

## **A TECHNICAL GUIDE BOOK OF BANANA**

PREPARED AND COMPILED BY

***IQRA JUNEJO***

SUPERVISED BY

***MEHBOOB UL HAQ***

**CEO SEDF**

## TABLE OF CONTENTS

S-NO	CONTENTS	PAGE #
1	Acknowledgment	3
2	Abstract	4
3	History of Banana	6
4	Major districts of Banana cultivation in Sindh	7
5	Growth cycle of Banana	9
6	Agronomic requirements of Banana	10
7	Production practices in Sindh	14
8	Pest and disease incidence	14
9	Banana bunchy top virus	15
10	Harvesting of Banana	18
11	Recommendations for better production in Sindh	19
12	Post harvest management of Banana	20
13	Recommendations for better post harvest management of banana	28
14	Post harvest losses of Banana	30
15	Recommendations to minimize post harvest losses of Banana	33
16	Post harvest processing or value addition of Banana	36
17	Analysis of business operation of Banana in Sindh	41
18	SWOT analysis of the sector of Banana in Sindh	42
19	Issues and problem of the Banana sector of Sindh	44
20	Banana priority cluster of SEDF	46
21	Status of international market of Banana	48
22	Nutritional profile of Banana	56
23	Benefits of Banana peel and pulp	57
24	Safety profile regarding Banana	60
25	A guide for better understanding of book	61
26	References	63

## **ACKNOWLEDGMENT:**

I am thankful to almighty ALLAH who blessed me with an opportunity to work in Sindh Enterprise Development Fund, Finance Department, Government of Sindh.

I would like to take this value able opportunity to thanks my BOSS, and my SUPERVISER for this Project report based guide book MR MEHBOOB UL HAQ, CEO, Sindh Enterprise Development Fund. He cooperated and appreciated me a lot which gave me potential through which I became able to make this report. (Technical guide book)

I would like to thanks MR HADI LEGHARI, Technical Manager, ASIM FARMS, Tando Allah yar, Sindh, and DR KAZI SULEMEN MEMON, Project Coordinator, Sindh Agriculture University, Tando Jaam for cooperation.

I would like to thanks Prof Dr SALEEM SHAHZAD, Dr KAZI SULEMAN MEMON, MR ABDUL RAHIM KHAN for review.

I with the help and support of my supervisor have tried my level best to collect and provide maximum technical information regarding banana to the reader I hope I succeed in my attempt.

**IQRA JUNEJO**

**Management Trainee**

**Sindh Enterprise Development Fund**



## ABSTRACT

Banana is a major fruit crop of Pakistan. It is grown on 34,800 hectares with production of 154,800 tons. It is mainly grown in Sindh province where the soil and climatic conditions are favorable for its successful cultivation. The total share of Sindh province alone in its cultivation is 87 per cent. Major districts in Sindh where banana is grown are Thatta, Hyderabad, Badin, Mirpurkhas, Tando Allahyar, Matiari, Tando Muhammad Khan, Sangar, Naushero Feroz, and Nawabshah. However, its cultivation has extended to northern parts of Sindh particularly district Khairpur. Ninety five per cent of area is under Basrai variety (Cavendish dwarf), and the remaining under William Hybrid. Recent introductions include variety Grand Naine (G-9) while the work is underway to introduce high yielding Chinese varieties viz. B-10, W-11, and Pishang.

Banana sector of Pakistan is facing serious problems from production to post harvest management and export marketing. In view of limited awareness and technical know how about this sector, our basic aim of this guide is to provide technical assistance to growers, post harvest managers and exporters in order to overcome pre- and post-harvest problems and enhance production and quality of banana for local and foreign markets while ensuring increased profitability for banana growers. It includes the information about banana varieties and their potential, banana disease management particularly banana bunchy top virus, nutrient management in banana, pre-harvest banana bunch care, banana cool chain requirements, and also to establish effective linkages among the key players in banana value chain management including production, post-harvest management and marketing of banana.

In recent years, different banana growers, exporters, contractors and government officials of Pakistan have expressed alarm about the post harvest losses of banana ranging from 30 to 40 % of total production. These losses could be avoided through better management of banana production system including disease and pest management, bunch care during production, and post-harvest management of banana including cool chain and appropriate marketing system. Not only the wastage of banana can be avoided but also production of high quality banana can be increased by adopting these practices which can fetch good returns to the growers. It is the fact that only 15% of world production of banana is involved in world trade rest of banana is consumed domestically but value added sector of the banana is yet to be developed. This book provides all the information regarding banana including agronomic practices for high production of quality banana, post harvest management for local use and for export, recommendations for best pre and post harvest management in order to minimize pre and post harvest losses. This book provides information regarding value added sector of banana, nutritional profile of banana,

health benefits and safety profile regarding banana. This book also contains all the statistics of world export, import, import prices, production.

## **HISTORY OF BANANA:**

Bananas trace their roots back to the jungles of Malaysia, Indonesia, the Philippines, and northern Australia. They have been in cultivation since the time of recorded history and are mentioned in ancient Hindu, Chinese, Greek, and Roman texts. The first Europeans to refer to bananas were the armies of Alexander the Great during their conquest of India in 327 B.C.

Today, banana is the premier fruit of Asia and the Pacific. It is one of the most cultivated fruits in Indonesia, Thailand, Vietnam, Philippines, Bangladesh, the South Pacific island countries, India and Pakistan. Banana also occupies an important position in the agricultural economy of Australia, Malaysia, Taiwan, Sri Lanka, and Southern China.

## **COUNTRIES OF ORIGIN:**

<b>Europe</b>	Spain
<b>Africa</b>	Congo, Liberia, Ivory Coast, Cameroon, Somalia
<b>Asia</b>	Philippines, Thailand, India, Indonesia, Malaysia
<b>America</b>	Jamaica, Cuba, Haiti, Guatemala, Honduras, Costa Rica, Brazil, Colombia, Ecuador, Panama
<b>Australia</b>	

Note: This table shows only selected countries of origin because of their historical importance.

Pakistan is a land of promise and tremendous development possibilities by virtue of its unique geographical location, fast inquisitional talents of its people, and richness of natural and cultural resources. Agricultural sector of Pakistan is usually divided into four main sub-sectors: crops, livestock and forestry and fisheries, Banana is an important sector of Pakistan

Banana is extensively grown in the lower part of Sindh where the soil and climatic conditions are favorable for its successful cultivation. The total share of Sindh province alone in its cultivation in the area is 87 per cent and 89 per cent in production.

The area under banana at the time of independence was only 117 hectares and the production reported was 368 M. tons. The popular Hari chhal (Basrai) banana variety has been successfully acclimatized, then multiplied and spread all over the Sindh Province and it covers approximately 98% of total production area in Sindh. Since then it seems that during that period till now, there have been no technical know-how ever established about better banana cultivation practices. According to “Pakistan Statistical Year Book 2011”, out of 34,800 hectares 32,200 hectares were grown in Sindh province and Sindh produced 127,4000 tones of banana out of 154,800 tones of total production of banana in Pakistan and the average yield per hectare was 3957 kg in Sindh and overall production of Pakistan per hectare was 4448 kg. Average cost of production in Sindh is RS 80,000 to RS 150,000.

According to FAO-Pakistan statistic 2011:

ESTIMATED AREA HARVESTED OF BANANA =25000 hec

ESTIMATED YIELD =52000 Hg/ha

ESTIMATED PRODUCTION =130000 Tones

### **MAJOR DISTRICTS OF BANANA CULTIVATION IN SINDH ARE:**

Major districts in Sindh where banana is grown are

- Thatta
- Hyderabad
- Badin
- Mirpurkhas
- Sangar
- Nawabshah
- Mtiary
- Naushero feroz
- Tando Muhammad khan
- Tando Allahyar
- Recently cultivation of banana has been extended from Khairpur to Sakkur. Mostly Basrai variety (Cavendish dwarf) and William Hybrid are grown in Khairpur, it is also being cultivated in Karachi.

### **MAJOR VARIETIES GROWN IN SINDH ARE:**



- CAVENDISH DWARF (BARSAL) 98% (CONVENTIONAL VARIETY)



#### TISSUE CULTURED VARIETIES:

- Grand naine



- William hybrid





Work is being done on three Chinese cultivar in PARC, islamabad

- Pishang image was not available
- B-10



- W-11 image was not available

## **GROWTH CYCLE OF BANANA:**

Scientifically classified in the genus *Musa*, bananas are fast-growing giant herbs from the same family as lilies and orchids. They are the largest plants on Earth without a woody stem like that of a tree trunk. A cultivated banana plant does not grow from a seed, but rather from a bulb-like structure called a corm. The “trunk” of the plant, called the “pseudo stem,” rises from the corm and is made of sheaths of overlapping leaves tightly wrapped around each other like celery stalks. Emerging from the center of the pseudo stem, 4-15 frond-like leaves unfurl at a rate of one per week in optimal conditions as the plant grows. The leaves extend upward and outward, forming broad glossy blades up to 9 feet (2.7 m) long and 2 feet (0.6 m) wide.

