden describir 3 métodos que se ilustran:

1.- Secado en bandejas o cajones poco profundos,

2.- Secado en depósitos

3.- Secado en " el suelo"

1.- Secado en bandejas o cajones poco profundos:

Este método puede ser utilizado para pequeños lotes y para productores de cebolla en pequeña escala.

En la figura 1 se muestra un recinto construído de paneles desmontables, de unos 4 pies y 6 pulgadas hechos de playwood, madera u otro material disponible. El área contenida forma un depósito poco profundo con un suelo ventilado de listones o tablillas de madera.

Las cosechas depositada sobre este suelo y secada por un ventilador conectado por un conducto o canal. Se pueden hacer muchas variaciones de este sistema dependiendo de la ingeniosidad del productor. La cebolla puede ser removida para la venta o almacenamiento simplemente retirando uno de los paneles. No se requiere ningún tipo especial de edifico para este sistema y puede acomodarse en cualquier cobertizo o local bien ventilado.

2.- Secado en depósitos:

Este sistema, tal cual se ilustra en la Fig. 2, se adapa a unidades para 20- 40- tons. Estos depósitos son hechos normalmente de madera y la cosecha se almacena a una altura máxima de 10 pies. Para el llenado y vaciado de estos depósitos, se pueden sacar y reponer las secciones en la medida que sea necesario. El ventilador esta dentro de la parte vertical del conducto prin-

cipal de madera el cual suministra aire a los distribuidores laterales a 3 pies del centro o alternativamente a todo el suelo emparrillado o entablillado. El sistema de ventilación puede abastecer por cualquier combinación de ambiente o aire reciculador y calentadores que pueden ser incorporados. Más adelante se darán detalles en la sección de almacenaje.

3.- Secado en "el suelo"

Este sistema es el considerado como el mejor para el secado a granel. Vea ilustración en Fig. 3. Se compone de un conducto principal con laterales como se ve en dicha Fig. 3 y puede ser instalado dentro de una variedad de construcciones en la finca. Se adapta para productores en gran escala y puede ser usado para otros tipos de cosecha siempre que se hagan las modificaciones adecuadas. Cierto grado de recirculación y de provisión de calor es posible. Una buena administración cuando se trata de grandes tonelajes es particularmente importante.

Lotes separados de hasta 400 tons. ha sido satisfactorio en este sistema. En la sección de almacenaje se darán más detalles de este sistema.

En los dos primeros sistemas, cada unidad puede tratarse por separado y el enfriamiento puede comenzar inmediatamente después que el secado se ha completado.

En el secado sobre el suelo, se debe empezar a soplar tan pronto como los primeros conductos estan cubiertos con cebollas. Cada conducto debe estar ventilado continuamente y tanto como se requiera para secar esa porción. Después de 3 - 4 días de ventilación a razón de 250 pies cubicos por minuto por ton, esta puede ser reducida en la proporción de 50-60 pies cúbicos por minuto / por ton. simplemente cerrando parcialmente los laterales. Cuando el

almacén o local está lleno, todos los laterales deben ser cubiertos con una ventilación continua hasta que la cebolla está completamente seca.

Al completarse el secado, todo el local puede ser refrescado con una ventilación selectiva con aire de afuera. El propósito es reducir la temperatura del monton a 4°- 5 °C (39°-41° F) .

A L M A C E N A J E

La cebolla se almacena para asegurar el mercadeo ordenado y la ventaja de obtener mejores precios por un producto de buena calidad. Es importante que la cebolla se mantenga durante el almacenamiento en las mejores condiciones posibles y esto requiere una ventilación controlada de aire fresco para mantaner la temperatura tan baja como sea necesario pero por encima de la congelación, y mantener una humedad razonablemente baja. Si el almacenaje se continua por largo plazo, la refrigeración se hace necesaria.

Para almacenaje sin refrigeración, ventilación por aire ambiental, la temperatura de 0-5°C (32 - 41 F) y humedad relativa de 65-75 por ciento es necesaria.

Para almacenaje con refrigeracion, la temperatura recomendada es 0° (32 °F) con una humedad relativa de 80%.

En muchos casos, el almacenaje debe realizarse en el mismo lugar que del secado, el ventilador usado para el secado será siempre adecuado para el propósito de la ventilación siempre que se le equipe con los controles apropiados.

En orden a ver las alternativa disponibles al productor con relación al almacenaje, es conveniente dividir los métodos mencionados en dos tipos, como son: a granel y en envases.

ALMACENAMIENTO A GRANEL.

Las cebollas almacenadas a granel pueden ser mantenidas en depositos o compartimentos o en el suelo.

En el almacenaje en depósitos o compatimientos estos pueden adaptarse en construcciones o recintos existentes, y pueden construirse de madera, con un sistema de conductos similares a lo que se describió anteriormente en el secado en depósitos, pero con la provisión de un techo con completo preparativo para la recirculación y uso del aire ambiental y suministro de calor para controlar la humedad relativa así como aislamiento suficiente en las paredes y techos con abertura para entrada y salida del aire. La refrigeración puede ser usada utilizando una unidad móvil que puede transferirse a diferentes compartimientos pero básicamente esto significa contrucciones más costosas que la que el sistema de depósito justifica. Es apropiado para lotes de cebolla de, digamos 20- 40 tons. Estos compartimientos pueden adaptarse a condiciones de mucha más permanente naturaleza que podrían ser adaptadas para capacidades de 50-80 Ton. y puedan formar parte de unas instalaciones más grandes. En un compartimiento de esta naturaleza las paredes deben diseñarse para acomodar cargamentos adicionales de la cosecha por lo que el aislamiento mencionado es requerido. La refrigeración bien puede introducirse para siempre, manteniendo en mente la posibilidad del uso alternativo para ese almacenamiento. El grado de aislamiento puede ser incrementado. En esa circunstancias puede ser necesario de proveer aislamiento a nivel del suelo y las aberturas de salida será necesario aislarlas completmente. El conducto principal está bajo con los conductos laterales distribuídos tanto a nivel como por encima del

piso o suelo.

Almacenamiento a Granel en el Suelo:

El sistema de secado a granel en el suelo y almacenamiento en el mismo lugar hasta que se remueve para clasificación y venta ha sido practicado con éxito por muchos años. Siempre que la cosecha sea sana y de buena calidad, y el secado y almacenado se haya hecho /a/ razonable altura (no excediendo de 10 pies) y en lotes de tamaño razonable, podría diseñarse un sistema de ventilación adecuado sobre el suelo que puede ser satisfactorio y más económico en construcción para el productor.

Los principios generales de la construcción de este tipo estan basados en el tipo moderno para el almacenaje de la papa y que puede adaptarse a los especiales requerimientos de esta cosecha. Teniendo en cuenta la necesidad de mantener una temperatura promedio de refrigeración de 0 °C (32 °F) puede aplicarse a una porción de la cosecha, una sección del recinto pero el tipo de construcción de este debe ser considerado cuidadosamente al momento de diseñarse pues de otra manera puede haber escape aire o aumento de calor a través de la estructura con considerable y consiguiente esfuerzo del equipo en uso y altos costos. Lo mejor sería limitar la refrigeración de las cebollas a granel al tipo de "en depósitos o compartimientos."

El tamaño del conducto principal y de la longitud de los laterales deberá ser considerado en cada caso dependiendo de la ventilación recomendada y de la velocidad del aire. La deciscón de que esten localizados debajo del suelo o encima los laterales, debe ser también decisión del productor.

Almacenamiento en Cajones o Envases:

Este sistema comprende el uso de envases o cajones especiales y sistema de conductos verticales en el cual se tiene especial cuidado en que el aire ventilado pase a través de la cebolla en las cajas en la proporción requerida. Estos envases o cajones tienen unfondo entablillado (parrilla) y que pueden colocarse sobre conductos debajo del suelo o piso al final de los cuales el ventilador y calentador pueden situarse. Una vez que la cebolla ha sufrido el proceso de secado, esta puede almacenarse en otra parte aun del mismo edificio. Estos cajones o envases se diseñan y construyen con altos standards para prevenir perdidas de aire que ocurre entre las cajas y alrededor de las mismas. En adición, un piso realmente nivelado es esencial para la colocación de los cajones o envases. La construcción del edificio ensí puede ser construído economicamente siempre que reuna la condición de aislante requerida . Para el almacenamiento refrigerado en cajones o envases, asumiendo siempre que la cebolla haya sido secada propiamente, pueden construirse cámaras de frío para mantener las cosechas siempre que la humedad relativa se mantenga a un 80%.

Se puede contruír un almacén con compartimientos o divisiones con las dimensiones adecuadas que podría mantener los cajones o envases para almacenaje ventilado ó para refrigeración a largo término.

Es de notar la conveniencia de soplar aire en la cebolla almacenada en refrigeración antes de retirarla del almacén. Esto usualmente no se aplica a la cebolla retirada de las cámaras de frío donde han estado largo tiempo aún cuando elproblema de la transpiración tiene que ser reconocido.

Cuando la corona o extremidad de la cebolla se ha sacado y la clasificación se ha llevado a cabo después del almacenaje, problemas considerables de polvo se presentan y una adecuada extracción mecanica es necesaria. Esto puede ser más difícil

donde la clasificación se lleva a cabo en el mismo edifico del almacenaje, pero ambas situaciones se encuentran en la práctica. Si la cebolla es empacada en sacos de malla y se va a mantener un tiempo largo en el local, los sacos pueden colocarse en la parte atrás del mismo y en lugar ventilado para mantener la cebolla en buenas condiciones.

Cuando los operadores u obreros estan trabajando es importante porveer condiciones confortables lo cual envuelve el hecho de que los locales deben estar aislados y frescos. Las fig. 10 y 11 ilustran lo que podría ser un local ideal para las operaciones aunque se pueden hacer cambios para adaptarlos a las condiciones locales.

Datos de interés-

1.- La cebolla seca ocupa un volumen de 70 pies cúbicos (2 M^3 aproximadamente) por tonelada.

2.- La cebolla húmeda con la coronilla ocupa un volumen de 110 pies cúbicos (3.1 M^3 aproximadamente) por tonelada.

3.- La máxima altura a que se puede apilar o amontontonar la cebolla es de 10 pies (3.M. aproximadamente).