Once the plant has produced a certain number of leaves, the flowering stem, called the “inflorescence,” also grows up through the pseudo stem. At first, it is a large tapered purplish bud. As the bud opens, groups of tubular white flowers are revealed. Both male and female flowers are present, and the fruit (technically a berry) develop from the females without pollination. As the young bananas grow, they resemble slender green “fingers.” A cluster of mature fruit becomes a “hand,” and under the weight of the bananas the stem bends down toward the ground. As bananas ripen, they turn from green to yellow or red depending on the variety. A single banana plant can produce 100-300 individual fruits, and can reach a height of more than 30 feet (9 m).

The time for a plant to grow and bear fruit varies, depending on climate and variety, but generally can take anywhere from 10 to 15 months, it takes approx 9 months incase of 2<sup>nd</sup> generation and so on. During that time, the plants are susceptible to drought and wind damage because the pseudo stem is 93 percent water. Severe windstorms can knock down acres of plants, and many growers will prop their crops with sturdy poles or overhead cables. Growers may also cover the fruit with a transparent plastic bag, which provides protection from insects, birds, and leaf damage, yet allows sunlight to penetrate. Once a banana plant bears fruit, it dies, and new shoots grow from the corm. Thus, bananas can be grown and harvested year-round.

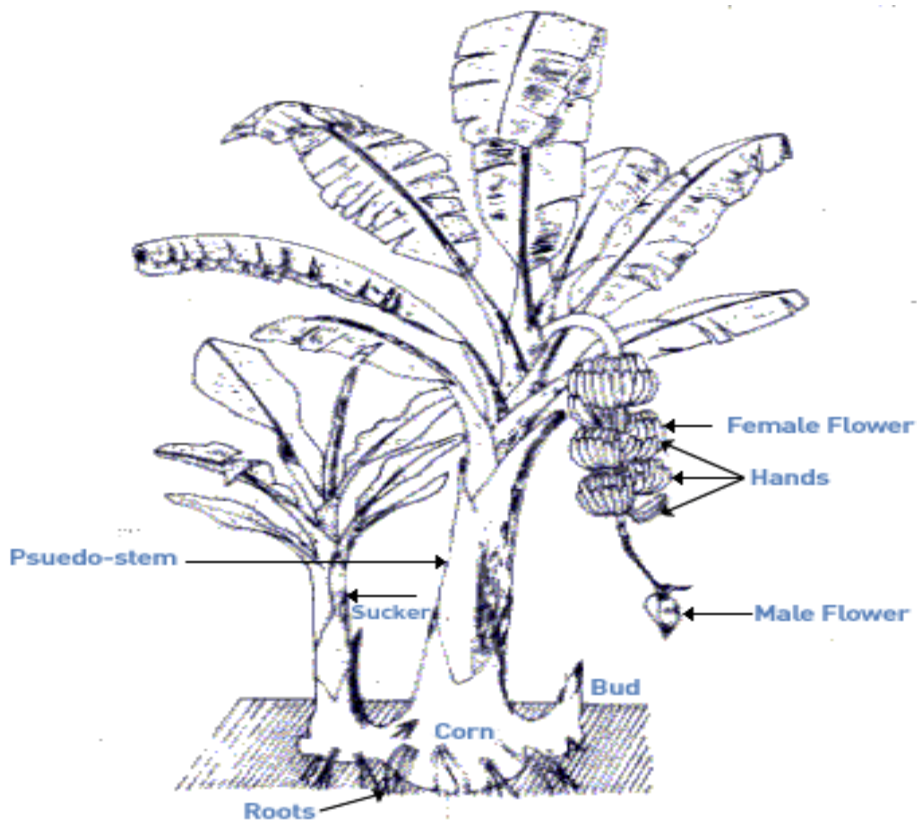


Figure presents the development of banana (Champion, 1963)

## **AGRONOMIC REQUIREMENTS OF BANANA:**

Agronomic requirements are the requirements related with crop production.

## **CLIMATE AND TEMPERATURE REQUIREMENTS:**

The banana cultivated in humid tropic of south East Asia is mainly grown between 30° S and N on equator. A mean temperature of about 27°C is optimal for growth. Minimum temperature for adequate growth is about 16°C, below which growth is checked and shooting delayed. Temperatures below 8°C for long periods cause serious damage. Maximum temperature for adequate growth is about 38°C, depending on humidity and the radiation intensity. Bananas are day-neutral in their response to day length.

## **HUMIDITY AND WIND VELOCITY REQUIREMENTS:**

A humidity of at least 60 percent or more is preferable. Strong winds, greater than 4 m/sec, are a major cause of crop loss due to the pseudo stems being blown down. Under high wind conditions windbreaks are desirable in order to protect banana plants from damages caused by high wind velocity. Wind velocity in lower Sindh is a great problem, as much as 15-20% plus losses are observed. In order to save banana from high wind velocities windbreaks are often planted around banana fields to provide some protection from cold and wind.

## **SOIL REQUIREMENTS:**

Bananas can be grown on a wide range of soils provided they are fertile and well-drained. Stagnant water will cause diseases such as the Panama disease. The best soils are deep, well-drained loams with a high water holding capacity and humus content. Optimum pH is between 5 and 7. Banana is very sensitive to salinity and soils with an ECe of less than 1 mmho/cm are required for good growth. Soils which have potassium level above 300 ppm and phosphorus level greater than 15 ppm are ideal soils for its successful cultivation. Banana is a long duration, highly sensitive, nutrient consuming crop, before taking decision to plant banana on any soil it is advised to get the soil analysis done so that the future investment on it could be properly utilized.

## **FERTILIZER REQUIREMENTS:**

The demands for nitrogen and especially potash are high in banana. Since the early stages of growth are critical for later development, nutrients must be ample at the time of planting and at the start of a ratoon crop. Short intervals between fertilizer applications, especially nitrogen, are recommended. Sindh is located in desert like hot climate and dry sub tropics fertilization program starts from 15 February soon after winter. More N is required, before hot summer less K,P application full dose Zn application at vegetative phase. In reproductive phase reverse the dose K&N, at this stage more K is required almost 60% total dose along with boron.



According to DR KAZI SLUEMAN MEMON:

8 bags of UREA per acre (184 kg N/acre)

4 bags of DAP per acre (92 kg P/acre)

8 bags of SOP acre (200 kg k/acre)

Plus 200 mds of farmyard manure are required in order to full fill the nutritional requirement.

Other sources can be used to apply NPK are

CAN (Calcium ammonium nitrate, 26% nitrogen)

SOP (Sulphate of potash, 50% potash)

SSP (single superphosphate, 14-18 % phosphorus)

## **WATER REQUIREMENTS:**

In Sindh province, the annual rainfall is not sufficient to meet the requirements of banana plant (50 to 200 mm per annum). Whereas banana produce excellent quality crop where average rainfall ranges from 1200 to 2500 mm/annum. Banana is mainly located in the Indus Delta zone of Sindh, it perform extremely well in the coastal belts; recently its cultivation has expanded up to the much warmer north. There should not been more than 3 months of dry season. Cool weather and prolonged drought retard growth. Banana plants hardly produce only one leaf per month in winter, 4 per month in summer (maximum in the month of May). If a low temperature (at 13 degree C) in winter occurs, the bunch may not be able to emerge from the centre of crown, which is called ‘Choke Throating’ a typical character of ‘Dwarf Cavendish’ and the bud may not be able to emerge from the stem. This will have a major impact on yield and quality. If the temperature even lower than that of 13 degree C, the leaves and new suckers starts to burn. Smudging, by burning dry trash covered with green leaves to create smoke, can raise the temperature 2 to 4 degrees

Banana being a long duration crop, the total water requirements of banana are high. Water requirements-per year vary between 1200 mm in the humid tropics to 2200 in the dry tropics. For rain fed production, average rainfall of 2000 to 2500 mm per year, well-distributed, is desirable, but banana often grows under less rainfall.

Regular water supply under irrigation over the total growing season as compared to rain fed production with seasonal differences in water supply produces taller plants, with greater leaf area, and results in earlier shooting and higher yields. Interval between irrigation has a pronounced effect on yields, with higher yields being achieved when intervals are kept short. Under conditions of limited water supply, total production will be higher when full crop water requirements are met over a limited area than when crop water requirements are partially met over an extended area.

### **REQUIREMENTS FOR IRRIGATION:**

Since a depletion of total available soil water in excess of about 35 percent during the total growing period is harmful to growth and fruit production, frequent irrigation is important. The irrigation interval will depend on ET<sub>m</sub> and the soil water holding capacity in the rooting depth and may vary from 3 days under high evaporative conditions and light soils up to 15 days under low evaporative conditions and high water retaining soils. When rainfall and irrigation water is limited, it is advantageous to reduce the depth of each water application rather than to extend the irrigation interval.

### **METHODS OF IRRIGATION UTILIZED TO IRRIGATE BANANA FIELD:**

Overhead sprinkler systems with small application at frequent intervals are commonly used in commercial banana plantations. Surface irrigation methods include the basin, furrow or trench irrigation systems. The trench system also serves as a drain during the rainy periods. Also drip irrigation is used; with drip irrigation under conditions of high evaporation, low rainfall and particularly when irrigation water contains even a small amount of salt, accumulation of salts at the boundary of wet and dry soil area will occur. Under such conditions leaching will often be needed since banana plants are highly salt-sensitive and damage to the crop can otherwise easily occur.

In sindh mostly flood irrigation is preferred.

### **REQUIREMENTS OF PLANTING DISTANCE IN THE FIELD:**

Planting distances vary according to variety, climate, soil and management and are between 2 x 2 m and 5 x 5 m, corresponding to a density of 400 to 2500 plants/ha. On steep slopes contour planting is practiced. The crop is sometimes inter planted or is used as a nurse crop for crops such as cocoa.

### **ESTIMATED YIELD OF BANANA WITH GOOD AGRONOMIC PRACTICES:**

Yields can vary enormously, Under poor management yields are usually highest for the planted (first) crop and decline for the ratoon crops. Under intensive management with correct de suckering and



control of pests and diseases, yields from the first ratoons are usually higher than for the plant crop. Good commercial yields of banana are in the range of 40 to 60 ton/ha. The water utilization efficiency for harvested yield ( $E_y$ ) of fruits, containing about 70 percent moisture, is 2.5 to 4 kg/m<sup>3</sup> for the plant crop and 3.5 to 6 kg/m<sup>3</sup> for ratoon crops.

## **ORGANIC PRODUCTION OF BANANA:**

According to the united nation, there is no information available as yet regarding how many countries are following organic practices in banana cultivation. And there is no official data available that how many acres or hectares are under cultivation organically, or how many producers are currently doing organic practices or how many producers are willing to produce banana organically.

## **PRODUCTION PRACTICES IN SINDH:**

Less than 1% banana plantation is managed by owner themselves and all rest by contractors and traders because banana field soon after plantation is given to contractors said MR HADI. Desuckering is done after 4 or 5 months depending of season. Mostly conventional variety is preferred in Sindh for cultivation .Site selection, land preparation “primary & secondary tillage tools including lazar land leveling”, planting layout, intercrops, cultivars (new), healthy & disease free planting materials, time of planting, spacing, planting methods, plant establishment, followers, planting density, composting or manuring (time of application), chemical fertilization macro & micro (application timings each through soil and foliar feed on the basis of soil & leaf analysis and growth cycle), irrigation water application, earthing up, weeding, interculturing (timings and frequency), mulching, deleafing, cutting height of bunch harvested pseudostem, stool or mat management, trash management, winder breakers, debelling, propping and bunch harvest, are the cultural practices often followed by banana growers of sindh.

## **PEST AND DISEASE INCIDENCE:**

Black Sigatoka disease is considered the most economically important disease of banana worldwide, causing typical yield losses up to 50%. The fungus grows on the leaves producing dark spots and causes the fruits to ripen prematurely. Banana Xanthomonas Wilt (BXW) attacks almost all varieties of Musa, destroying the fruits and devastating the crop. It was first identified in Ethiopia in the 1970s, but spread rapidly to other parts of the Great Lakes region after reaching Uganda in 2001. Fusarium wilt has had a huge impact on the world banana trade and is found in every banana/plantain producing area. It is spread through corms used for planting.

The major banana and plantain pests are the burrowing nematode and the banana weevil. Nematode species attack the plant's roots, resulting in whole plant toppling or reduced yield. The banana weevil, *Cosmopolites sordidus*, attacks the plant's underground corm, weakening the plant and causing stem breakage.



## **BANANA BUNCHY TOP VIRUS:**

BBTV is widespread in tropical and subtropical Asia. It was first reported in Fiji in 1889 and Taiwan in 1900. Nohara also reported it in Okinawa, Japan, in 1968. In almost all these countries except for the islands located in Micronesia, banana plants were found to be infected with BBTV. The existence of BBTV was newly confirmed by ELISA (enzyme linked immunosorbent assay) tests in Indonesia (1989). The first symptoms of the virus consist of darker green streaks on the lower portion of the midrib, and later on the secondary veins of the leaf.

A single vector transmits BBTV semi-persistently; the honeydew that the aphid produce attracts the banana black aphid, and the black ants, which live mutually with black aphid. Black aphid appears in the months of September to December. Sometimes the damage caused by BBTV disease is overlooked due to the apparent losses due to Fusarium wilt and Sigatoka diseases, and banana plants are considered to be free from BBTV.

Previously, the disease problem was not serious in Pakistan as compared to other parts of the world such as Australia, Panama, Surinam, Central America, India and Colombia. In December 1988, some unknown disease was reported from the Thatta district at Gorabari and Mirpur Sakro. It received public attention in April 1989 when the disease had damaged more than 50 per cent of the banana crop in that area.

Now the disease has spread in the districts of Thatta, Hyderabad, Tharparkar and Nawabshah and covered more than 90 per cent of the area in individual fields. In 2001 the disease appeared with low intensity in Karachi, Mirpurkas and Sakkur and other districts. About 50-60 per cent of the crop has been damaged. The disease has now spread over more than 50 per cent of the total area.





### **PRESENT STATUS OF BBTV IN SINDH:**

Here are few pictures to show present status of bbtv in sindh:







## **HARVESTING OF BANANA:**

The harvesting standards may vary place to place, season, transport distance and the end use of the fruit. The fruit may be harvested fully matured stage for short distance transport; the fruit may be harvested at 90% maturity level for long distance transport. The fruit may be harvested at 75% maturity level again, the fruit are harvested for table purpose or for processed for value addition of the fruit for processing fully matured and yellow banana are preferred, in later case ,usually green banana is used which has yet to reach the climacteric stage. In cooler season, the fruit may be harvested after 105 days of flowering, but during hot season, the fruit even may be harvested between 98 to 115 days (Robinson 1996).

## **HARVESTING FOR EXPORT AND LOCAL USE:**

1. Irrigation of banana plantations should be stopped well in advance of the harvest date, preferably a week, so as to facilitate drying of the soil for movement of labor, harvesting, loading, etc.
2. Temporary sheds should be erected near banana fields and all operations such as cutting into hands, application of fungicidal paste should be carried out under the shade.
3. Bunches selected should be green, three-fourths ripe, whole, free from rubbing, scratching, bruises, sunburns or other blemishes. Bunches having malformed fingers, octopus-shaped hands, broken, torn or split fingers etc. should be rejected. (For export)
4. Three quarters full stage is recognized by sharp angularities of the fingers. In some banana growing countries, bunches are marked with date and month as soon as the inflorescence is shot. Under irrigated conditions the variety 'Dwarf Cavendish' takes 99-107 days to reach three quarters full maturity.
5. 'Dwarf Cavendish' banana at three-fourths full maturity shows a pulp skin ratio of 1.35 to 1.40 under normal conditions and this gives a fairly accurate index of maturity.
6. for cutting (harvesting) bunches; one cutter and one helper are required. The bunch should be cut in one stroke 20 cm to 25 cm above the first band or 7.5 cm to 10 cm from the tip of the fingers of the first hand. The helper should hold the same portion and place it carefully on the freshly cut leaves spread on the ground. The last hand is removed if undersized.
7. For carrying bunches to packing shed it is necessary that after 15 minutes of harvest, when the latex flow ceases, bunches should be taken two at a time on stretchers and should not be allowed to come into contact with soil.

## **HARVESTING IS NOT THE END OF CARING FOR THE BANANAS:**

Carefully place individual green hands in plastic bags along with another ripening fruit, such as a red apple. The ripening fruit emits ethylene gas that the green banana uses to ripen.

1. Place the bag in a dark area, such as a cabinet. Do not place in a refrigerator.
2. The banana in the plastic bag should be removed in 24 to 48 hours and be allowed to finish ripening on its own.

## **TOOLS UTILIZED IN HARVESTING OF BANANA:**

- The curved blade knife is used to cut the bunch when the fruit is not so high in the tree.



- Otherwise it is necessary to use a long pole ended with a similar knife.

## **THREE KEY TIPS FOR HARVESTING OF BANANA:**

- Harvest the fruit during the cool part of the day when possible.
- Shade the fruit during transport to the packing shed.
- Avoid delays in transporting the fruit to the packing shed.

## **RECOMMENDATIONS FOR BETTER PRODUCTION IN SINDH:**

The bad practice of selling banana crop to contractors need to be immediately stopped. This will help banana producers to learn many things in the field by themselves.

Sindh has desert like hot & dry sub-tropical climate where normal growth & physiology of banana plants do suffer from winter and extremely higher temperatures in hot summer therefore manipulating the banana plant has become extremely important for consistent production of banana bunches. It can only be achieved by timing of sucker selection, fertilization (soil & leaf analysis) on the basis of growth cycle and with higher efficiency irrigation & fertigation systems like micro sprinklers even with wise use of flood irrigation.

Banana cultivation is a highly labor intensive, therefore labor force needs to be arranged prior to plantation. For better quality banana production these workers need to be properly trained on various aspects of improved banana cultural practices including banana bunchy top virus disease management.