---o---

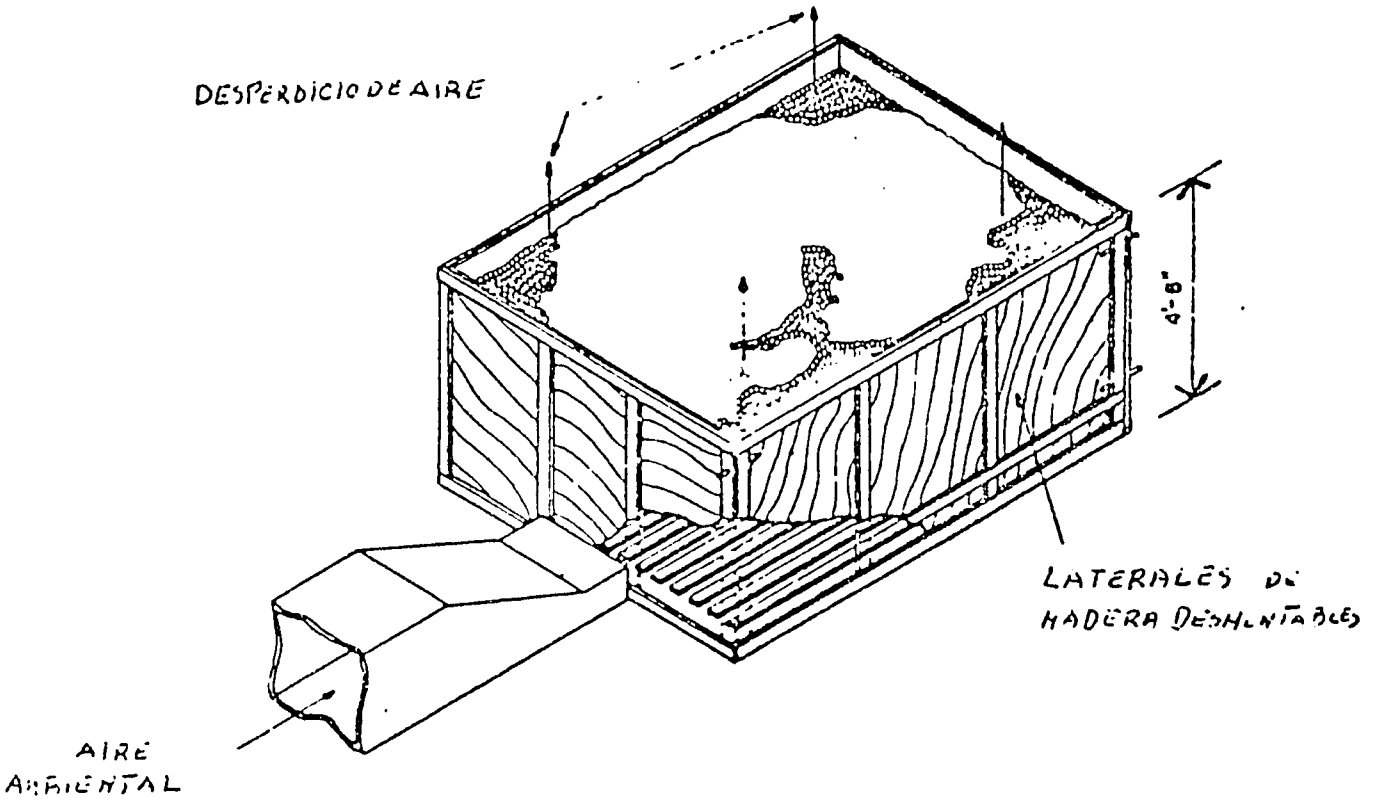


FIG .1. SECADO EN BANDEJAS POCO PROFUNDAS

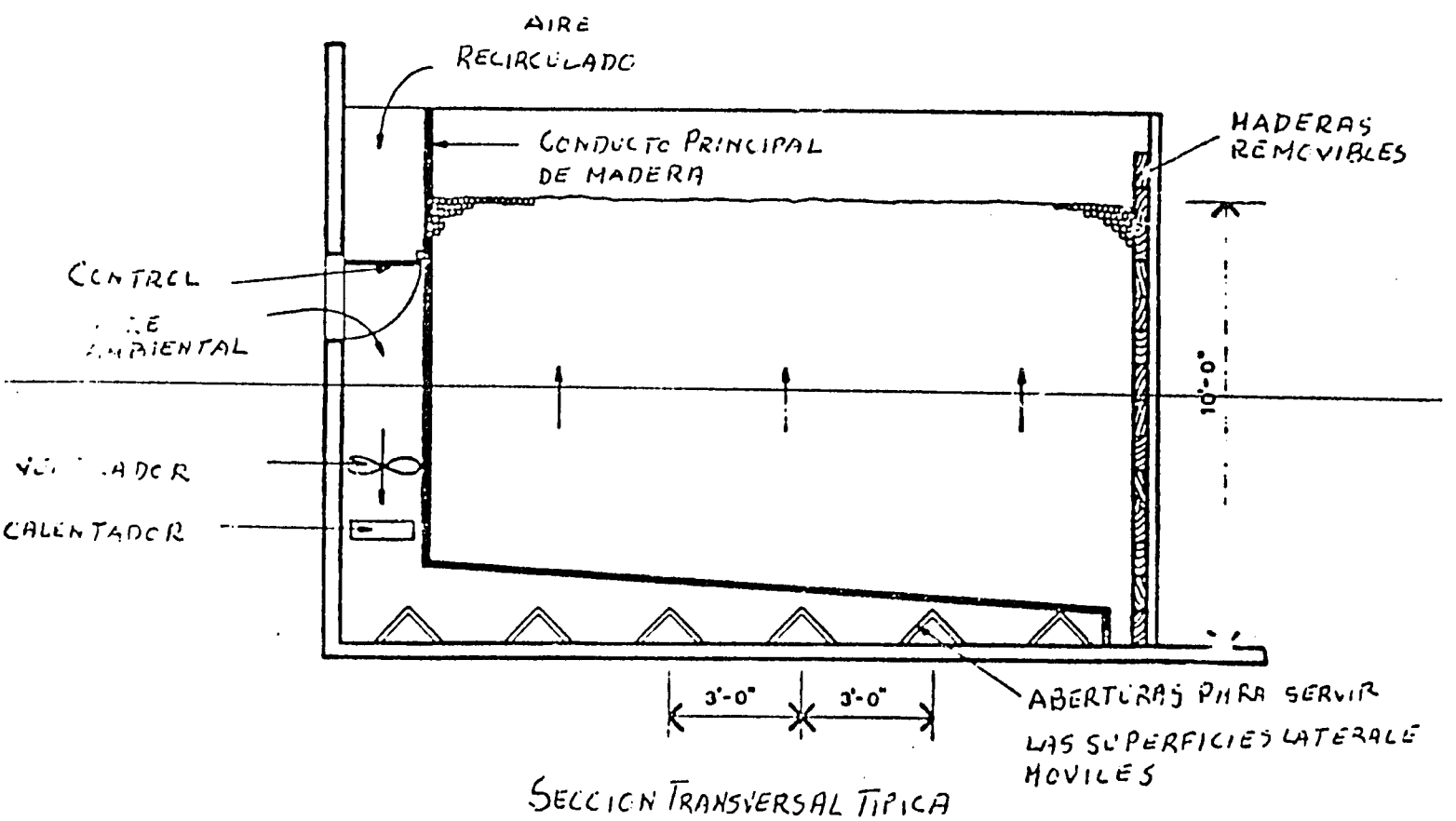


FIG .2. SECADO EN DEPOSITOS

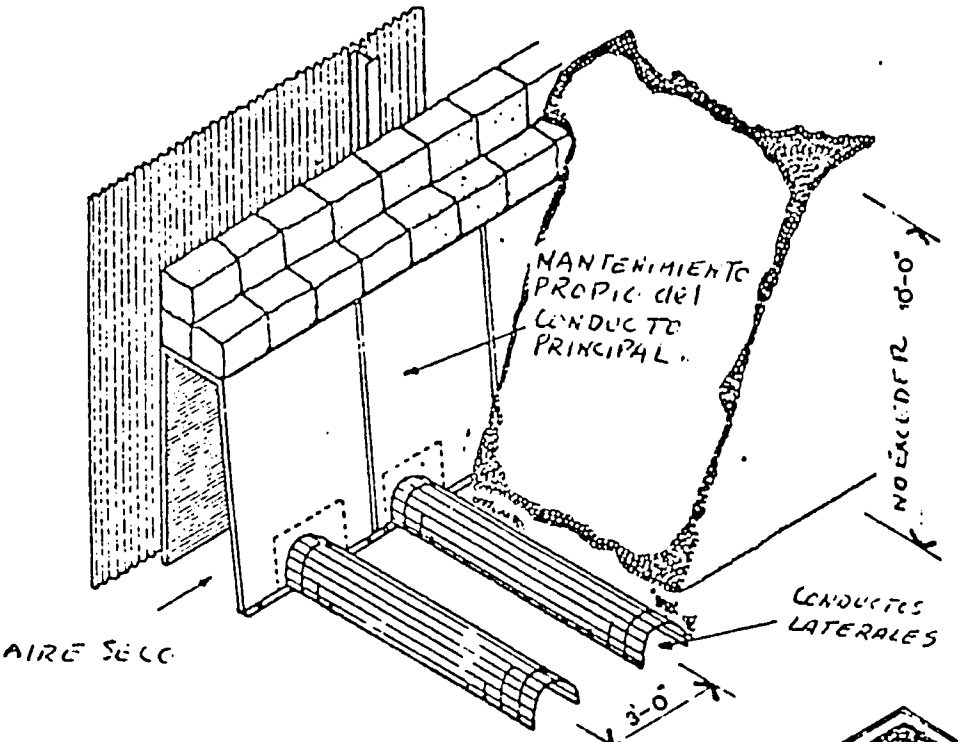


FIG.3. SECADO EN EL SUELO EN EDIFICIOS EXISTENTES

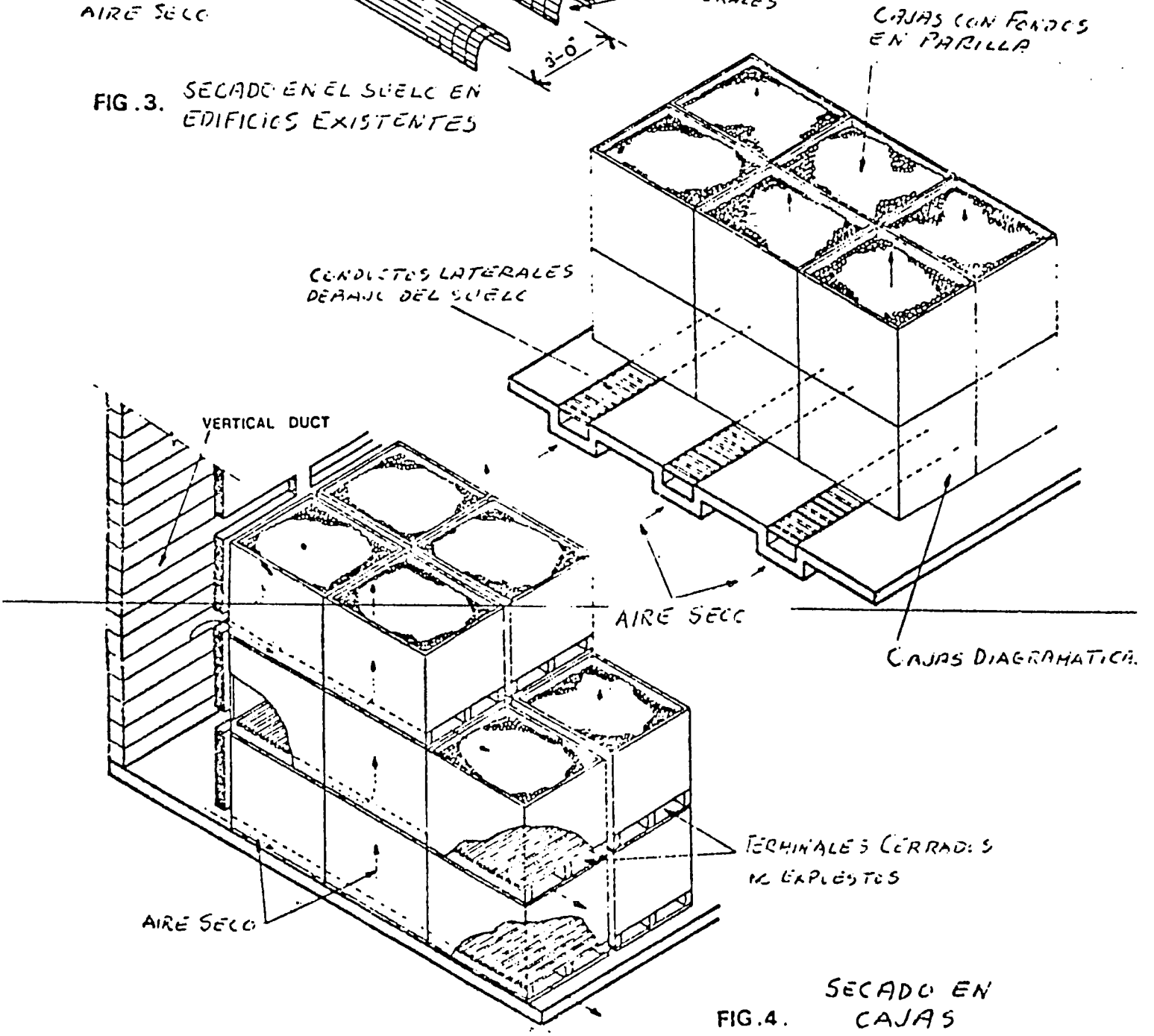
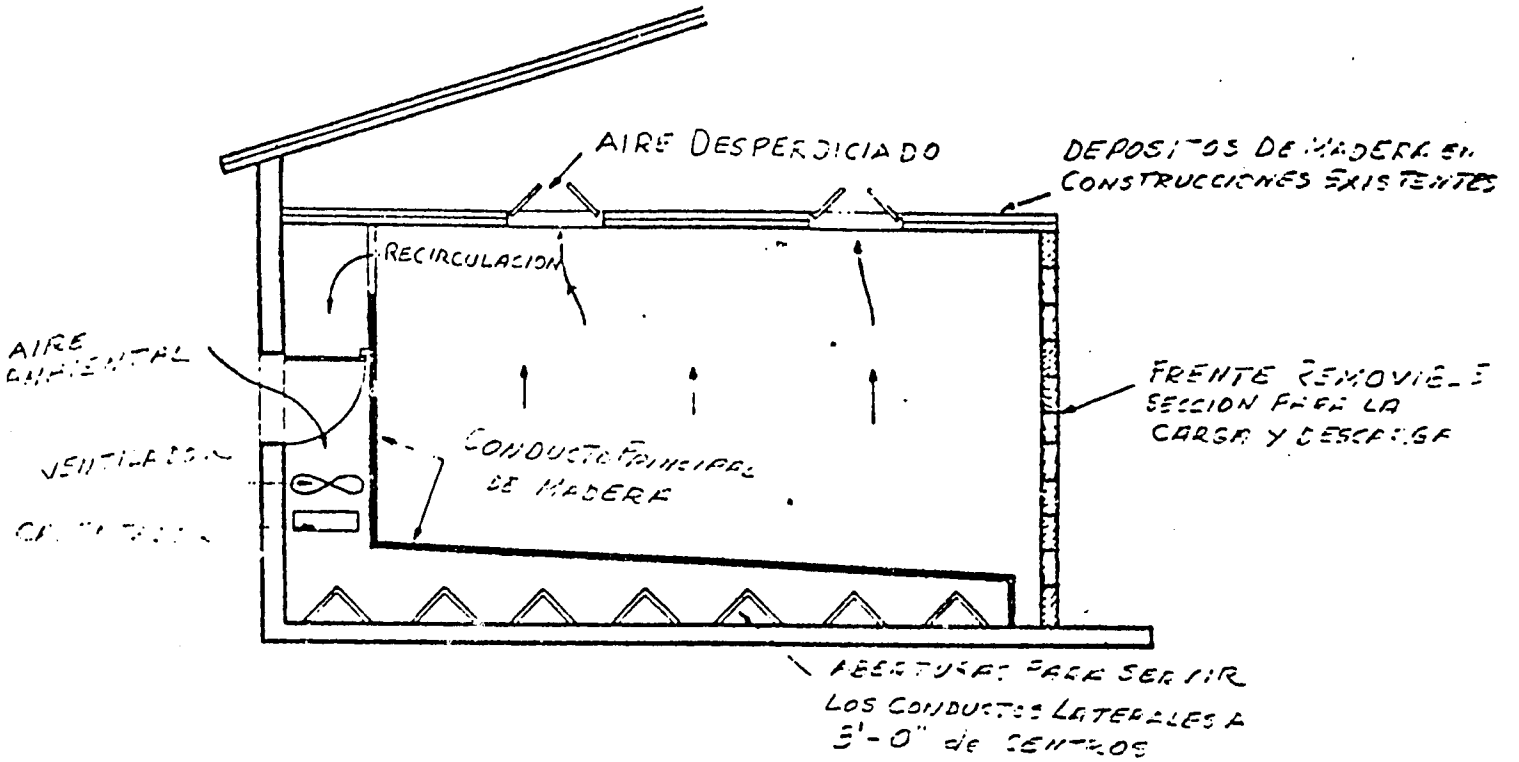
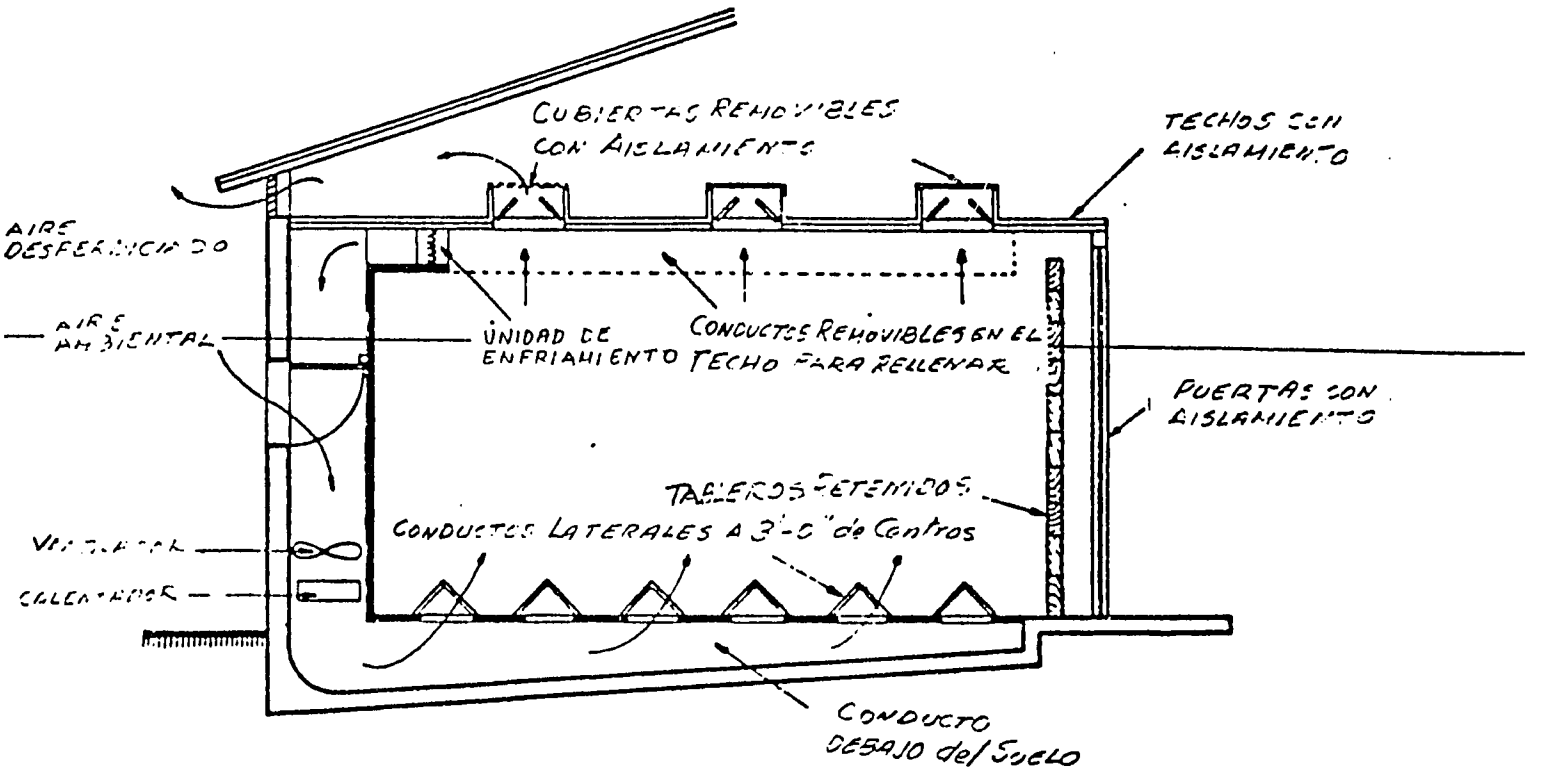