Plantation managers use knowledge of these stages to implement farm practice and manage productivity. This includes matching fertilizer and irrigation requirements to plant growth, and identifying when key pest & disease management practices must be applied.

## **POST HARVEST MANAGEMENT OF BANANA:**

According to different researchers, post harvest technologist approximately 10 to 40 % of total production is wasted due to improper post harvest handling, post harvest handling starts immediately after harvesting it includes grading, sorting, packaging, transportation, storage in fact all the steps of supply chain management and value chain come under the umbrella of post harvest management.

### **GRADING:**

The hands are graded based on the number and size of fingers in each hand. Overripe and injured fruits are discarded at this stage. Banana is sent to the local market as bunches. It is done in order to check the diameter of individual fingers.

### **QUALITY CHECK DURING TRANSPORTATION:**

For transport, bananas must be sound, clean, whole, fresh, free of foreign odors and taste, free of abnormal moisture and undamaged. The color of the fruits should correspond to ripeness grade 1. In addition, they must be free from rot and mechanical damage. The hands must be treated against comb or stalk rot with fungicidal paste.

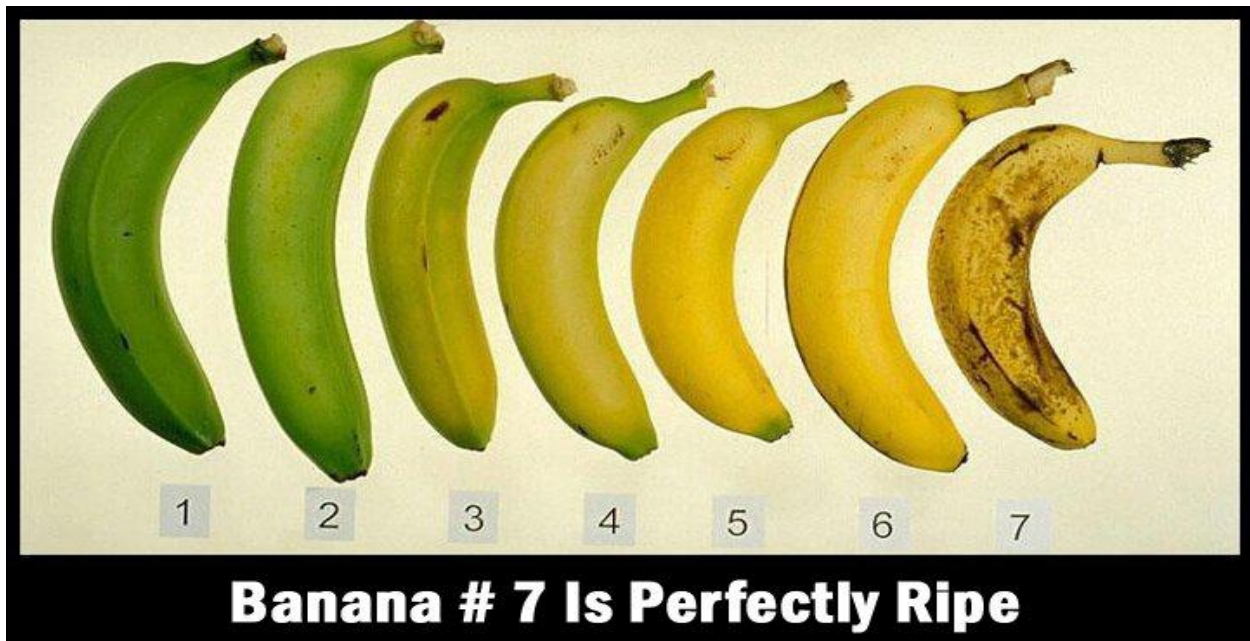
### **DIVISION OF BANANA ON THE BASIS OF DEGREE OF RIPENESS:**

Bananas may be divided into seven different degrees of ripeness in accordance with their external color:

DEGREE OF	APPEARANCE OF	CHARACTERISTICS
-----------	---------------	-----------------



RIPENESS	SKIN	
1	Green	Color at time of loading
2	Green with faint hint of yellow	Color at time of unloading
3	More green than yellow	Incipient discoloration of skin indicates continuing ripening process
4	More yellow than green	Correct degree of ripeness for ordering by wholesalers and retailers and delivery from ripening warehouse
5	Yellow with green tip	Best condition for retail sale, as the fruit can still be kept for several days
6	Completely yellow	Fruit appears at its best and is very tasty. When the fruit is this ripe, the skin is very sensitive to mechanical influences
7	Yellow with brown spots	Small brown spots indicate that the fruit is fully ripe. Its aroma and flavor are at their best



**MEANS OF TRANSPORTATION FOR LOCAL AND EXPORT MARKET:**

Banana can be transported to the local and international market by means of truck, ships, railroad etc.

#### **CONTAINERS REQUIRED FOR TRANSPORTATION:**

Refrigerated containers with fresh air supply or controlled atmosphere are required to transport banana.

#### **CARGO HANDLING AND CARGO SECURING FOR EXPORT OF BANANA:**

Because of its impact- and pressure-sensitivity, the fruit has to be handled with appropriate care. The required refrigeration temperature must always be maintained, even during cargo handling. In damp weather (rain, snow), the cargo must be protected from moisture, as there is otherwise a risk of premature spoilage. Spaces between packages or pallets must be filled in such a way that they are prevented from damaging each other. By selecting the correct packaging size or cargo unit holds can be tightly loaded (without spaces).

#### **STOWAGE FACTOR:**

- 2.30 - 2.90 m<sup>3</sup>/t (corrugated board cartons)
- 3.63 - 3.90 m<sup>3</sup>/t (cartons)
- 3.40 - 3.68 m<sup>3</sup>/t (corrugated board cartons)

#### **STOWAGE SPACE REQUIREMENTS:**

Cool, dry, good ventilation

#### **SEGREGATION:**

Marker pen/oil crayon

#### **PACKAGING OF BANANA:**

Bananas are packaged in perforated cartons of stable corrugated board with perforated plastic film lining. Two rows of approximately 8 - 10 clusters are laid in the bottom of the cartons and covered with protective packing material and then another two rows of 6 - 8 clusters are laid on top. The polyethylene bags are sealed or merely folded.

Bananas may also be packaged in special packaging known as Banovac packaging. This consists of polyethylene bags 0.4 mm thick, in which the carbon dioxide content is raised to 5% and the

oxygen content is reduced to 2% ("modified atmosphere"). The ethylene which arises is absorbed by the addition of potassium permanganate. This renders the fruit dormant, i.e. its respiration processes are interrupted, leaving it as harvested and unable to ripen, so extending storage life.



Bananas shall be packed in each container in compliance with the Recommended International Code of Practice for Packaging and Transport of Fresh Fruits and Vegetables (CAC/RCP 44-1995, Amd. 1-2004).

**MARKING OR LABELLING:**

**CONSUMER PACKAGES:**

In addition to the requirements of the Codex General Standard for the Labeling of Prepackaged Foods (CODEX STAN 1-1985, Rev. 1-1991), the following specific provisions apply:

**IDENTIFICATION AND ORIGIN OF PRODUCE:**

Name and address of exporter, packer and/or dispatcher. Identification code (optional) should be mentioned for identification. Country of origin, optionally, district where grown or national, regional or local place name should also be mentioned. If the produce is not visible from the outside, each package shall be labeled as to the name of the produce and may be labeled as to name of the variety.

**COMMERCIAL IDENTIFICATION:**

- Bananas in fingers (when appropriate);
- Class
- Net weight (optional);

**OFFICIAL INSPECTION MARK (OPTIONAL):**

**HEAVY METALS:**

Bananas shall comply with those maximum levels for heavy metals established by the Codex Alimentarius Commission for this commodity for export.

**PESTICIDE RESIDUES:**

Bananas shall comply with those maximum pesticide residue limits established by the Codex Alimentarius Commission for this commodity for export.