FIG.4. SECADO EN CAJAS

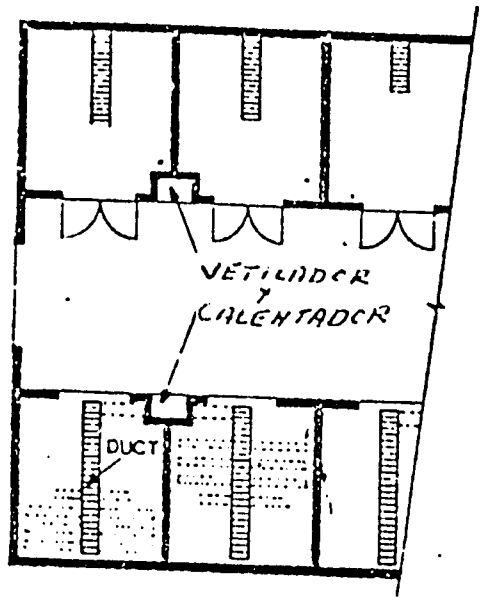


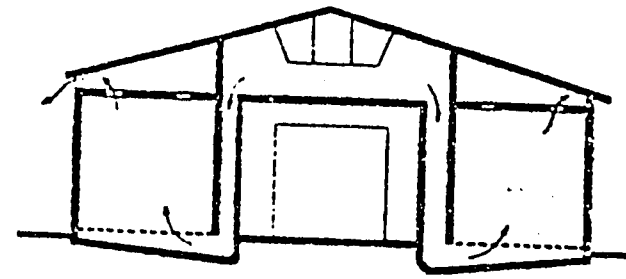
SECCIÓN TRANSVERSAL ALMACENAMIENTO CONTINUO EN DEPOSITOS



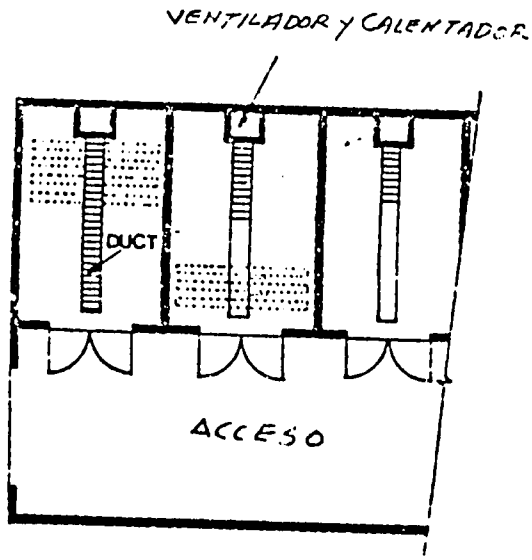
SECCION TRANSVERSAL ALMACENAMIENTO CONTINUO EN COMPARTIMIENTOS

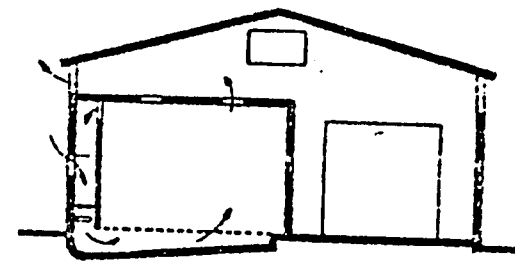
FIG. 5 ALMACENAMIENTO EN DEPOSITOS Y COMPARTIMIENTOS



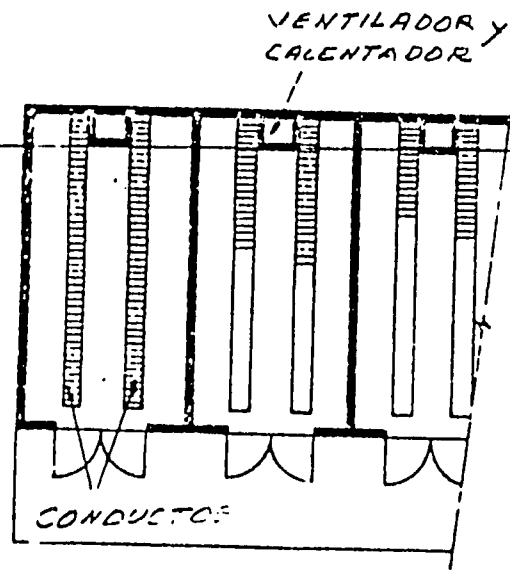


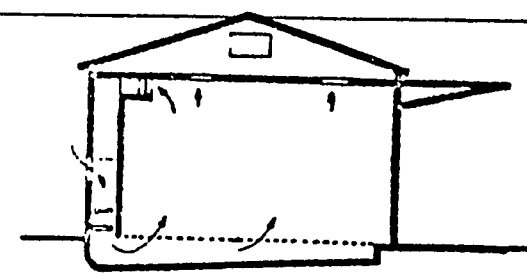
DOBLE HILERA





SIMPLE HILERA
CON ACCESO INTERNO





ESTACIONAMIENTO LIBRE CON
ACCESO INDIVIDUAL EXTERNO

FIG. 6. ALTERNATIVAS PARA ALMACENAMIENTO EN COMPARTIMIENTOS

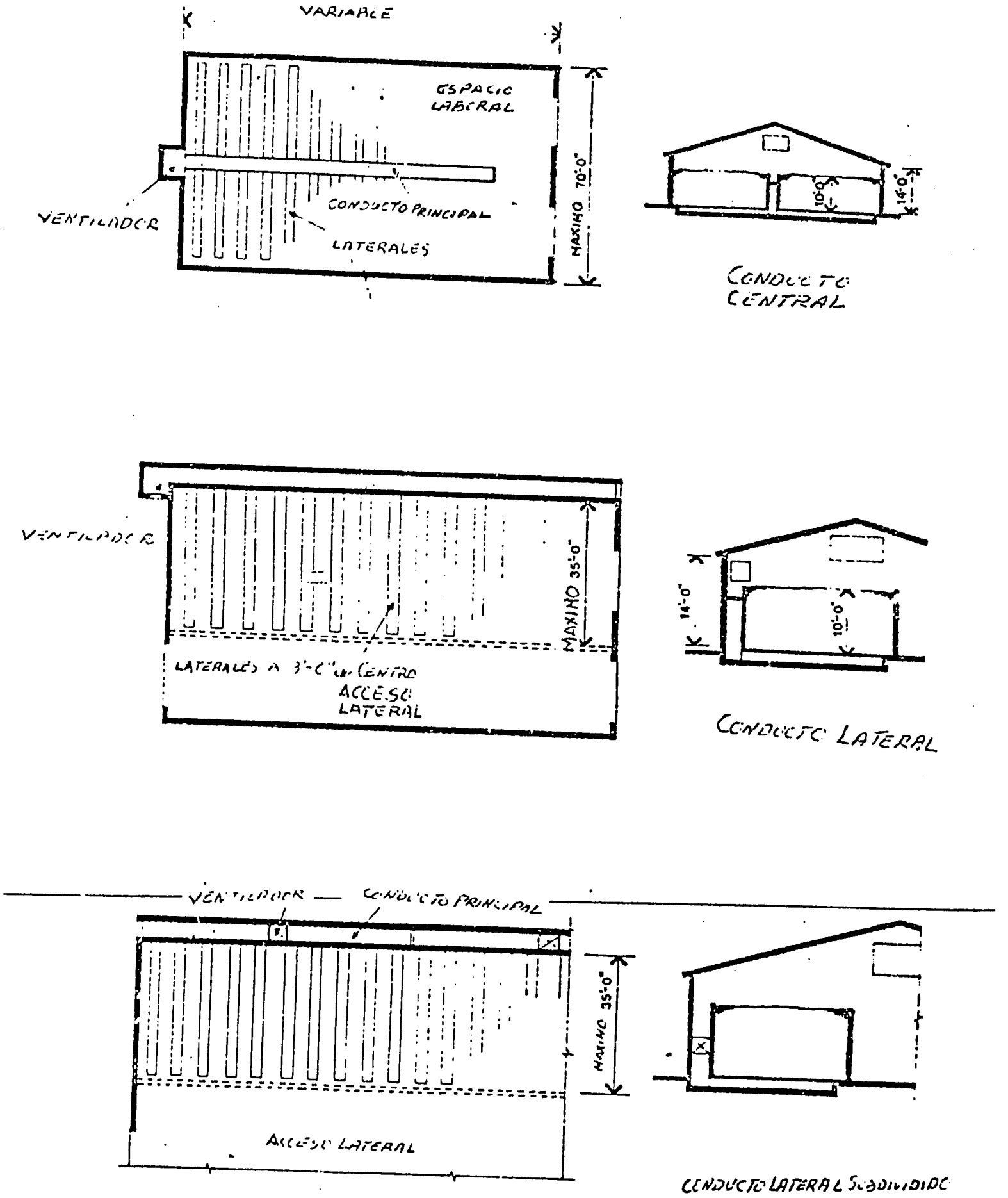
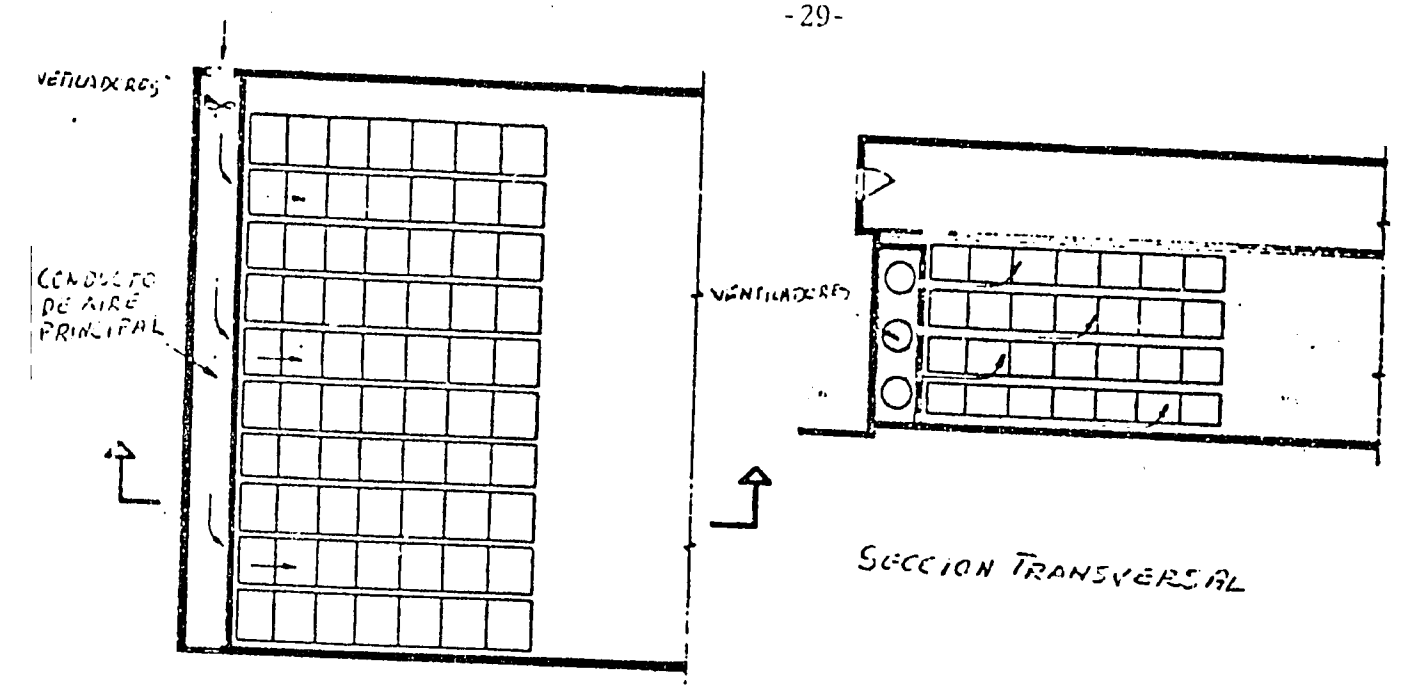
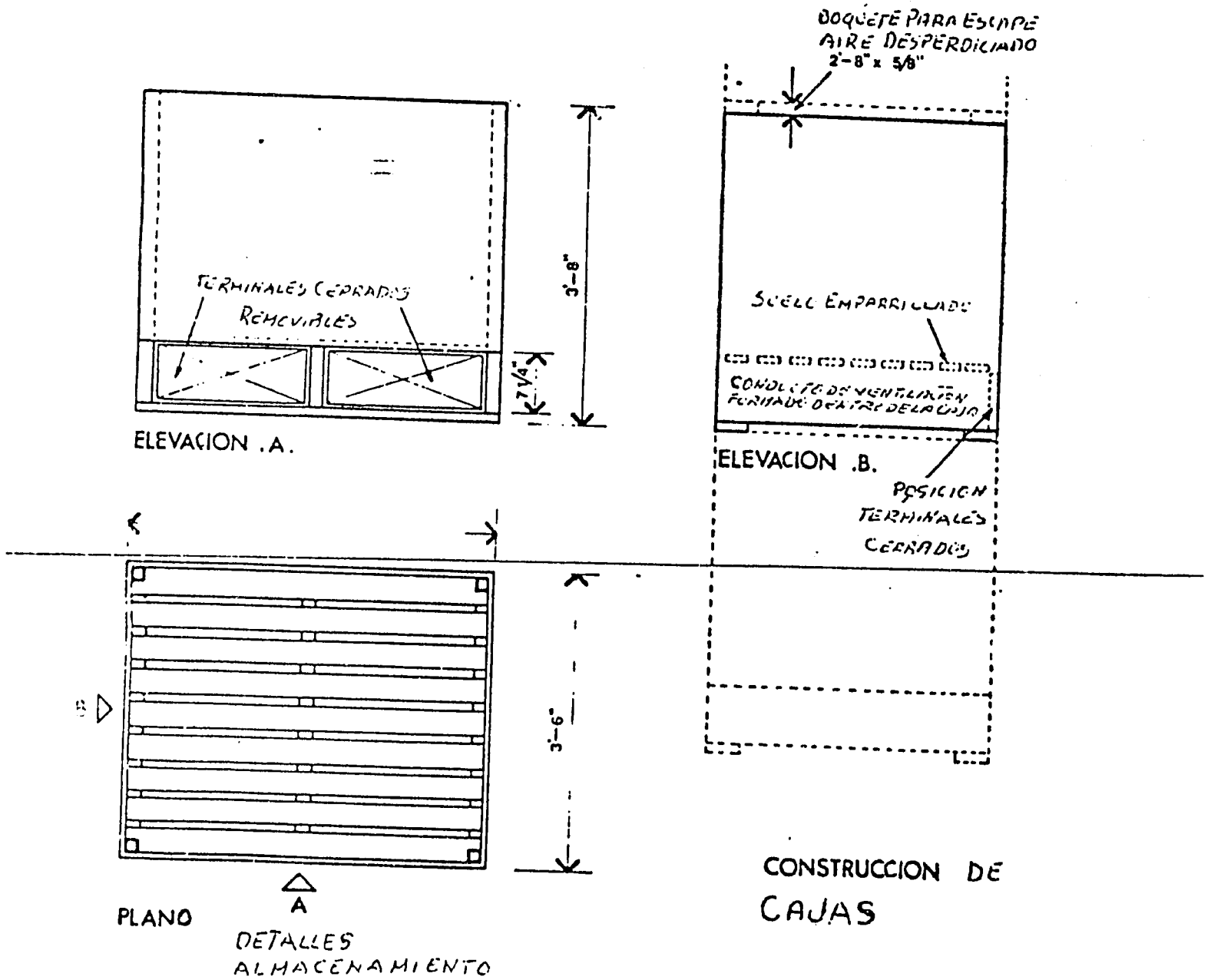


FIG. 7. ALTERNATIVAS PARA EL SISTEMA SOBRE EL SUELO



PLANO



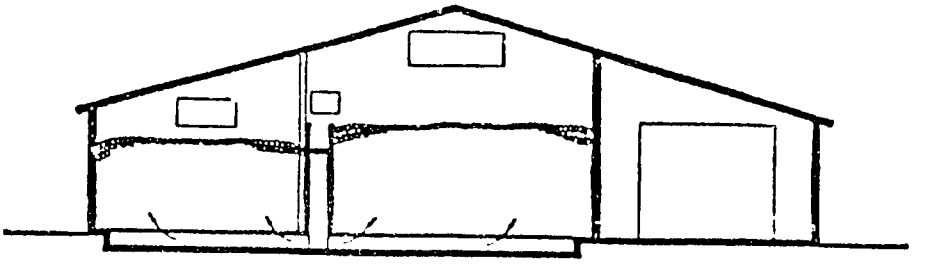
ELEVACION .A.

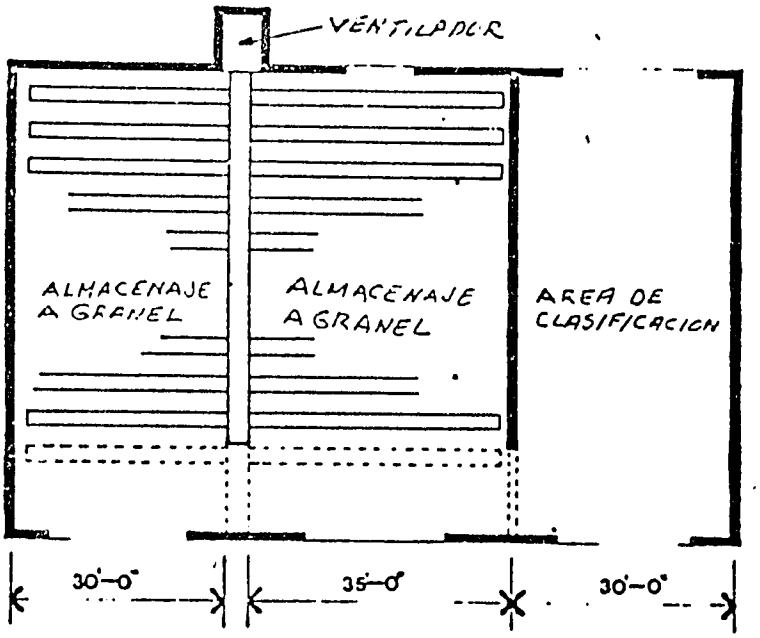
ELEVACION .B.

PLANO

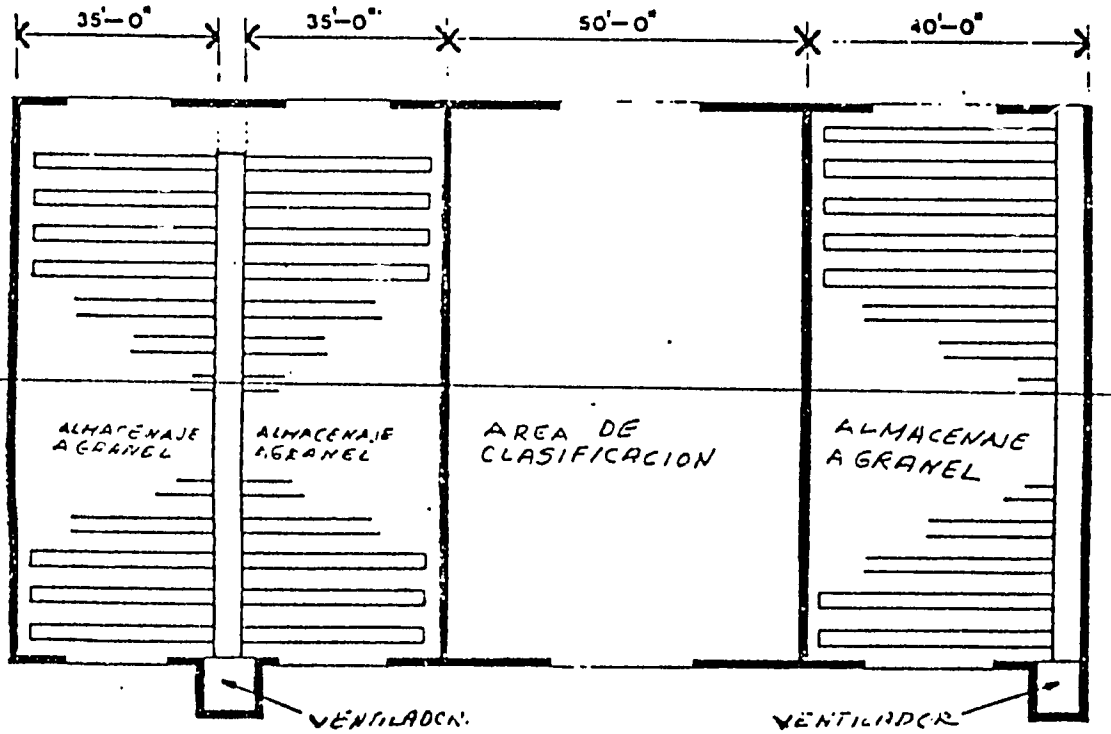
DETALLES ALMACENAMIENTO

CONSTRUCCION DE CAJAS



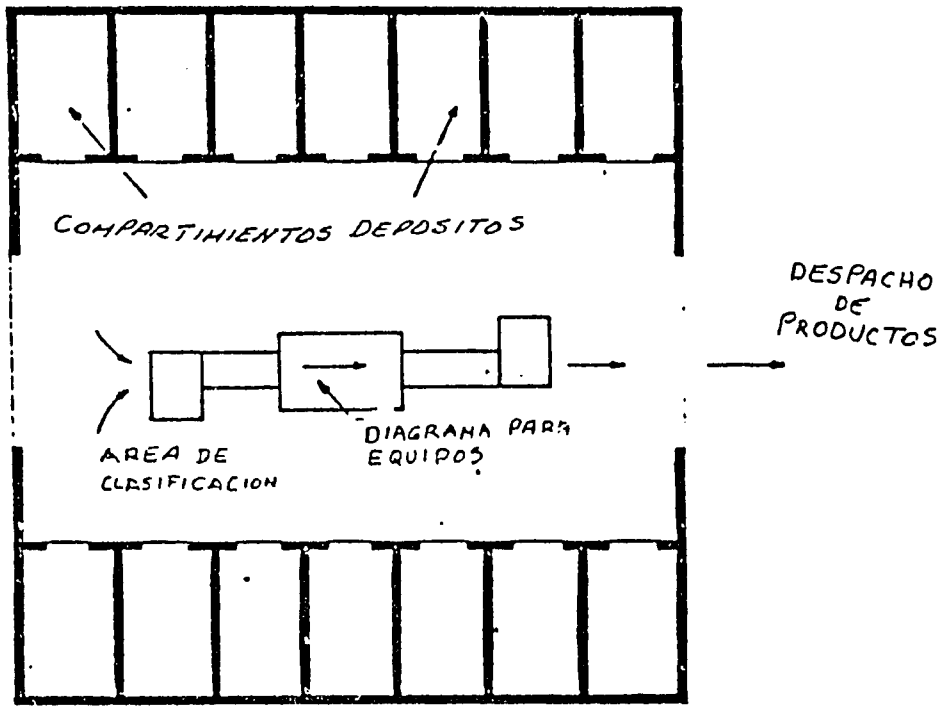


PLANO

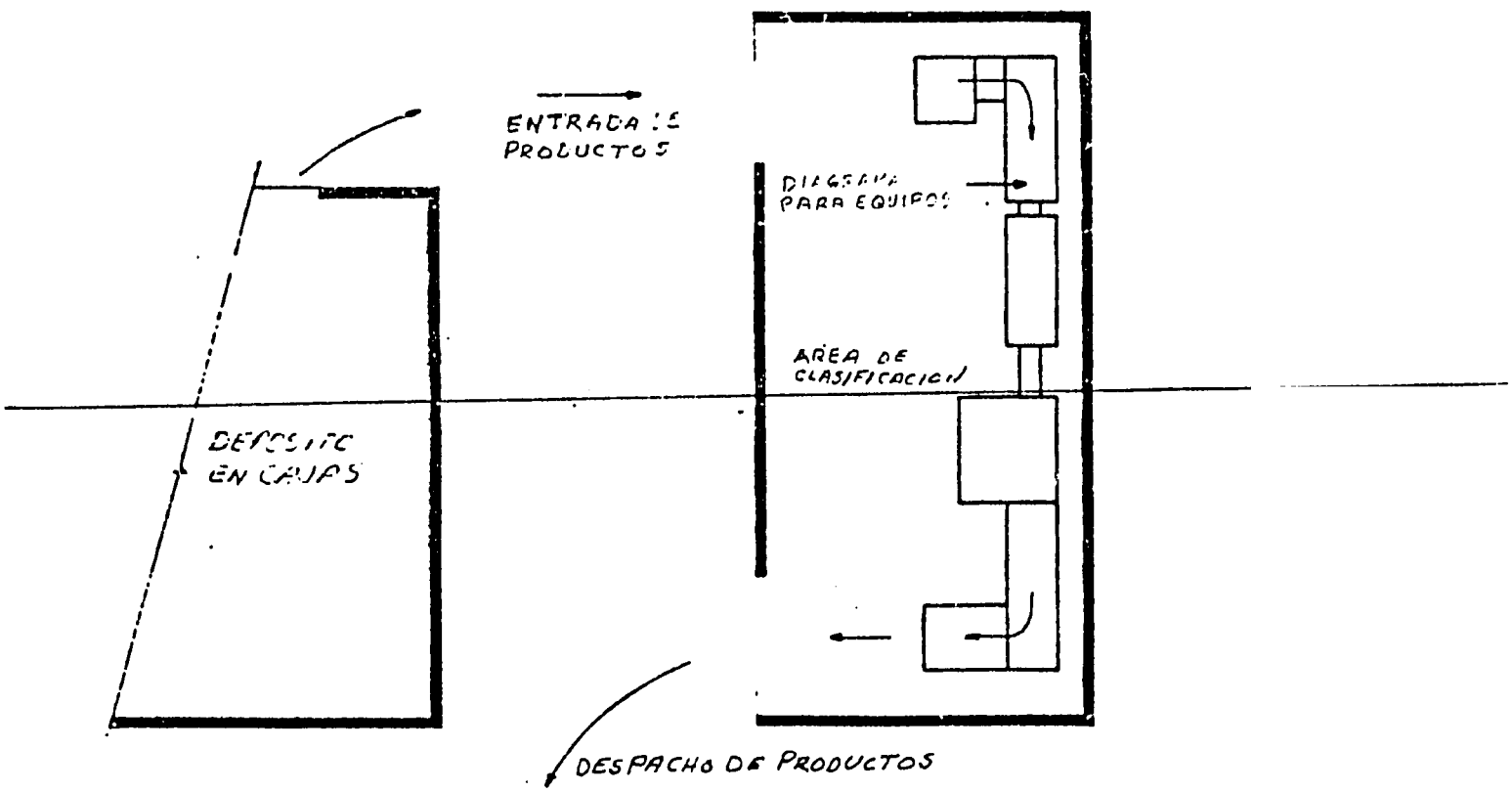


PLANO

FIG .10. ALTERNATIVAS PARA LA CLASIFICACION Y DESPACHO DE PRODUCTOS EN EL ALMACENAJE SOBRE EL SUELO

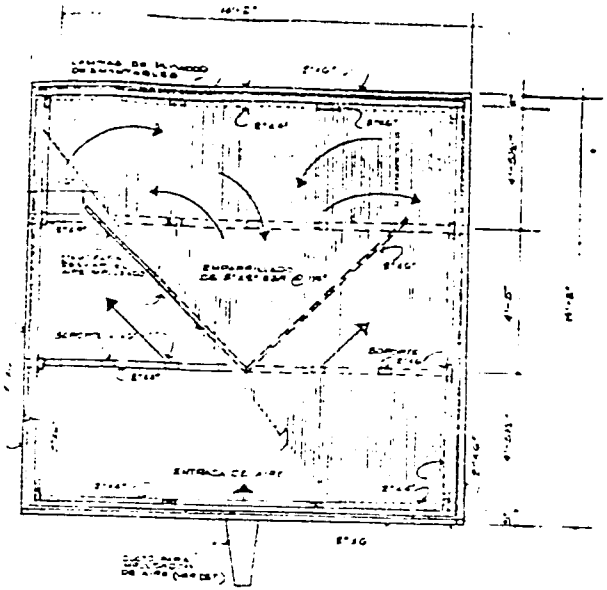


AREA DE CLASIFICACION INTERNA

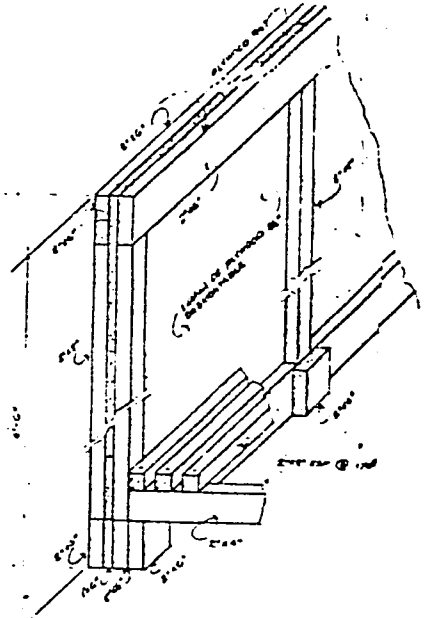


EDIFICIOS SEPARADOS PARA ALMACENAJE Y CLASIFICACION

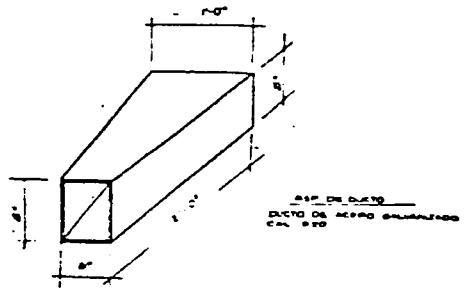
FIG . 11. PLANOS PARA CLASIFICACION Y DESPACHO DE PRODUCTOS



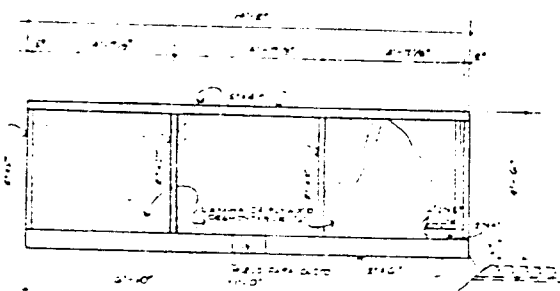
PLANTA DE SECADORA DE CEBOLLAS



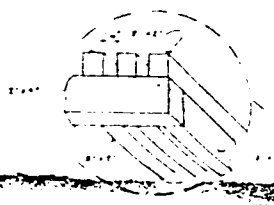
DETALLE DE ARMAZON



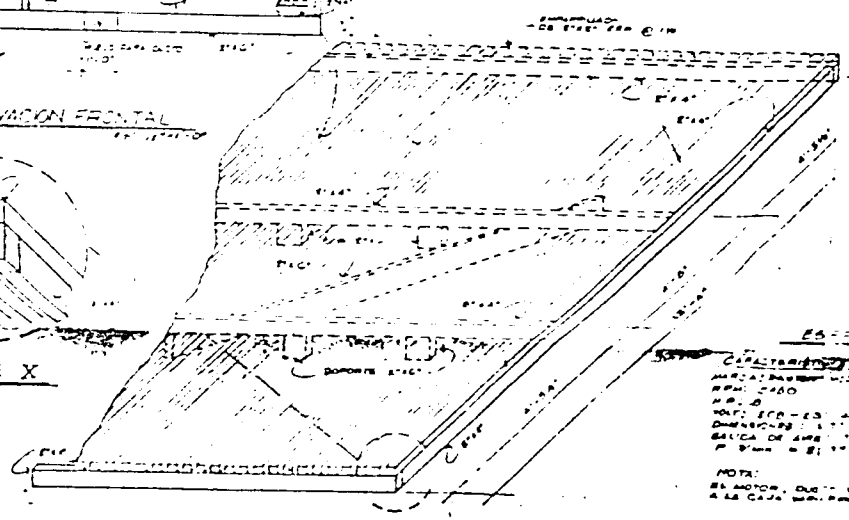
DETALLE DE DUCTO



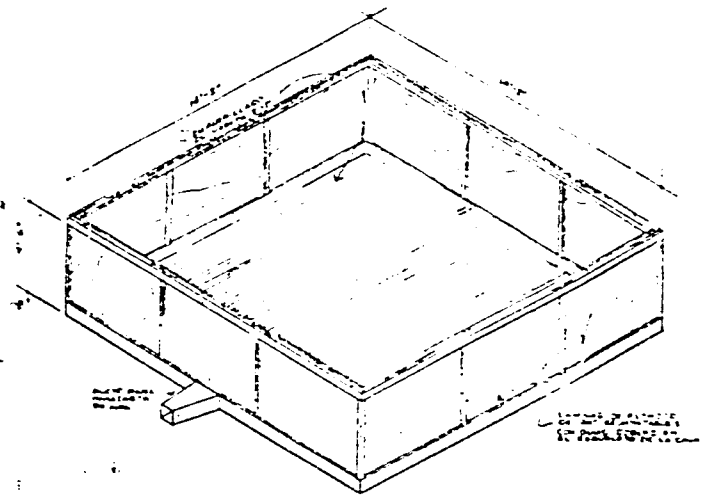
ELEVACION FRONTAL



DETALLE X



EMPARRILLADO DE MADERA



ISOMETRICO DE SECADORA DE CEBOLLAS

CAPACIDAD DE SECADORA 150 ℔

INSTITUTO DE MERCADEO AGROPECU

PROYECTO: SECADORA

APPENDIX III

PICTURES OF DRYERS AND SOME OF THE EQUIPMENT USED IN THE DRYERS IN TEXAS.