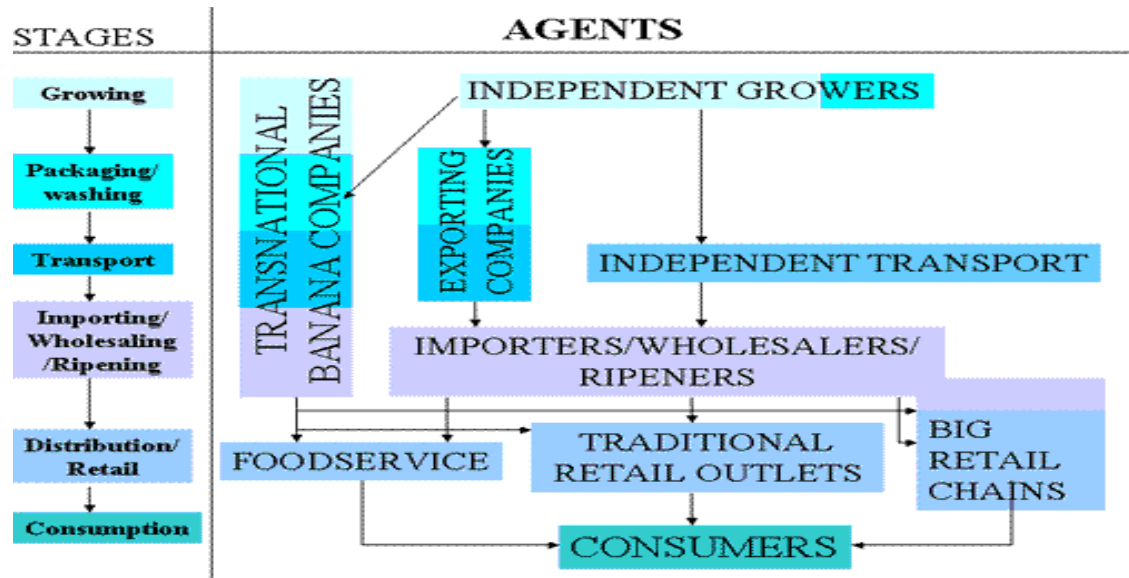


### **COLD STORAGE REQUIREMENTS OF BANANA:**

In the cold storage, bananas are stored at 13-14°C with 90-95% relative humidity. Under controlled atmospheric conditions, 2-5% oxygen and 2-5% carbon dioxide should be used to supplement temperature and humidity management during transport and storage. Maintaining ethylene concentration below 1 ppm can extend postharvest life of mature green bananas. Mature-green bananas can be stored for up to 3 weeks in ethylene-free air or up to 6 weeks in a controlled atmosphere at 14 °C.

### **COOL CHAIN OF BANANA:**

Cool chain is essential during the transport of export quality commodity all the way from the farm to the customer. This helps in maintaining the temperature inside the box at the same low level as in the cold storage and it is also helpful in maintaining the quality till banana reach to the consumer for table consumption.



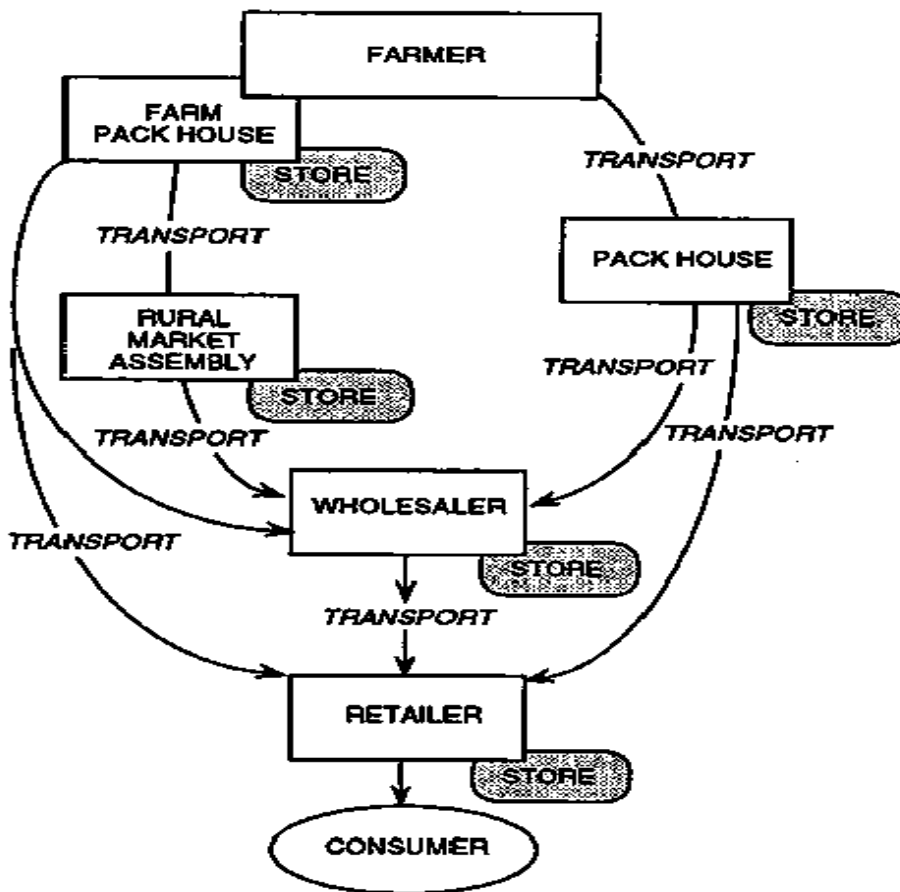
**THE VARIOUS STEPS OF THE COOL CHAIN OF BANANA FOR EXPORT ARE:**

1. Cold store at the farm.
2. Refrigerated truck from farm to the airport
3. Cold store at the airport.
4. Building up of the pallet in a cold store at the airport.
5. Loading the aircrafts directly from the cold store in a short time.
6. Cargo aircraft maintains cold store temperature in hold.
7. Off loading direct into a cold store in the receiving country.
8. Refrigerated truck to the customers.

**SUPPLY CHAIN OF BANANA FOR LOCAL MARKETS:**

Supply chain of banana for local markets can be understood by following flow chart. This flow chart shows various steps of supply chain of banana for local markets:





**DIFFERENCE BETWEEN HARVESTED AND MATURE BANANA:**

Harvested banana and mature banana can be divided on the basis of following features.

FRESHLY HARVESTED BANANAS	HARVESTED	MATURE BANANA
Fingers are square, lie close together, are hard, green, clean, without insect Infestation.		Fingers are flabby, some turners (bananas which are approaching being "ripe to eat") present
Fruit breaks with an audible snap when broken in two		Fruit does not break with an audible snap when broken in two
Pulp temperature no higher than the external temperature		Pulp temperature higher than the external temperature
The cutting test gives rise to mucilaginous threads of juice 3 - 4 cm in length		The cutting test gives rise to no mucilaginous threads of juice

Pulp (flesh of the fruit) = color of white flour	Pulp = discoloration from pink to brown to black or dark spots
Skin cannot be separated from pulp	Skin can be separated from pulp. Brown spots under skin: banana frosted, will not ripen properly
No brown spots under skin	. Brown spots under skin: banana frosted, will not ripen properly

## **RECOMMENDATIONS FOR BETTER POSTHARVEST MANAGEMENT OF BANANA:**

Post harvest losses can be minimized if proper handling is done following are few recommendations in order to prevent banana from post harvest losses.

### **MATURITY INDICES OF BANANA:**

**DEGREE OF FULL RIPENESS OF FINGER:** Degree of full ripeness of finger is disappearance of angularity in a cross section. Bananas are harvested mature-green and ripened upon arrival at destination markets since fruits ripened on the plant often split and have poor texture.

### **QUALITY INDICES OF BANANA:**

- Maturity (the more mature the better the quality when ripe)
- Finger length (depending on intended use and demand for various sizes)
- Freedom from defects, such as insect injury, physical damage, scars, and decay.
- As bananas ripen their starch content is converted into sugars (increased sweetness). Other constituents that influence flavor include acids and volatiles.

### **TEMPERATURE AND CONTROLLED ATMOSPHERE:**

#### **OPTIMUM TEMPERATURE:**

For storage and transport required temperature is 13-14°C (56-58°F) .

For ripening required temperature is 15-20°C (59-68°F) .

#### **OPTIMUM RELATIVE HUMIDITY:**

Optimum relative humidity for better post harvest management is 90-95% .

#### **RATES OF RESPIRATION PRODUCTION:**

Temperature	13°C (56°F)	15°C (59°F)	18°C (65°F)	20°C (68°F)
ml CO <sub>2</sub> /kg·hr <sup>1,2</sup>	10-30	12-40	15-60	20-70

Low end for mature-green bananas and high end for ripening bananas

To calculate heat production multiply ml CO<sub>2</sub>/kg·h by 440 to get Btu/ton/day or by 122 to get kcal/metric ton/day.

#### **RATES OF ETHYLENE PRODUCTION:**

Temperature	13°C (56°F)	15°C (59°F)	18°C (65°F)	20°C (68°F)
ul C <sub>2</sub> H <sub>4</sub> /kg·hr <sup>1</sup>	0.1-2	0.2-5	0.2-8	0.3-10

Low end for mature-green bananas and high end for ripening bananas

#### **RESPONSES TO ETHYLENE:**

Most commercial cultivars of bananas require exposure to 100-150 ppm ethylene 24-48 hours at 15-20°C (59-68°F) and 90-95% relative humidity to induce uniform ripening. Carbon dioxide concentration should be kept below 1% to avoid its effect on delaying ethylene action. Use of a forced-air system in ripening rooms assures more uniform cooling or warming of bananas as needed and more uniform ethylene concentration throughout the ripening

#### **RESPONSES TO CONTROLLED ATMOSPHERES (CA):**

- Optimum: 2-5% O<sub>2</sub> and 2-5% CO<sub>2</sub>
- CA delays ripening and reduces respiration and ethylene production rates.
- Postharvest life potential of mature-green bananas: 2-4 weeks in air and 4-6 weeks in CA at 14°C (58°F)
- Exposure <2% O<sub>2</sub> and/or >7% CO<sub>2</sub> may cause undesirable texture and flavor.