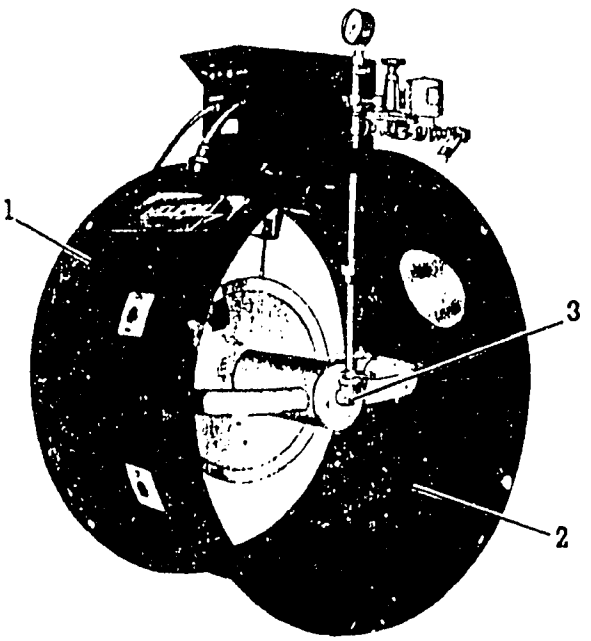
HELIFOIL®

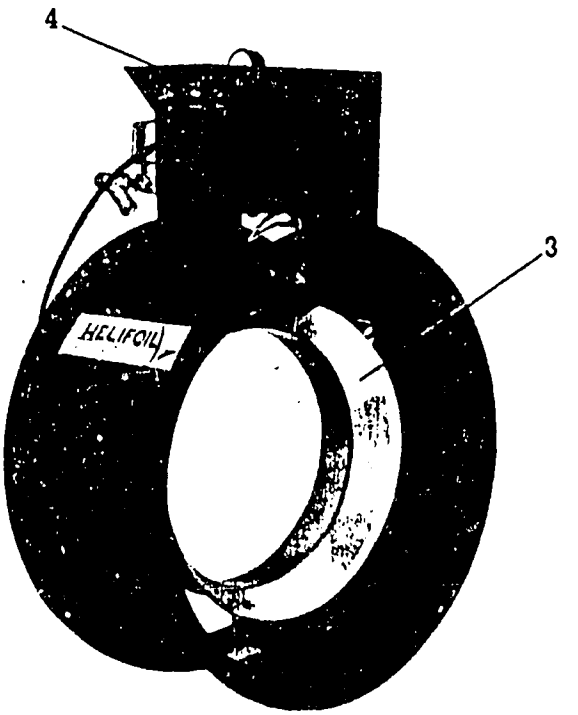
DEPENDABLE PRODUCTS THROUGH RESEARCH

SPLIT BURNER UNIT ADAPTS TO ANY DRYER FAN UNIT

Burner Units come in 24" and 26" diameters. Special adapters for other diameters of Dryer Housings.

FULLY AUTOMATIC





COMPARE THESE FEATURES:

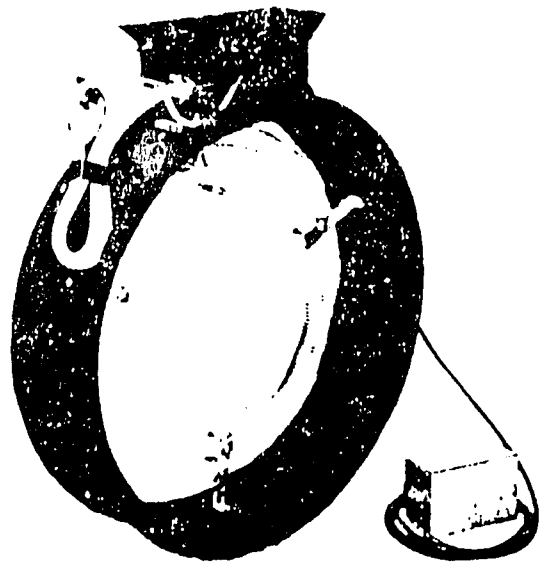
1. Rugged heavy gauge steel all welded housing
2. New process enamel coating for longer lasting finish.
3. Choice of either the Gun-type Burner or the Ring-type with Spun-Steel Flame Spreader
4. Temperature compensated automatic heater control system with electronic burner ignition.

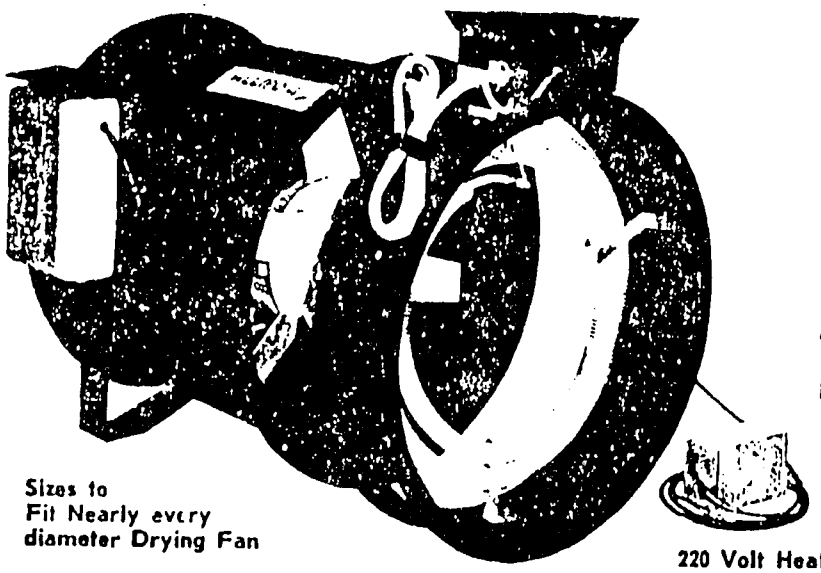
Burner Controls and Safety Devices

- Power switch to disconnect power to burner control system.
- humidistat switch to provide either automatic or manual burner control.
- adjustable pressure regulator for more accurate heat regulation.
- solenoid valve (5 year coil guarantee) and regulator are both designed to operate at tank pressures (propane), thereby eliminating the need for a tank regulator and allowing the use of a smaller supply line.
- manual reset high limit switch to shut down system in case debris blocks fan intake or in case of partial power failure.
- automatic continuous electronic ignition for maximum safety and convenience.
- low temperature flame rod to sense flame and no-flame conditions.
- the temperature compensated time delay switch has two functions:
  - A. initial firing switch.
  - B. to shut down burner control system in case of burner misfire.
- power for heater is connected to motor side of magnetic switch to insure burner shut down automatically when motor is shut off.

HELIFOIL™

ELECTRIC HUMIDITY CONTROLLER





Sizes to Fit Nearly every diameter Drying Fan

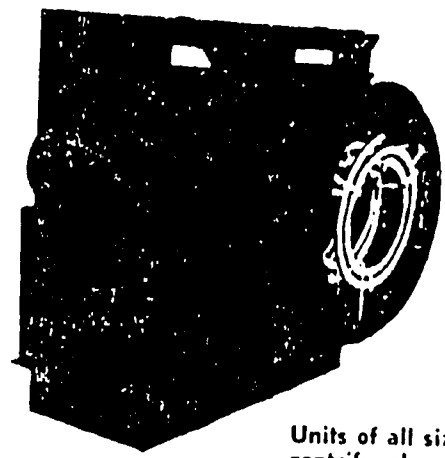
Electric Heat coils are Humidistat controlled to add a few degrees of heat only when outdoor Relative Humidity is high, reducing the moisture in the air. Now you can Natural Air Dry grain under adverse weather conditions

ECONOMICALLY!

220 Volt Heating Elements

Electric Heat Drying offers the advantage of filling the bin as fast as you desire without regard to the previous grain in the bin being dryed. Will not over dry the bottom layers of grain.

LEADERS IN LOW TEMPERATURE DRYING



Units of all sizes for centrifugal applications

Middle State Manufacturing Co. Inc.

DEPENDABLE PRODUCTS THROUGH RESEARCH

P.O Box 788 COLUMBUS, NEBRASKA 68601

MIDDLE STATE MANUFACTURING INC.

AXIAL FANS

1750 RPM FANS

MODEL	PART NO	LIST PRICE	HP	DIA	PHASE	VOLT	WT
*TF16-1.5-1	174-1-0022	507.15	1.5	16"	1	230	50
*TF16-1.5-3	174-1-0023	502.95	1.5	16"	3	230/460	63
*TF18-3-1	174-1-0024	675.15	3	18"	1	230	145
*TF18-3-3	174-1-0025	656.25	3	18"	3	230/460	150
**TF38-7.5-3	100-1-0193	2759.00	7.5	38"	3	230/460	250
**TF38-15-3	100-1-0194	3115.00	15	38"	3	230/460	285
**TF38-20-3	100-1-0195	3342.00	20	38"	3	230/460	313
**TF38-25-3	100-1-0196	3592.00	25	38"	3	230/460	413

*Units include: Heavy gauge steel housing with angle ring both ends, cast aluminum blade, totally enclosed motor, heavy steel screen guard and tapered bushing.

**Same as * except has open-drip proof motor. Also includes magnetic starter with electric line heater strips pre-wired at factory. Motors have internal thermal protection.

All units enamel painted. Available in hot-dipped galvanized. Contact Middle State Manufacturing for galvanized prices.

All fans are factory tested under static pressure and inspected for correct amperage draw and proper blade balance.

All units shipped in cartons.

MIDDLE STATE MANUFACTURING INC.

HEATERS

GAS FIRED FOR AXIAL FANS

MODEL	PART NO	LIST PRICE	DIA	FUEL	BTU	WT
HTFG-IV-24	104-1-0149	829.05	24"	Liq. Prop.	500,000-2,000,000	85
HTFG-VP-24	104-1-0228	540.75	24"	Vap. Prop.	500,000-2,000,000	70
HTFG-IV-MV-24	104-1-0153	1072.65	24"	Liq. Prop.	500,000-2,000,000	90
HTFG-VP-MV-24	104-1-0230	784.35	24"	Vap. Prop.	500,000-2,000,000	75
HTFG-NG-24	104-1-0150	624.75	24"	Nat. Gas	500,000-1,500,000	70
HTFG-NG-MV-24	104-1-0154	868.35	24"	Nat. Gas	500,000-1,500,000	75
HTFG-IV-26	104-1-0151	941.25	26"	Liq. Prop.	500,000-2,000,000	90
HTFG-VP-26	104-1-0229	575.40	26"	Vap. Prop.	500,000-2,000,000	75
HTFG-IV-MV-26	104-1-0155	1185.45	26"	Liq. Prop.	500,000-2,000,000	95
HTFG-VP-MV-26	104-1-0231	819.90	26"	Vap. Prop.	500,000-2,000,000	80
HTFG-NG-26	104-1-0152	653.10	26"	Nat. Gas	500,000-1,700,000	75
HTFG-NG-MV-26	104-1-0156	896.00	26"	Nat. Gas	500,000-1,700,000	80
HTFG-IV-MV-38	104-1-0001	1609.00	38"	Liq. Prop.	500,000-2,000,000	100
HTFG-NG-MV-38	104-1-0002	1309.00	38"	Nat. Gas	500,000-1,700,000	110

Units include: Heavy gauge steel housing, angle ring on each end, gun burner with combustion air tubes, 1/2" plumbing, 17" target, air straighteners, propane 5/32 orifice (additional orifice sizes are available), pressure regulator, pressure gauge, solenoid valve, flame sensor, air switch, gas strainer, and test light.

Units enamel painted. Available in hot dipped galvanized. Contact Middle State Manufacturing for galvanized prices.

115 Volt heater controls must be interlocked to the fan through the fan's magnetic starter.

IV models include liquid and vapor solenoid valves plus liquid propane vaporizer.

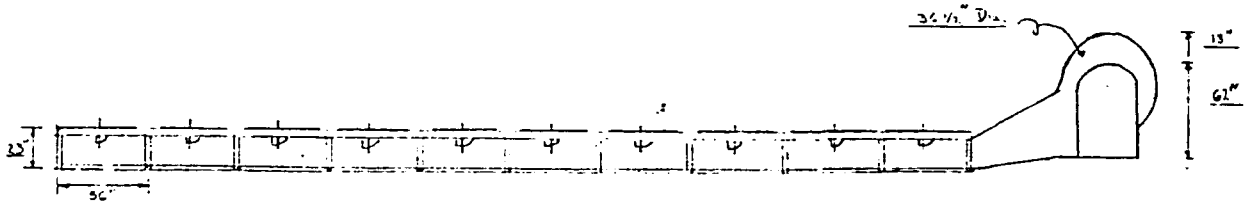
MV models include factory installed modulating valve.

NG burners require an upstream regulator (supplied by gas company) installed within 10' of the burner and 3 lbs. continuous minimum gas pressure.

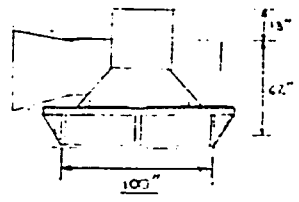
Downstream high limit (manual reset) is supplied with all burners. Instructions for installation are in the Instruction Manual supplied with the burner.

All units shipped in cartons.

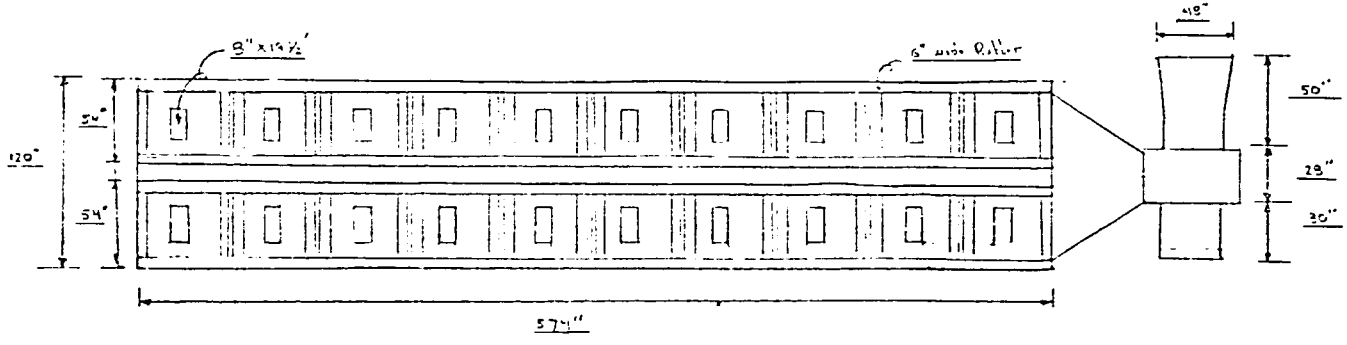
All gas heaters are factory tested to assure field performance.



SIDE



END ELEVATION



PLAN

BLOWER SPECIFICATION:

WHEEL DIA 36 1/2"

BLOWER 928 RPM

17 900 CFM AT 3" SP

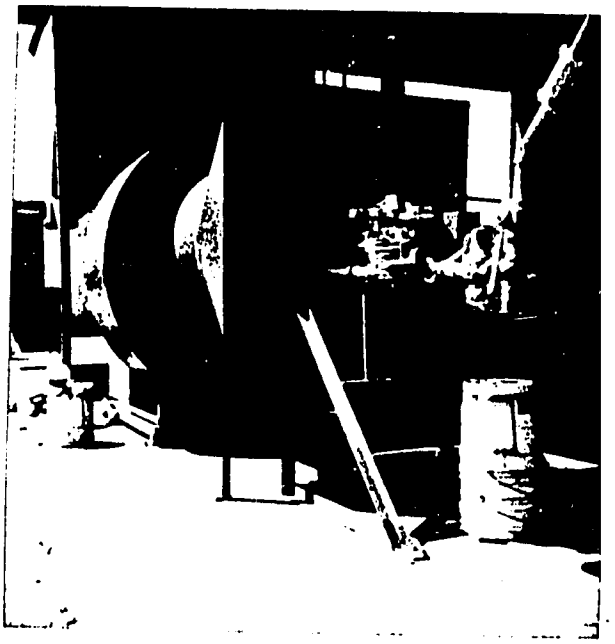
BOX SPECIFICATION

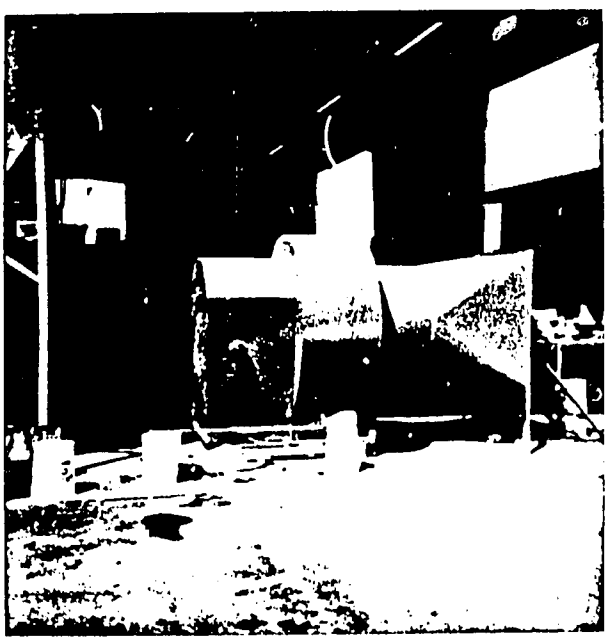
VOL 400 CU FT

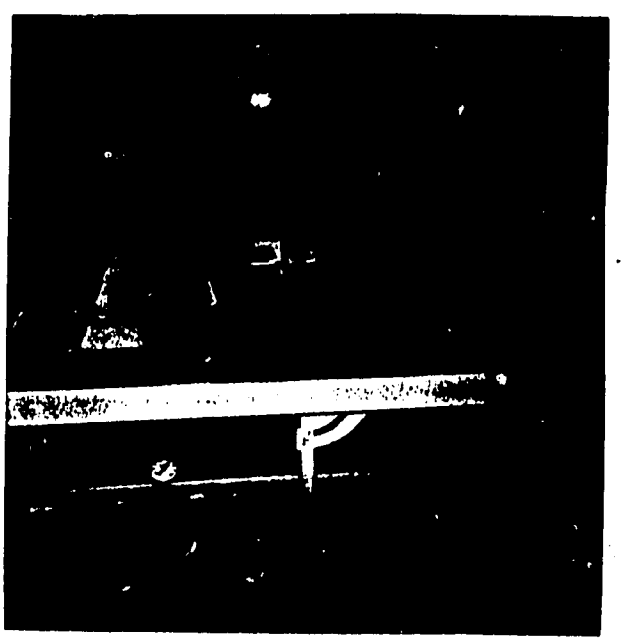
BOXES CAN BE FOT 3 TO 4 HIGH

ARCO SEED CO
ALFALFA DRYER

MARCH 1984







JOHN CALANDRI FARMS
42016 IVESGROVE DRIVE
LANCASTER, CA 93534

APPENDIX VI

March 07, 1984

Archie Desert
Arco Seed Company
P. O. Box 181
El Centro, CA 92244-0181

Dear Archie,

Art Caston asked me to prepare some photos for your trip to Panama and I hope these will be adequate. We also hope you are enjoying your visit and are learning much.

To begin with the secret to storing onions is the quality that goes into the storage facility. If bad onions go in, poor quality onions come out. Sorting is of the utmost importance.

Next we feel temperature and relative humidity must be controlled very closely. (see additional articles). Also air movement must always be maintained to circulate cold air into potential "hot" spots.

The inclosed photos show our coils (#1). There are 6 per 10,000 sq. feet, displacing 582,000 B.T.U.'s per hour. There are many other types and sizes. Each operator needs to know his specific needs. I might add there are other types of cooling systems used throughout the United States and Canada, but I'm sorry to say I'm not familiar with them. The Department of Agriculture in Canada could assist you. I believe the Directors name is Mat Valk. Each area must investigate the most economical methods.

Photo #2 shows how we "rack" the onions. You can see they are all palletized anywhere from 36 to 40 sacks per pallet. Some parts of the United States store onions in bins and some in bulk piles. Both of these methods are successful. Especially if the onions are to be regraded. It is a much less expensive method. We stack ours 3 tiers high. Note there are air aisles between each pallet.

Pictures 3 thru 7 are just other views of product in racks. Photo #8 is a top view looking over total room. Coils are well above product to prevent freezer burn and promote air circulation.

Hope these help you out. Enjoy your stay.

Sincerely,
John A. Calandri
John A. Calandri

ity of strawberry plants, bare-root rose bushes and certain other nursery stock in storage. Strawberry plants can be stored up to 10 months in polyethylene-lined crates.

NUTS

See Chapter 27.

ONIONS

A comparatively low relative humidity is essential in the successful storage of onions. At higher humidities in which most other vegetables keep best, onions are disposed to root growth and decay and at too high a temperature sprouting is encouraged. Therefore, a storage temperature of 32 F with a relative humidity of 70–75% is recommended to keep them dormant. Onions in cold storage are usually held in 50 lb mesh sacks which are best piled in pairs laid crosswise of each other in stacks five or six sacks high. The stacks are set on dunnage strips to allow air passage beneath and spaced a few inches apart to allow further air circulation. *Onion sets* require practically the same temperature and humidity conditions as onions, but since they are smaller in size they tend to pack more solidly. They are handled in approximately 25 lb bags and should be stacked to allow the maximum of air circulation.

ORANGES

See Chapter 25.

PAPAYAS

Papayas should be ripened at 78–86 F to a firm ripe condition before shipment or storage. This usually requires one to six days. The best shipping or storage temperature is 45 F and the fruit should keep for two to three weeks without undue decay. *Anthracnose* is the principal decay of stored papayas.

PEACHES

Peaches can be stored for only short periods. However, if well matured but not overripe, they can be held at 31 to 32 F for two to four weeks. Deterioration is marked by loss of flavor and bright natural color and by browning of the flesh, especially around the pit. This deterioration occurs much more rapidly at 36 to 40 F than at 31 or 32 F.

PEARS

See Chapter 24.

POPCORN

Popcorn should be stored at 32–40 F and at a relative humidity of about 85%. For optimum popping condition a moisture content of about 13.5% is desirable. The above relative humidity should maintain about this amount of moisture.

PLUMS AND FRESH PRUNES

Plums and fresh prunes are not stored extensively and are not adapted to long storage. *Abundance, Wild Goose*, and varieties of the *Damson* type store l than the softer-fleshed plums, such as *Santa Beauty, Wickson* and *Duarte*. If held longer about three to four weeks, even at 32 F all var become too ripe for commercial handling and somewhat in flavor. Italian prunes, if held l than about three weeks, are likely to develop int breakdown as well as abnormal odor and flavor. much confidence should not be placed on the ap ance and condition of the fruit while it is in sto as more deterioration, decay, shriveling, and int browning may take place within three days removal from storage than during the whole sto period.

POTATOES

Early crop potatoes are usually not stored ex during congested periods. They should be consid as perishable and not be expected to keep as we as long as late crop tubers. Refrigerated storag 50 F following a curing period of a few days at 80 F is recommended. If early crop potatoes ar be used for chipping or french frying a storage t perature of 70 F is recommended.

Late crop potatoes should keep in sound dorm condition at 40 F for five to eight months. A temp ture below this is not desirable except for seed st for late planting. For this purpose 38 F is best. 40 F or below Irish potatoes tend to become sw For ordinary table use potatoes from 40 F are sa factory but they probably will be unsatisfactory chipping or french frying without being desugared conditioned at about 70 F for one to three we previous to use. Potatoes will remain dormant at 5 for from two to four months, and since tubers fr this temperature are more desirable for both table and processing than those from 40 F it is reco mended that late crop potatoes for use within fo months be stored at 50 F and those for later use 40 F. All potatoes should be stored in the dark. Th should not be kept in the same room with fruits, nu eggs or dairy products because of the objection flavor they may impart.

POULTRY

Frozen poultry should be stored at 0 F to −10 with the temperature maintained as constant possible. Temperatures of from −20 to −40 F a desirable for the actual freezing operation. Und optimum conditions, broilers, fryers and roaste (New York dressed) can be held without appreciab deterioration for six to nine months. Ready-to-co chickens packed in institutional packs with goo quality liners should remain in satisfactory conditio for 9–10 months, and similar classes of birds in vidually wrapped in film should hold up in stora for 12–18 months. Improper handling during a of the processing operations could materially red these safe storage times.

When frozen poultry is held under severely fluctu ating temperatures, evaporation of moisture from the skin may be so great that it causes light-colored pockmarks to appear. Such a condition is called

Commodity	Storage Temp, F	Relative Humidity, %	Approximate Storage Life	Water Content, %	Average Freezing Point, F	Specific Heat Above Freezing[1]	Specific Heat Below Freezing[1]	Latent Heat (Calculated) Btu
Lamb—Fresh	32–34	85–90	5–12 days	60–70	28–29	0.68–0.76	0.38–0.51	86–[illegible]
Frozen	−10– 0	90–95	8–10 months	—	—	—	—	—
Livers—Frozen	−10– 0	90–95	3– 4 months	70.0	—	—	—	—
Pork—Fresh	32–34	85–90	3– 7 days	35–42	28–29	0.48–0.54	0.30–0.32	50–[illegible]
Frozen	−10– 0	90–95	4– 6 months	—	—	—	—	—
Smoked Sausage	40–45	85–90	—	—	—	—	—	—
Sausage Casings	40–45	85–90	—	—	—	—	—	—
Veal	32–34	90–95	5–10 days	70–80	28–29	0.76–0.84	0.42–0.51	100–[illegible]
Mangoes	50	85–90	2– 3 weeks	81.4	29.4	0.85	0.44	11[illegible]
Melons								
Cantaloupe and Persian	45–50	85–90	1– 2 weeks	92.7	29.9	0.94	0.48	13[illegible]
Honey Dew and Honey Ball	45–50	85–90	2– 4 weeks	92.6	29.8	0.94	0.48	13[illegible]
Casaba	45–50	85–90	4– 6 weeks	92.7	29.9	0.94	0.48	13[illegible]
Watermelons	36–40	85–90	2– 3 weeks	92.1	30.6	0.97	0.48	13[illegible]
Milk, powdered	32–40	Moistureproof containers	several weeks	—	—	—	—	—
Mushrooms[1]	32–35	85–90	3– 5 days	91.1	30.0	0.93	0.47	130
Mushroom spawn								
Manure spawn	34	75–80	8 months	—	—	—	—	—
Grain spawn	32–40	75–80	2 weeks	—	—	—	—	—
Nursery stock (Table 4)	32–35	85–90	3– 6 months	—	—	—	—	—
Nuts (Chap. 27)	32–50[1]	65–75	8–12 months	3–6	—[1]	0.22–0.25	0.21–0.22	4–[illegible]
Oil (vegetable salad)	35	—	1 year	0	—	—	—	—
Okra	50	85–95	7–10 days	89.8	28.6	0.92	0.46	12[illegible]
Oleomargarine	35	60–70	1 year	15.5	—	0.32	0.25	2[illegible]
Olives, fresh	45–50	85–90	4– 6 weeks	75.2	28.5	0.80	0.42	10[illegible]
Onions and onion sets	32	70–75	6– 8 months	87.5	30.1	0.90	0.46	12[illegible]
Oranges (Chap. 25)	32–34	85–90	8–12 weeks	87.2	28.0	0.90	0.46	12[illegible]
Papayas	45	85–90	2– 3 weeks	90.8	30.1	0.82	0.47	1[illegible]
Parsnips	32	90–95	2– 6 months	78.6	29.8	0.84	0.46	1[illegible]
Peaches	31–32	85–90	2– 4 weeks	86.9	29.6	0.90	0.46	12[illegible]
Pears (Chap. 24)	29–31	85–90	—[1]	82.7	27.7	0.86	0.45	11[illegible]
Peas, green	32	85–90	1– 2 weeks	74.3	30.1	0.79	0.42	10[illegible]
Peppers, Sweet	45–50	85–90	8–10 days	92.4	30.5	0.94	0.47	13[illegible]
Peppers, Chili (dry)	32–40	65–75	6– 9 months	12.0	30.9	0.30	0.24	1[illegible]
Persimmons	30	85–90	2 months	78.2	27.5	0.84	0.43	11[illegible]
Pineapples								
Mature green	50–60	85–90	3– 4 weeks	—	29.1	—	—	—
Ripe	40–45	85–90	2– 4 weeks	85.3	29.7	0.88	0.45	12[illegible]
Plums, including fresh prunes	31–32	80–85	3– 4 weeks[1]	85.7	28.7	0.88	0.45	12[illegible]
Pomegranates	34–35	85–90	2– 4 months	—	26.5	—	—	—
Popcorn, unpopped	32–40	85	—[1]	13.5	—	0.31	0.24	1[illegible]
Potatoes								
Early crop	50–55	85–90	—[1]	—	30.0	—	—	—
Late crop	38–50[1]	85–90	—[1]	77.8	29.8	0.82	0.43	111
Poultry (Chap. 2 and 16)								
Fresh	32	—	1 week	74.0	27.0	0.79	—	10[illegible]
Frozen, New York dressed	−10– 0	—	6– 9 months	—	—	—	0.37	—
Frozen, eviscerated	−10– 0	—	9–10 months	—	—	—	—	—
Pumpkins	50–55	70–75	2– 6 months	90.5	29.9	0.92	0.47	1[illegible]
Quinces	31–32	85–90	2– 3 months	85.3	28.1	0.88	0.45	12[illegible]
Radishes—Spring, bunched or prepackaged	32	90–95	10 days	93.6	30.1	0.95	0.48	13[illegible]
Winter	32	90–95	2– 4 months	93.6	—	0.95	0.48	13[illegible]
Rabbits								
Fresh	32–34	90–95	1– 5 days	—	—	—	—	—
Frozen	−10– 0	90–95	0– 6 months	—	—	—	—	—
Raspberries								
Black	31–32	85–90	7 days	80.6	29.4	0.84	0.44	12[illegible]
Red	31–32	85–90	7 days	84.1	30.3	0.87	0.45	12[illegible]
Frozen (red or black)	−10– 0	—	1 year	—	—	—	—	—
Rhubarb	32	90–95	2– 3 weeks	94.9	29.9	0.96	0.48	13[illegible]
Rutabagas	32	90–95	2– 4 months	89.1	29.7	0.91	0.47	1[illegible]
Salsify	32	90–95	2– 4 months	79.1	29.6	0.83	0.44	11[illegible]
Spinach	32	90–95	10–14 days	92.7	31.3	0.94	0.48	13[illegible]
Squash		—						
Acorn	45–50	75–85	4– 5 weeks	—	30.0	—	—	—
Summer	3[illegible]–40	85–95	10–1[illegible] days	[illegible]5.0	30.4	0.96	—	13[illegible]
[illegible]	50–[illegible]	[illegible]	[illegible]	8[illegible]	29.[illegible]	[illegible]	—	1[illegible]

er starts on the outer ad leaves, but in severe cases :fect all leaves. *Control:* There is no known control d.

urn: Dead, brown areas along the edges and tips of eaves. This is considered to be of field origin, but occa- s the severity of the disease increases after harvest. *l:* Keep the affected stock well-cooled and market it tly after unloading to avoid secondary bacterial rots.

ery Soft Rots (see Table 4, Note 4).

as

l storage is hardly used for most kinds of melons except id temporarily adverse market conditions. To avoid by chilling, most melons are stored at 7 to 10°C with 85 rh.

ans should keep at this temperature range for up to eks; *honeydews* for two to three weeks; and *casabas* ar to six weeks. It is reported that these melons will be dy injured in eight days at temperatures as low as 0°C. dews are usually given an 18- to 24-h ethylene treat- 000 mg/kg) to obtain uniform ripening. Pulp tempera- ould be 21°C or above during treatment. Honeydews e mature when harvested; immature melons fail to en if treated with ethylene.

aloupes harvested at the hard stage (less than full slip) held about 15 days at 2 to 4°C. Lower temperatures use chilling injury. Full-slip hard-ripe cantaloupes can for a maximum of 10 to 14 days at 3 to 4°C. Canta- are precooled by hydrocooling or forced air cooling, loading, or by top-icing after loading in railcars or

ermelons are best stored at 4 to 10°C and should keep o to three weeks. Watermelons decay less at 0°C than but they tend to become pitted and have an objec- e flavor after one week at 0°C.

naria Rot: Irregular, circular, brownish spots, nes with concentric rings, later covered with black Often found on melons that have been chilled. *Control:* chilling temperatures. If cold melons are to be held at emperature, they should be so stacked that condensed e will evaporate readily. Market melons promptly.

racnose (*Colletotrichum*): Numerous greenish, d spots with yellow centers, later sunken and covered oist pink spore masses. *Control:* Apply recommended ntrol measures.

ng Injury: Honeydew and honeyball melons stored weeks or longer at temperatures of 0 to 1°C sometimes rge, irregular, water-soaked, sticky areas in the rind. Store melons at 7 to 10°C.

osporium Rot: Small black shallow spots later covered vety green mold. On cantaloupes, this rot is evident on e shallow areas at the stem ends, or at points of con- ween melons, and can be rubbed off easily. *Control:* measures are the same as for *Alternaria rot*, above.

um Rot: Brown areas on white melons; white or pink er indefinite spots on green melons. Affected tissue is and soft, with white or pink mold. *Control:* Avoid ical injuries; reduce carrying temperatures to 7°C.

phthora Rot: Brown, slightly sunken areas; later aked and covered with a wet, appressed, whitish *Control:* Cull out the affected fruits during packing. arrying temperatures to 7°C.

pus Rot: The affected melon is soft, but not soupy y as it is in similar decay on other vegetables. Coarse trands may be demonstrated in decayed tissue. (See Note 3).

End Rot (*Diplodia*): Brown, fairly firm decay usually starting at the stem end and affecting a large part of the watermelon. Black fruiting bodies develop later. *Control:* At the time of loading in cars, recut the stems and treat them with Bordeaux paste or another recommended fungicide.