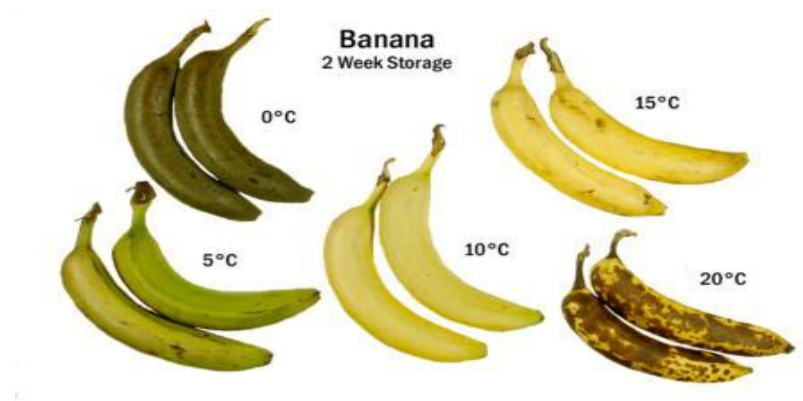
- Use of CA during transport to delay ripening has facilitated picking bananas at the full mature stage.

## DISORDERS OF BANANA OR POSYHARVEST LOSSES OF BANANA:

Poor post harvest handling may be responsible for following disorders in banana

### PHYSIOLOGICAL AND PHYSICAL DISORDERS:

**CHILLING INJURY:** Symptoms of chilling injury include surface discoloration, dull or smoky color, subepidermal tissues reveal dark-brown streaks, failure to ripen, and, in severe cases, flesh browning. Chilling injury results from exposing bananas to temperatures below 13°C (56°F) for a few hours to a few days, depending on cultivar, maturity, and temperature. For example, moderate chilling injury will result from exposing mature-green bananas to one hour at 10°C (50°F), 5 hours at 11.7°C (53°F), 24 hours at 12.2°C (54°F), or 72 hours at 12.8°C (55°F). Chilled fruits are more sensitive to mechanical injury.



**SKIN ABRASIONS:** It is caused from skin scuffing against other fruits or surfaces of handling equipment or shipping boxes. When exposed to low (<90%) relative humidity conditions, water loss from scuffed areas is accelerated and their color turns brown to black.



**Skin Abrasions**

**IMPACT BRUISING:** Dropping of bananas may induce browning of the flesh without damage to the skin caused by enzymatic oxidative degradation of phenolic compounds by polyphenol oxidase.



### **PATHOLOGICAL DISORDERS:**

**CROWN ROT:** This disease is caused by one or more of the following fungi: *Thielaviopsis paradoxa*, *Lasioidiplodia theobromae*, *Colletotrichum musae*, *Deightoniella torulosa*, and *Fusarium roseum*--which attack the cut surface of the hands. From the rotting hand tissue the fungi grow into the finger neck and with time, down into the fruit.

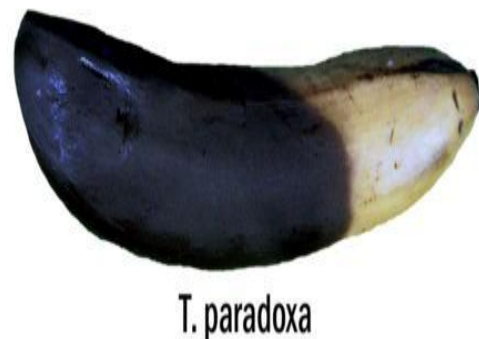
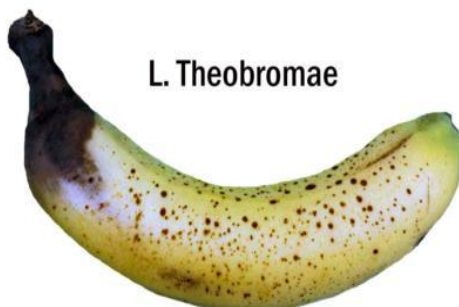




**ANTHRACNOSE:** It is caused by *Colletotrichum musae*, becomes evident as the bananas ripen, especially in wounds and skin splits.



**STEM-END ROT:** It is caused by *Lasiodiplodia theobromae* and/or *Thielaviopsis paradoxa*, which enter through the cut stem or hand. The invaded flesh becomes soft and water-soaked.



**CIGAR-END ROT:** It is caused by *Verticillium theobromae* and/or *Trachysphaera fructigena*. The rotted portion of the banana finger is dry and tends to adhere to fruits (appears similar to the ash of a cigar).





## **REASONS OF POST HARVEST LOSSES:**

Following are the major and basic reasons of post harvest losses in banana sector.

- Unskilled and Un educated labor
- Wrong use of technology (wrong operation of machinery)
- Wrong or delayed harvesting
- Early or delayed marketing
- Poor storage conditions
- Winter season
- Sanitizing problems of handling equipments.

## **RECOMMENDATIONS TO MINIMIZE POST HARVEST LOSSES IN BANANA:**

Banana can be prevented from post harvest losses by working on following recommendations.

Minimizing bruising

Prompt cooling to 14°C (58°F)

Proper sanitation of handling facilities

Hot water treatments [such as 5 minutes in 50°C (120°F) water]

By providing Fungicide (such as Imazalil) treatment to control crown rot

## **VARIETIES OF BANANA ON THE BASIS OF USE:**

Banana can be divided into following on the basis of its usage.

### **DESERT BANANA:**

Desert banana are suitable for eating fresh because they are fleshy, sweet and they have some amount of flavor and many health benefits.

### **BABY BANANA:**

It is a miniature variety of desert banana, which has recently enjoyed greater popularity.

### **COOKING BANANAS:**

Cooking banana are bananas which have to be cooked before eating (mealy, starchy and plantains)

### **FIBER BANANAS:**

Fiber banana are used for obtaining fibers. (abaca, manila hemp )

## **GLOBALLY GROWN VARIETIES OF BANANA:**

According to estimation there are approximately 200 to 300 known varieties of banana exits in this world following are few known varieties of banana

- DWRAF CAVENDISH
- ROBUSTA
- MONTHAN
- POOVAN
- NENDRAN
- RED BANANA
- NYALI
- SAFED VELCHI
- ARDHAPURI
- RASTHALI
- KARPURVALLI
- KARTHALI
- GRANDI NAINA
- B-10

- WILLIAM HYBRID

Majority of above mentioned varieties are grown in India and G9 variety is gaining popularity all over the world because of its good quality bunches and tolerance to words Biological stresses.

## **CLASSES OF BANANA ACCORDING TO CODEX STANDARDS FOR BANANA (CODEXSTAN205-1997, AMD. 1-2005)**

Bananas are classified in three classes defined below:

### **“EXTRA” CLASS:**

Bananas in this class must be of superior quality. They must be characteristic of the variety and/or commercial type. The fingers must be free of defects, with the exception of very slight superficial defects, provided these do not affect the general appearance of the produce, the quality, the keeping quality and presentation in the package.

### **CLASS I:**

Bananas in this class must be of good quality. They must be characteristic of the variety. The following slight defects of the fingers, however, may be allowed, provided these do not affect the general appearance of the produce, the quality, the keeping quality and presentation in the package:

- Slight defects in shape and color;
- Slight skin defects due to rubbing and other superficial defects not exceeding 2 cm<sup>2</sup> of the total surface area.

The defects must not, in any case, affect the flesh of the fruit.

### **CLASS II:**

This class includes bananas which do not qualify for inclusion in the higher classes, but satisfy the minimum requirements specified in Section 2.1 above. The following defects, however, may be allowed, provided the bananas retain their essential characteristics as regards the quality, the keeping quality and presentation:

- Defects in shape and color, provided the product retains the normal characteristics of bananas;
- Skin defects due to scraping, scabs, rubbing, blemishes or other causes not exceeding 4 cm<sup>2</sup> of the total surface area.
- The defects must not, in any case, affect the flesh of the fruit.

## **POSTHARVEST PROCESSING OR VALUE ADDITION OF BANANA:**

### **WHAT IS VALUE ADDED OR PROCESSING?**

Value added describes what happens when you take a basic product and increase the value of that product (and usually also the price) by adding extras in the manufacturing process, or by taking extra products and/or services in that particular product.

An activity is considered value added when some customer is willing to pay more for the additional output.

### **WHY VALUE ADDITION IS DONE?**

- It is done for better income.
- It is done for improved processing utilization
- It is done to keep in-phase with customer need
- It is done to provide variety of products
- It is done to increase shelf life of fresh fruit and vegetable by adding some preservatives.

### **PRESERVATION AND PROCESSING OF BANANA:**

Both preservation and processing are done in order to maximize the shelf life of banana, it is the fact that only 15% of total production of banana is involved in world trade rest of banana is consumed domestically but value added sector of the banana is yet to be developed

Following are the methods of preservation and processing of banana:

#### **DRYING OF BANANA :( traditional method)**

Both ripe and unripe bananas and plantain are peeled and sliced before drying, banana figs are sometimes prepared by whole ripe fruit, SUNDRYING is the most widespread technique of drying of banana where the climatic is suitable but drying in oven or over fire is also practiced Plantains are often soaked or parboiled before drying. The slices of unripe fruit are normally spread out on bamboo frame work, or on mat, or on roof, or on sheet of corrugated iron.