Mushrooms (0°C and 90% rh)

Mushrooms are usually processed or sold in a retail market within 24 to 48 h after they are harvested. They keep in good salable condition at 0°C for five days, at 4°C for two days, and at 10°C or above for about one day. A rh of 90% is recommended during storage. While being transported or displayed, for retail sale, mushrooms should be refrigerated. Deterioration is marked by brown discoloration of the surfaces, elongation of the stalks, and opening of the veils. Black stems and open veils are correlated with dehydration.

Controlled-atmosphere storage reportedly can prolong the shelf life of mushrooms held at 10°C, if the oxygen concentration in the atmosphere is 9% or the carbon dioxide concentration is 25 to 50%.[60]

Moisture-retentive film overwraps of film caps usually are beneficial in reducing moisture loss. Treatment with a solution of salt and sodium bisulfite has been found effective in reducing discoloration.

Mushroom spawn made with rye grain deteriorates in two to three days at 21°C after it is removed from the culture bottle for delivery to the grower. It will, however, keep in good condition for two weeks when stored in well-ventilated containers at temperatures of 0 to 4°C.

During the growing period, the temperature in mushroom houses must not exceed 18°C. For summer growing in eastern Pennsylvania, about 35.2 KW of refrigeration capacity is required for each double house (with cinder block walls) containing 540 to 900 m^2 of bed space.

Okra (7 to 10°C and 90 to 95% rh)

Okra deteriorates rapidly, and normally it is stored only briefly before marketing or processing. It has a very high respiration rate at warm temperatures. Okra in good condition can be kept satisfactorily for seven to 10 days at 7 to 10°C. A rh of 90 to 95% is desirable to prevent wilting. At temperatures below 7°C, okra is subject to chilling injury, which is manifest by surface discoloration, pitting, and decay. Holding okra for three days at 0°C may cause pitting. Contact or top ice causes water spotting in two or three days at all temperatures.

Fresh okra bruises easily; blackening of the damaged areas occurs within a few hours. A bleaching type of injury may also develop when okra is held in hampers for more than 24 h without refrigeration.

Onions (0°C and 65 to 70% rh)

A comparatively low rh is essential in the successful storage of dry onions. However, humidities as high as 85% and forced air circulation have given satisfactory results. At higher humidities, at which most other vegetables keep best, onions are disposed to root growth and decay; at too high a temperature, sprouting is encouraged. Storage at 0°C with a of 65 to 70% rh is recommended to keep them dormant.

Onions should be adequately cured either in the field, in open sheds, or by artificial means before or in storage.[61, 62] The most common method of curing in northern areas is by forced ventilation in storage. Onions are considered cured when the necks are tight and the outer scales are dried until they rustle. If not cured, onions are likely to decay in storage.

Onions are stored in 22.7-kg bags, in crates, in pallet boxes that hold about 0.45 Mg of loose onions, or in bulk bins. Bags

of onions are frequently stored on pallets. Bagged onions should be stacked to allow proper air circulation. Modern air-cooled storages have forced ventilation systems. Air is introduced through floor racks beneath the bins of onions. The air can be heated if necessary. Onions in bins are stored about 1.1m deep. Soft onions at the bottom of the bin might be distorted in shape when stored in this manner. Onions should not be stored with other products that tend to absorb odors.

When onions are removed from storage in warm weather, they are apt to sweat because of moisture condensation. This may favor decay. Warming onions gradually should avoid this difficulty.

In the northern onion-growing states, onions of the globe type are generally held in common storage, since average winter temperatures are sufficiently low to permit common storage. They should not be held after early March unless they have been treated with maleic hydrazide in the field to reduce sprout growth.[62]

Refrigerated storage is often used to hold onions for marketing late in the spring. Onions to be held in cold storage should be placed there immediately after curing. A temperature of 0°C will keep onions dormant and reasonably free from decay, provided the onions are sound and well- cured when stored. Sprout growth indicates too high a storage temperature, poorly cured bulbs, or immature bulbs. Root growth indicates the relative humidity is too high.

Globe onions can be held for six to eight months at 0°C. Mild or Bermuda types can usually be held at 0°C for only one to two months. Onions of the Spanish type are often stored; if well matured, they can be held at 0°C, at least until January or February. In California, onions of the sweet Spanish type are held at 0°C until April or May.

Onions are damaged by freezing, which appears as water-soaking of the scales when cut after thawing. Onions that have been slightly frozen may recover with little perceptible injury if allowed to thaw slowly and without handling.

Onion sets require practically the same temperature and humidity conditions as onions, but since they are smaller in size they tend to pack more solidly. They are handled in approximately 11.3-kg bags and should be stacked to allow the maximum air circulation.

Green onions (scallions) and green shallots are usually marketed promptly after harvest. They can be stored three to four weeks at 0°C with 95% rh. Crushed ice spread over the onions will aid in supplying moisture. Packaging in polyethylene film will also aid in preventing moisture loss. Storage life of green onions at 0°C can be extended to eight weeks by packaging them in perforated polyethylene bags or in waxed cartons and holding them in a controlled atmosphere of 1% oxygen with 5% carbon dioxide.[63]

Ammonia Gas Discoloration: Exposure of onions to 1% ammonia in air for 24 h causes the surface of yellow onions to turn brown, red onions to turn deep metallic black, and white onions to turn greenish yellow. *Control:* Ventilate storage rooms as soon as possible after exposure.

Bacterial Soft Rot: This decay often affects one or more scales in the interior of the bulb. Decayed tissue is more mushy than gray mold rot. (See Table 4, Note 1.)

Black Mold (*Aspergillus*): Black powdery spore masses on the outermost scale or between outer scales. *Control:* Store onions at just above 0°C and at 65% rh.

Freezing Injury: A Water-soaked, grayish yellow appearance of the entire outer fleshy scales results from a slight freezing injury. All scales are affected and become flabby with severe injury. Opaque areas appear in affected scales. *Control:* Prevent exposure to −1°C temperatures or lower. Thaw frozen onions at 4°C.

Fusarium Bulb Rot: Semiwatery to dry decay progressing up the scales from the base. Decay usually is covered with dense, low-lying white to pinkish mold. *Control:* Do not store badly affected lots. Pull out infected bulbs in slightly affected lots. Store onions at 0°C.

Gray Mold Rot: This is the commonest type of onion decay; it usually starts at the neck, affecting all scales equally. Decay often is pinkish. (See Table 4, Note 2.) *Control:* Cure onions thoroughly. Protect them from rain. Store them at just above 0°C.

Smudge: Black blotches or aggregations of minute black or dark green dots on the outer drying scales of white onions. Under moist conditions, sunken yellow spots develop on fleshy scales. *Control:* Protect onions from rain after harvest. Store them just above 0°C.

Translucent Scale: The outer two or three scales are gray and water-soaked, as in freezing. The entire scale may not be discolored; no opaque area is noticeable. Sometimes translucent scale is found in the field. *Control:* No control is known. Store onions at 0°C after curing.

Parsley (0°C and 95% rh)

Parsley should keep one to two months at 0°C and for a somewhat shorter period at 2 to 4°C. High humidity is essential to prevent desiccation. Package icing is often beneficial.

Bacteria Soft Rot (see Table 4, Note 1).

Watery Soft Rot (see Table 4, Note 4).

Parsnips (0°C and 98 to 100% rh)

Topped parsnips have similar storage requirements to topped carrots and should keep for two to six months at 0°C. Parsnips held at 0 to 1°C for two weeks after harvest attain a sweetness and high quality equal to that of roots subjected to frosts for two months in the field. Ventilated polyethylene box or basket liners can aid in preventing moisture loss. Parsnips are not injured by slight freezing while in storage, but they should be protected from hard freezing and should be handled with great care while in a frozen condition.

Bacterial Soft Rot (see Table 4, Note 1).

Canker (*Itersonilia sp.*): Organism enters through fine rootlets and through injuries. The surface of the infected parsnip is first brown to reddish; later, it turns black where a depressed canker is formed. *Control:* Follow the recommended field spray program. Practice crop rotation.

Gray Mold Rot (see Table 4, Note 2).

Watery Soft Rot (see Table 4, Note 4).

Peas, Green (0°C and 95% rh)

Green peas lose part of their sugar rapidly if they are not refrigerated promptly after harvest. They should keep in salable condition one to two weeks at 0°C.[42, 64] Top icing is beneficial in maintaining freshness. Peas keep better unshelled than shelled.

Bacterial Soft Rot (see Table 4, Note 1).

Gray Mold Rot (see Table 4, Note 2).

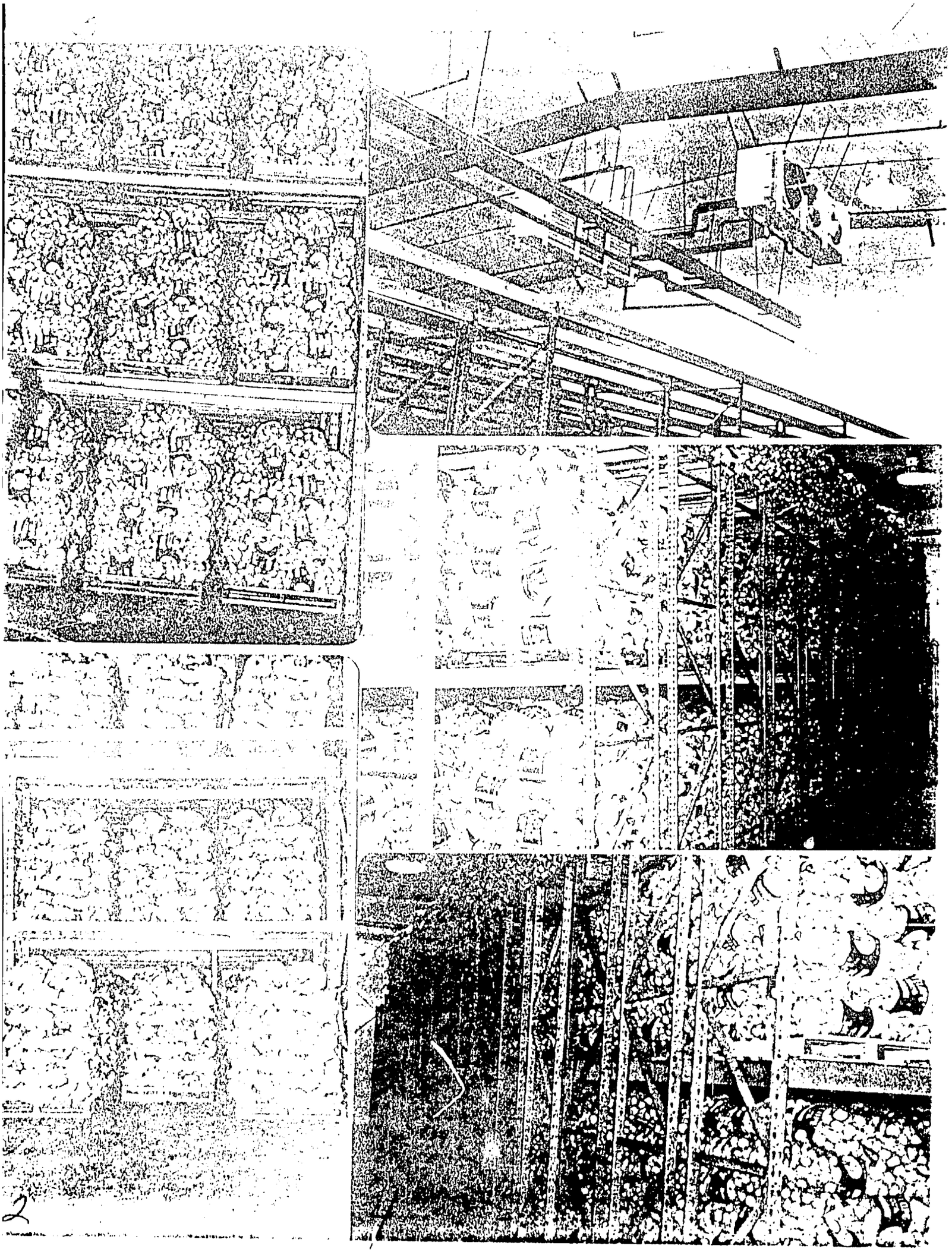
Watery Soft Rot (see Table 4, Note 4).

Peppers, Dry Chili or Hot

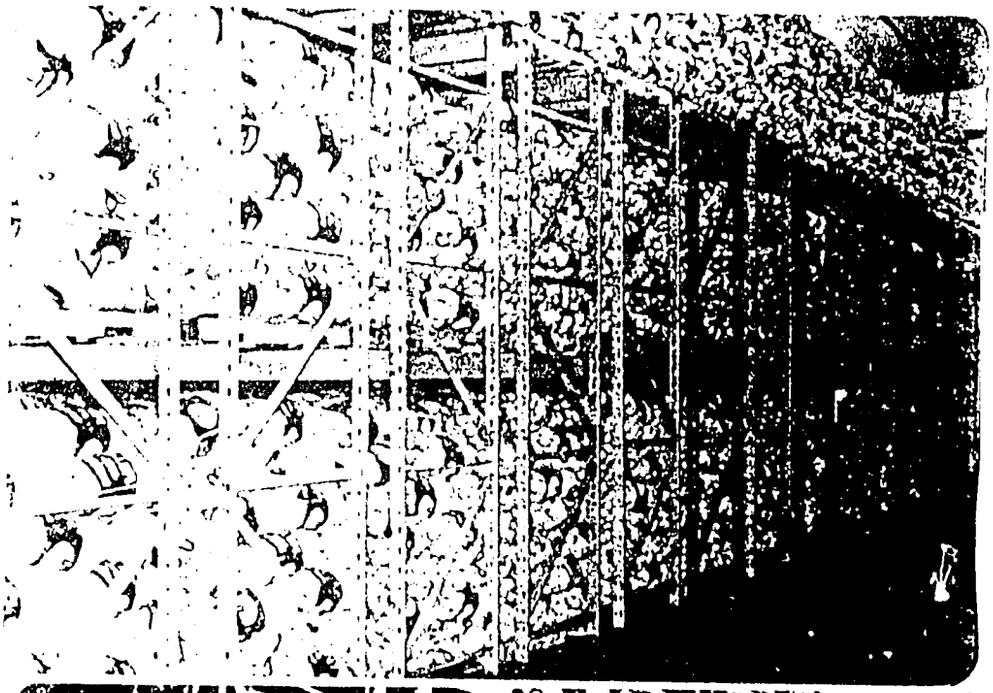
Chili peppers, after drying to a moisture content of 10 to 15%, are stored in nonrefrigerated warehouses for six to nine months. The moisture content is usually low enough to prevent fungus growth. A relative humidity of 60 to 70% is desirable. Polyethylene lined bags are recommended to prevent changes in moisture content. Manufacturers of chili pepper products hold part of their supply of the raw material in cold storage at 0 to 10°C, but they prefer to grind the peppers

Table 2 Storage Requirements and Properties of Perishable Products

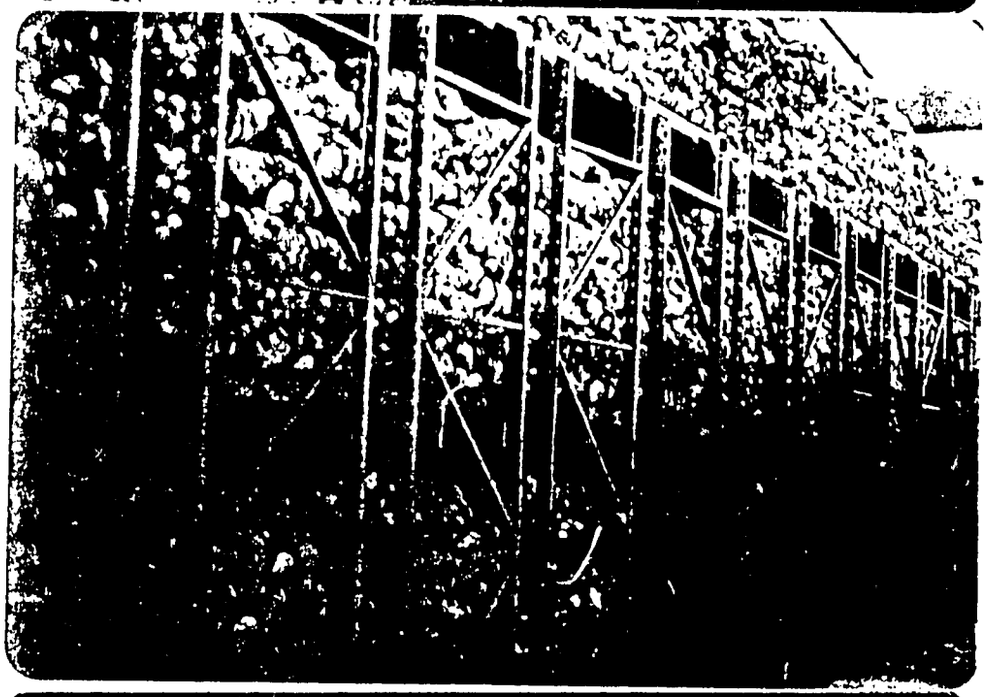
Commodity	Storage Temp °C	Relative Humidity %	Approximate Storage Life[a]	Water Content %	Highest Freezing °C	Specific Heat Above Freezing[d] J/kg · °C	Specific Heat Below Freezing[d] J/kg · °C	Latent Heat[e] J/kg
Vegetables[a]								
Artichokes								
Globe	0	95	2 weeks	84	−1.2	3.651	1.892	280.18
Jerusalem	0	90 to 95	5 months	80	−2.5[b]	3.517	1.842	266.84
Asparagus	0 to 2	95	2 to 3 weeks	93	−0.6	3.952	2.005	310.20
Beans								
Snap or Green	4 to 7	90 to 95	7 to 10 days	89	−0.7	3.818	1.955	296.86
Lima	0 to 4	90 to 95	3 to 5 days	67	−0.6	3.081	1.679	223.48
Dried	10	70	6 to 8 months	11	—	1.206	0.975	—
Beets								
Roots	0	95 to 100	4 to 6 months	88	−0.9	3.785	1.943	293.52
Bunch	0	95	10 to 14 days	—	−0.4	—	—	—
Broccoli	0	95	10 to 14 days	90	−0.6	3.852	1.968	300.20
Brussells Sprouts	0	95	3 to 5 weeks	85	−0.8	3.684	1.905	283.52
Cabbage late	0	95 to 100	5 to 6 months	92	−0.9	3.919	1.993	306.87
Carrots								
Topped—immature	0	98 to 100	4 to 6 weeks	88	−1.4	3.785	1.943	293.52
Topped-mature	0	98 to 100	5 to 9 months	88	−1.4	3.785	1.943	293.52
Cauliflower	0	95	2 to 4 weeks	92	−0.8	3.919	1.993	306.87
Celeriac	0	95 to 100	3 to 4 months	88	−0.9	3.785	1.943	293.52
Celery	0	95	1 to 2 months	94	−0.5	3.986	2.018	313.54
Collards	0	95	10 to 14 days	87	−0.8	3.751	1.930	290.19
Corn (sweet)	0	95	4 to 8 days	74	−0.6	3.316	1.767	246.83
Cucumbers	10 to 13	90 to 95	10 to 14 days	96	−0.5	4.053	2.043	320.21
Eggplant	7 to 10	90 to 95	7 to 10 days	93	−0.8	3.952	2.005	310.20
Endive (escarole)	0	95	2 to 3 weeks	93	−0.1	3.952	2.005	310.20
Frozen Vegetables	−23 to −18	—	6 to 12 months	—	—	—	—	—
Garlic, dry	0	65 to 70	6 to 7 months	61	−0.8	2.880	1.604	203.46
Greens, leafy	0	95	10 to 14 days	93	−0.3	3.952	2.005	310.20
Horseradish	−1 to 0	95 to 100	10 to 12 months	75	−1.8	3.349	1.779	250.16
Kale	0	95	3 to 4 weeks	87	−0.5	3.751	1.930	290.19
Kohlrabi	0	95	2 to 4 weeks	90	−1.0	3.852	1.968	300.20
Leeks, green	0	95	1 to 3 months	85	−0.7	3.684	1.905	283.52
Lettuce, head	0 to 1	95 to 100	2 to 3 weeks	95	−0.2	4.019	2.031	316.87
Mushrooms	0	90	3 to 4 days	91	−0.9	3.885	1.980	303.53
Okra	7 to 10	90 to 95	7 to 10 days	90	−1.8	3.852	1.968	300.20
Onions								
Greens	0	95	3 to 4 weeks	89	−0.9	3.818	1.955	296.86
Dry and onion sets	0	65 to 75	1 to 8 months	88	−0.8	3.785	1.943	293.52
Parsley	0	95	1 to 2 months	85	−1.1	3.684	1.905	283.52
Parsnips	0	98 to 100	4 to 6 months	79	−0.9	3.483	1.830	263.50
Peas								
Green	0	95	1 to 3 weeks	74	−0.6	3.316	1.767	246.83
Dried	10	70	6 to 8 months	12	—	1.239	0.988	—
Peppers								
Dried	0 to 10	60 to 70	6 months	12	—	1.239	0.988	—
Sweet	7 to 10	90 to 95	2 to 3 weeks	92	−0.7	3.919	1.993	306.87
Potatoes								
Early	10 to 13	90	—	81	−0.6	3.550	1.855	270.18
Main crop	3 to 10	90 to 95	5 to 8 months	78	−0.7	3.450	1.817	260.17
Sweet	13 to 16	85 to 90	4 to 7 months	69	−1.3	3.148	1.704	230.15
Pumpkins	10 to 13	70 to 75	2 to 3 months	91	−0.8	3.885	1.980	303.53
Radishes								
Spring	0	95	3 to 4 weeks	95	−0.7	4.019	2.031	316.87
Winter	0	95 to 100	2 to 4 months	95	−0.7	4.019	2.031	316.87
Rhubarb	0	95	2 to 4 weeks	95	−0.9	4.019	2.031	316.87
Salsify	0	98 to 100	4 to 6 months	89	−1.1	3.818	1.955	296.86
Salsify	0	98 to 100	2 to 4 months	79	−1.1	3.483	1.830	263.50
Seed, vegetable	0 to 10	50 to 65	10 to 12 months	7 to 15	—	1.206	0.976	036.69
Spinach	0	95	10 to 14 days	93	−0.3	3.952	2.005	310.20
Squash								
Acorn	7 to 10	70 to 75	5 to 8 weeks	—	−0.8	—	—	—
Summer	0 to 10	85 to 95	5 to 14 days	94	−0.5	3.986	2.018	313.54
Winter	10 to 13	70 to 75	4 to 6 months	85	−0.8	3.684	1.905	283.52
Tomatoes								
Mature green	13 to 21	85 to 90	1 to 3 weeks	93	−0.6	3.952	2.005	310.20
Firm, ripe	7 to 10	85 to 90	4 to 7 days	94	−0.5	3.986	2.018	313.54
Turnips								
Roots	0	95	4 to 5 months	92	−1.1	3.919	1.993	306.87
Greens	0	95	10 to 14 days	90	−0.2	3.852	1.968	300.20
Watercress	0	95	3 to 4 days	93	−0.3	3.952	2.005	310.20
Yams	16	85 to 90	3 to 6 months	74	—	3.316	1.767	246.83



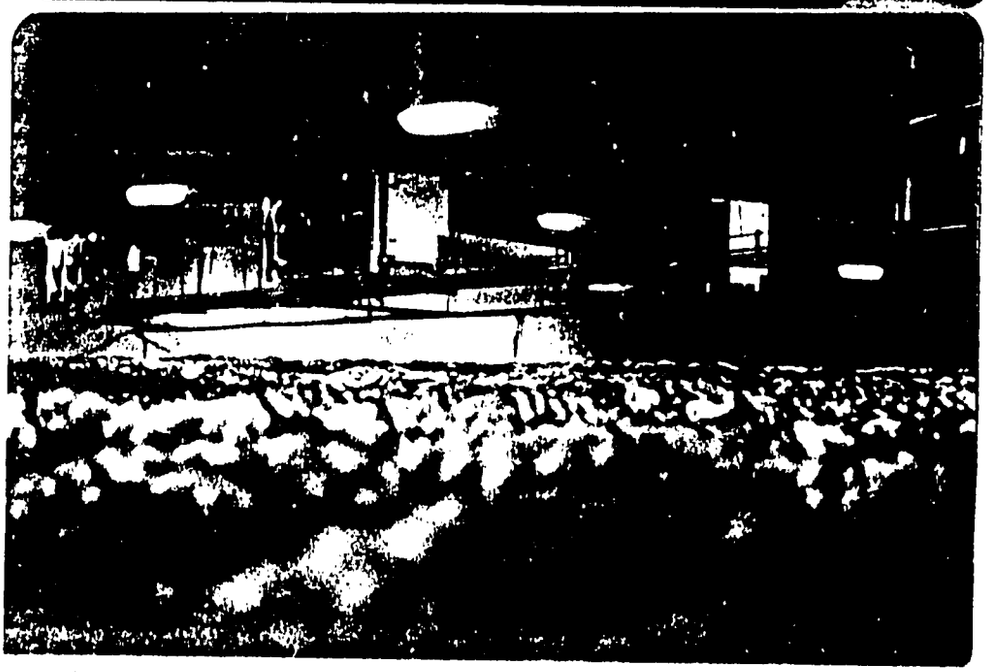
2



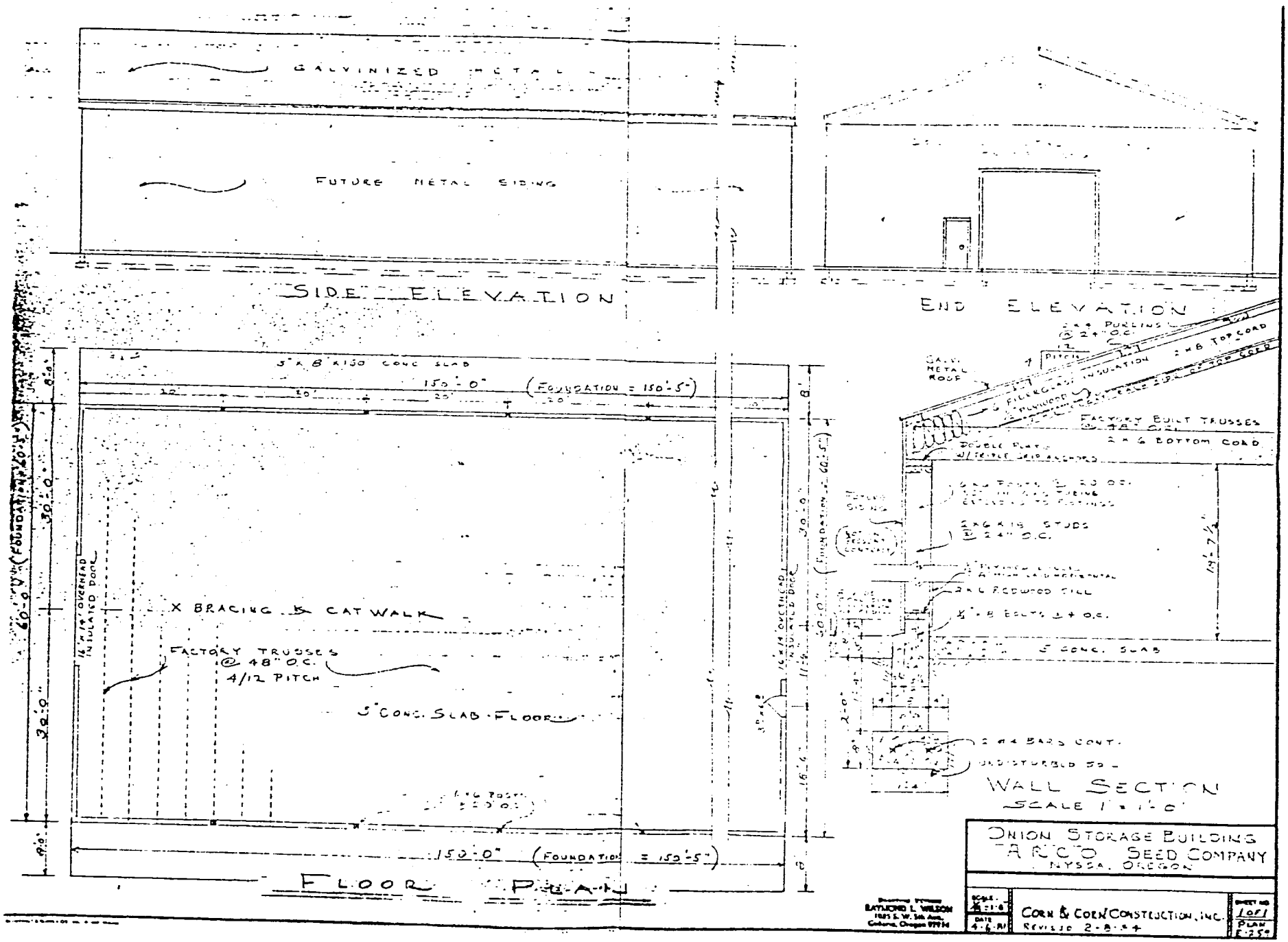
6



7

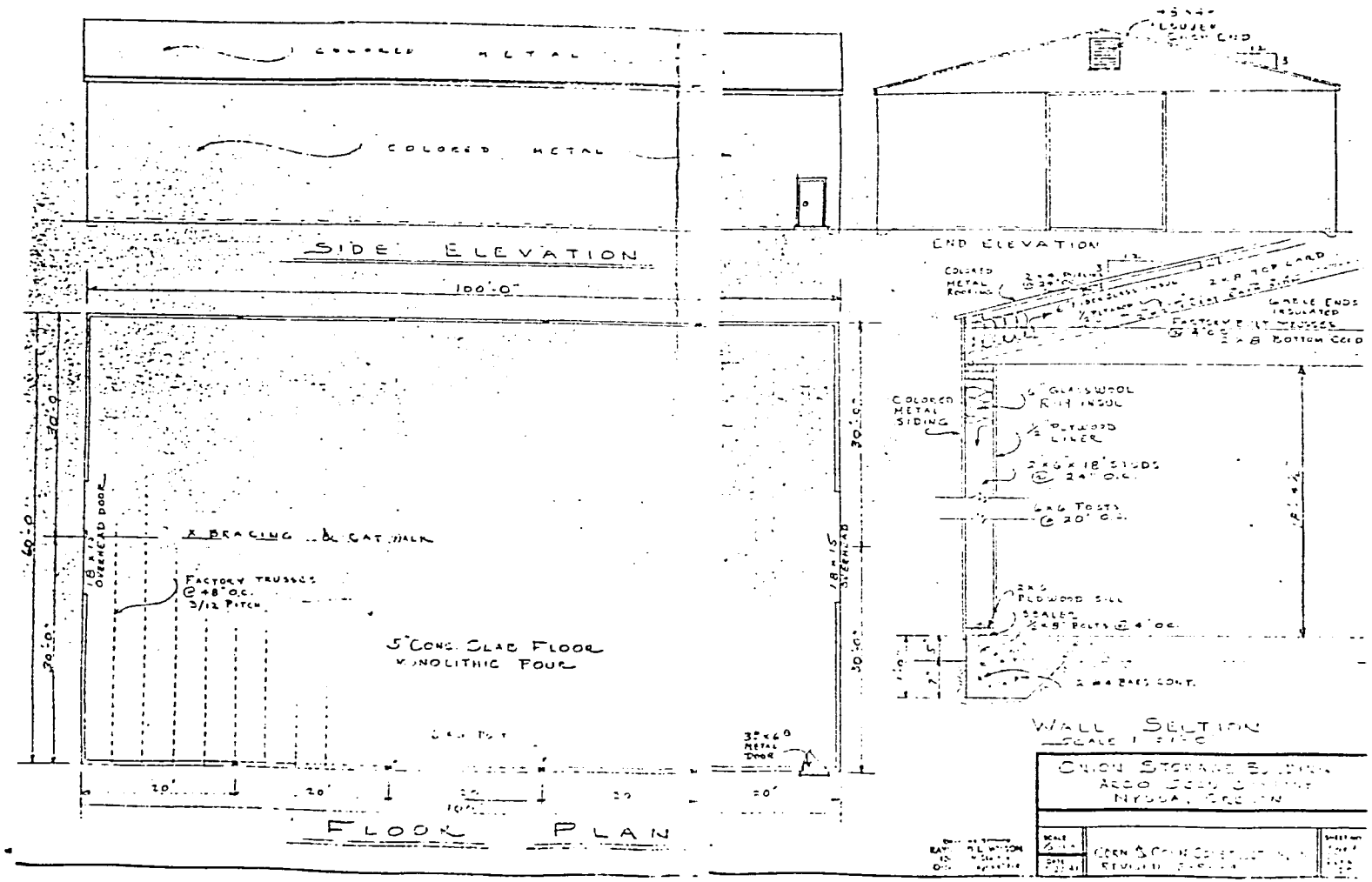


8



Best Available Document

APPENDIX VIII



Best Available Document