### **INDUSTRIAL METHODS OF PROCESSING OF BANANA:**

In general, to obtain good quality product from ripe-banana the fruit is harvested green and ripe under controlled conditions at the processing factory. After ripening the banana hands are washed to remove dust and any spray residue and peeled. Peeling is almost done by hands with the help of stainless steel knives, mechanical peeler to peel ripe banana are developed capable of peeling 450 kg per hour (banana bulletin 1974).

The peeling of unripe banana and plantain are facilitated by immersing the fruit in hot water. For example immersion in water for 5 minutes at 70 to 75°C suggesting as an aid for peeling green bananas for flour production, while peeling of green bananas for freezing has been facilitated by immersion in water at 93°C for 30 minutes.

## **VALUE ADDED PRODUCTS OF BANANA:**

Following are the value added products of banana.

### **BANANA FIGS:**

Fully ripe fruits with sugar content of about 19.6% are used and treated with sulphurous acid after peeling, then dried as soon as possible after words, various dried system have been described using temperature between 50 to 82°C for 10 to 24hrs to give a moisture content ranging from 8 to 18% and yield of dried figs of 12 to 17% of the fresh banana on the stem.

### **BANANA PUREE:**

Banana puree is obtained by pulping peeled, ripe bananas and then preserving the pulp by one of three methods: Canning aseptically, acidification followed by normal canning, or quick freezing.

The bulk of the world's puree is processed by aseptic canning techniques. Peeled, ripe fruit are conveyed to a pump which forces them through plate with ¼-in. then onto a homogenizer, followed by centrifugal de-aerator, and in to a receiving tank with 29in. vacuum, where the removal of air helps prevent discoloration by oxidation.

The puree is then passed through series of scraped surface heat exchangers where it is sterilized by steam, partially cooked and finally brought to filling temperature. The sterilized puree is then packed aseptically into steam-sterilized can which are closed in a steam atmosphere.

### **BANANA SLICES:**

Several methods for canning of banana slices in syrup are used. Best quality slices are obtained from fruit at an early stage of ripeness. The slices are processed in syrup of 25deg.Brix with PH



about 4.2, and in some processes calcium chloride (0.2%) or calcium lactate (0.5%) are added as firming agents.

A method for producing an intermediate-moisture banana product for sale in flexible laminate pouches has been developed. Banana slices are blanched and equilibrated in solution containing glycerol(42.5%),sucrose(14.85%),potassium sorbate (0.45%),and potassium meta bisulphite (0.2%) at 90 °C for 3 min to give moisture content of 30.2%.

### **BANANA POWDER:**

In the manufacture of banana powder, full ripe banana pulp is converted into a paste by passing through a chopper followed by a colloid mill. or 1 to 2% of sodium meta bisulphite solution is added to improve the color of final product. Spray or drum drying may be used, the latter being favored as all the solids are recovered.

A typical spray dryers can produced 70kg powder per hour to give yields of 8 to 10 % of fresh fruit, while drum drying gives final yield 13% of fresh fruit in the latter method moisture content is reduced to 8 to 12% and then further decreased to 2% by drying in a tunnel or cabinet dryer 60c.

### **BANANA FLOUR:**

Production has been carried out by peeling and slicing green fruit, exposure to sulphur dioxide gas, then drying in counter-current tunnel dryer for 7 to 8 hr with an inlet temperature of 75c and outlet temperature of 45°C, to a moisture content of 8% and finally milling.

### **BANANA CHIPS (CRIPS):**

Typically, unripe peeled bananas are thinly sliced, immersed in a sodium and potassium metabisulphite solution, fired in hydrogenated oil at 180 to 200°C.and dusted with salt and an antioxidant. Alternatively, slices may be dried before frying and the antioxidant and the salt added with oil. Similar processes for producing plantains chips have been developed.

### **BANANA BEVARAGES:**

In a typical process, peeled ripped fruit is cut in to pieces, blanched for 2 min in steam, pulped and pectolytic emzymes added at the concentration of 2 g per 1 kg pulp then held at 60 to 65° and 2.7 to 5.5 PH for 30 minutes.

In a simpler method lime is used to eliminate pectin. calcuim dioxide(0.5%) is added to the pulp and after standing for 15 mins. This is neutralized giving a yield up to 80% of a clear attractive

juice. In other process banana pulp is acidified, and steam blanched in a 28-in Hg in a vacuum which ensures destinging and enzymes inactivation. The pulp is then conveyed to a screw press, the resulting puree diluted in the ratio 1:3 in water and the PH adjusted by further addition of citric acid 4.2 to 4.3 which yield an attractive drink when it is centrifuged and sweetened.

### **BANANA JAM:**

A small amount of jam is prepared commercially by boiling equal quantities of fruit and sugar together with water and lemon juice, lime juice or citric acid, until setting point is reached.

### **CHALLENGES ASSOCIATED WITH VALUE ADDED PRODUCT STABILITY AND SPOILAGE:**

All dried banana products are very hygroscopic and susceptible to flavor deterioration and discoloration but this can be overcome to some extent by storing in moisture proof containers and sulphiting the fruit before drying to inactivate the oxidases.

The dried products are also liable to attack by insect and moulds if not stored in dry conditions, although disinfestations after drying by heating for 1 hr at 80°C, ensures protection against attack. Banana powder is said to be stored for up to a year commercially and flakes have been stored in vacuum sealed cans with no deterioration in moisture, color and flavor for 12 months.

Banana chips tend to have a poor storage life and to become soft and rancid. HOWEVER, chips treated with an antioxidant have been stored satisfactorily at room temperature in hermetically sealed container up to 6 months with no development of rancidity.

### **METHODS TO CONTROL QUALITY OF VALUE ADDED PRODUCTS:**

In general a good quality product is obtained if fruit is harvested at the correct stage of maturity and, where appropriate. Ripened under controlled conditions, for example in the case of banana figs the fruit should be fully matured (sugar content of 19.5% or above) or the final product is liable to be tough and lacking in flavor however, if over ripe fruit is used, the figs tend to be sticky and dark in color, so the fruit must be fully yellow but still firm.

For banana flour, which is prepared from unripe bananas, the fruit is harvested at three-quarters the full ripe stage and is processed within 24 hrs. Prior to onset of ripening. If less mature fruit is used the flour tastes slightly astringent and bitter due to the tannin content. Bananas harvested

between 85 to 95 days after emergence of the inflorescence, with a pulp-to-peel ratio of about 1.7, were considered to be most suitable for the deep-fat drying.

Other criteria suggested for assessing maturity were beta-carotene and reducing sugar content, Both of which increase with increasing maturity and PH which decreases as the fruit ripe and these should be , respectively, about 2000ug/100 gm, less than 1.5% and 5.8% or above. Browning was found to occur if the sugar content was higher than 1.5%.The determination of crude fat in processed chips is also considered to be a necessary quality control measure.

It is important to remove all impurities prior to processing of products and this is done by washing to remove dirt and spray residue and control on the processing line so that substandard fruit can be removed.

(Note: we have used this information of value added products in order to spread awareness and for educational purposes only)

## **RECOMMENDATION TO CONTROL HYGIENE OF PRODUCTS:**

It is recommended that the produce covered by the provisions of this Standard be prepared and handled in accordance with the appropriate sections of the Recommended International Code of Practice – General Principles of Food Hygiene (CAC/RCP 1-1969, Rev. 4-2003), Code of Hygienic Practice for Fresh Fruits and Vegetables (CAC/RCP 53-2003), and other relevant Codex texts such as Codes of Hygienic Practice and Codes of Practice.

The produce should comply with any microbiological criteria established in accordance with the Principles for the Establishment and Application of Microbiological Criteria for Foods (CAC/GL 21-1997).

## **ANALYSIS OF BUSINESS OPERATION OF BANANA IN SINDH:**

Banana is very important sector of sindh and good revenue can be generated by investing small amount in this sector ,before investing any amount in any sector it is necessary to analysis that particular from different angles in order to prevent business from losses and in order to do back up plan in case of sudden emergency or unexpected circumstances.

### **MARKET ANALYSIS OF BANANA SECTOR:**

- An efficient marketing system is essential for sustained development of agricultural commodities.
- There are several factors which influence the efficiency of fresh fruit marketing including the rotting of product, seasonal viability, quality, price and location of farm and markets.
- Banana producers avoid marketing to escape complications because of its perishable nature, fluctuation in price list, the business needs careful handling ,quick and timely transport, sound packaging and completion of operations on time in order to prevent business from losses.

### **TECHNOLOGY ANALYSIS OF BANANA SECTOR:**

- Lack of modern Technology and machinery in this sector.
- Only some big farmers are using some new machines.
- Due to the lack of information farmers feel hesitation for the use of new machines.
- Sindh Contributes 80-89 in banana production and its quiet unfortunate that there is no research institute to solve the problems of growers of sindh, laboratories are also not available to test the diseases, viruses and health of plants.

### **TWO MAJOR GROUPS OF BANANA CULTIVATORS:**

Banana growers or cultivators can be divided in to two majors group on the basis of utilization and availability of resources and capitals.

#### **1. BIG FARMERS’S GROUP OF SINDH:**

- Who are using new technologies?

- They have access to the healthy planting material.
- They possess land development facilities (ploughing, leveling etc.).
- They have easy access to the water sources.
- They have equity and also credit facilities from banks because of good contacts with officials and political leaders.
- They have strong relations with commission agents and banana traders.

## **2. SMALL FARMERS'S GROUP OF SINDH:**

- They don't have access to the latest technologies.
- They don't have access to the healthy planting material and facilities.
- They have improper land preparation facilities.
- They often face problem of Shortage of water.
- Neither they have equity nor banks are providing them loaning facilities.
- They run their business with the help of private creditors on very high interest rates and they are totally dependent on middle man or contractor..

## **SWOT ANALYSIS OF THE SECTOR OF BANANA IN SINDH:**

SWOT-ANALYSIS consists of strengths, weakness, opportunities and threats analysis of any sector, it is necessary to do such analysis in order to take steps for betterment of that particular sector and to analysis pre feasibility factors of business.

### **STRENGTHS OF BANANA SECTOR:**

- Availability of cheap labor in Sindh
- Availability of fertile land in sindh.
- Suitable environment for banana cultivation in sindh.
- Interest of farmers and landowners of sindh in banana sector.



- Govt.'s supporting institutions for this sector.
- Availability of markets, local as well as international because of best geographical location.

### **WEAKNESSES OF BANANA SECTOR:**

- Lack of awareness of pre and post harvest management.
- Lack of information about new technologies.
- Water shortage (they can overcome this problem by using new techniques).
- Character of middlemen or contractors in this sector.
- Improper transportation facilities. Un official export to Kabul and Afghanistan.
- Direct marketing problems.
- Bad infrastructure, Absence of cold storages.

### **OPPORTUNITIES OF BANANA SECTOR:**

- Increasing demand local and in international markets.
- Introduction of new technologies in this sector.
- New research and development in this sector can be done.
- Introduction of new machineries such as WHT plant etc.
- New Research and techniques to control diseases and other problems can be done.
- Drip irrigation and other new techniques to overcome water shortage can be introduced.

### **THREATS OF BANANA SECTOR:**

- Perishable product, because of ethylene production.
- Viral Diseases such as banana bunchy top virus.
- Improper Post harvest handling, such as grading sorting etc.

- Non-availability of proper packaging facilities and cold storages.
- Sudden shortage of water.
- Marketing issues because of perishable nature of banana.
- Plantation of unhealthy plants because of lack of awareness.

## **ISSUES AND PROBLEMS OF THE BANANA SECTOR OF SINDH ARE:**

There are different problems in the banana sector of Sindh, such as

- Uneducated farmers and labor in this sector.
- Untrained farmers and labor in this sector.
- Unawareness about new technologies in this sector.
- Lack of proper information about pre and post harvest management.
- Non availability of proper testing laboratories in sindh.
- Plantation of unhealthy suckers such as bbtv affected suckers.
- Its perishable nature and unreliable prices because of pre and post harvest losses.
- This sector is dependant on middlemen and contractors because of lack of knowledge, commission agents' bias, and engagements of farmers or growers in other crops force banana producers to make contracts with middlemen or contractor.
- Improper packaging and storage facilities.
- Unawareness about marketing techniques and no access to international markets.

## **PRICE MECHANISMS OF BANANA SECTOR IS SINDH:**

There is no proper price mechanisms exits in banana sector, price mechanisms varies from Grower to Gower, Contractor to Contractor, Commission agent to Commission agent, Wholesaler to Wholesaler, Area to Area and even from Small Stall Holder to Small Stall Holder we call it (thally wala in local language). It is depended on the Cost of Production, Cost of Transportation, Grading and Sorting of the commodity and on the Post Harvest Losses of that

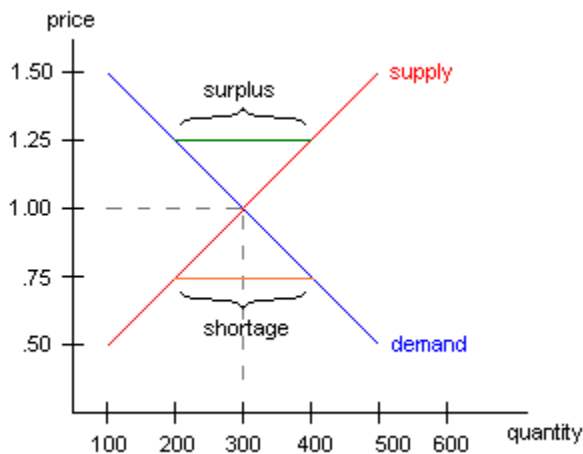


specific commodity like banana. Small stall holder also does sorting after purchasing the commodity from wholesales market or directly from grower or commission agent. He sorts the commodity on the basis of size and physical appearance. Prices of big size and good external appearance are high, while prices of small and comparatively less attractive physical appearance are less.

## **DEMAND AND SUPPLY OF BANANA IN SINDH:**

There is very close relationship between price, demand and supply, the supply declines if the prices are increased. We have observed that the prices of banana at wholesales market remain in between RS 20 or RS 25 to RS 60 per dozen depending on the quality of produce. In may 2012 banana supply at local markets was declined by 30 %, and prices were increased by 30 % still after passing a one long year prices of banana are high. It is making hard to buy fruit for consumer. Earlier banana was sold for Rs20 to Rs30 per dozen, but now it is being sold for Rs40 to Rs50 per dozen, while banana that was being sold for Rs50 to Rs60 is now being sold at Rs70 to Rs80 per dozen in the retail market in some markets of karachi like defense,clifton, steel town banana are being sold at RS 100 per dozen as well depending upon the quality of banana. In 2010 banana crop was damaged by mega flood in kacha areas which result in the short of supply of banana in 2011, 2012 and unfortunately we are still having problem of short of supply of banana in local retails markets. Virus also damages our crop due to improper agronomic activities and since the input cost of the crop has increased, growers switched to other crops, thus, increasing the gap between the demand and supply, Most of the fruit is consumed locally and only a small portion is exported through trucks to Afghanistan and Iran. Thousands of acres of fertile land are under banana cultivation in Thatta, Hyderabad, Sanghar and Khairpur districts. Fruiting takes place almost round the year. Since most of the banana export takes place informally to Iran and Afghanistan, there is hardly any data available on the export figures for this fruit. However, it is assumed that around 20 percent (around 25,000 metric tons) of Sindh's produce crosses borders into Iran and Afghanistan through Balochistan and Khyber-Pakhtunkhwa. One research report says that banana is a very popular fruit the world over and if Pakistan can overcome the problems with respect to fruit quality and transportation, it could potentially look at entering bigger and higher paying markets of Europe, as well. According to a FAO report, Iran alone imported 243,000 metric tons of bananas in 2004/05, whereas in 2006 the total import of bananas into Iran grew to 294,000 metric tons. In addition, Saudi Arabia and the UAE imported another 111,000 and 70,000 metric tons of bananas, respectively in 2004/05. Though, not only local but huge international markets exist for bananas that are easily accessible through sea and land routes, Pakistan has so far failed to successfully exploit the full potential of these markets, Due to poor variety selection, crop management and post-harvest fruit handling, According to government estimates, around 30–35 percent of all horticulture produce is wasted

due to poor post-harvest handling. These losses could be avoided by streamlining the supply chain, Sindh possesses all the ingredients such as right soil and climatic conditions; cheap labor; effective irrigation system; sea port and efficient road and rail networks that are required to produce and export world class bananas, but unfortunately still we are unable to full fill our local demand of this fruit because of high prices, demand and supply gap are in the management area which can be over come by systematic approach.it can be futher understand from this graph



## **BANANA PRIOTITY CLUSTER OF SINDH ENTERPRISE DEVELOPMENT FUND:**

### **VISION OF SEDF:**

To support entrepreneurship development based on Sindh's competitive advantage.

### **MISSION OF SEDF:**

To introduce technology & bring value addition in non conventional yet vital sectors of the economy by extending technical and credit assistance.

### **HOW SEDF WORKS:**

SEDf provides the following services to prospective Agri-business entrepreneurs:

#### **TECHNICAL ASSISTANCE:**

1. Facilitate applicants in preparing feasibility studies
2. Assist the applicant in fulfilling the requirement of financial institutions

**CREDIT ASSISTANCE:**

1. Interest rate subsidy:
2. 100% KIBOR of the Capital Cost
3. 50% of KIBOR for Working Capital

Selected individuals capable of setting up agri-business projects can apply for a loan from any financial institution for medium term (3-5 years).

SEDF will pay 100% KIBOR for capital cost and up to 50% of KIBOR for working capital for three years which may be extended up to 5 years on successful review.

The total monetary value of the SEDF interest subsidy shall not exceed PKR. 50 Million.

SEDF financial support shall not exceed projects valuing PKR. 200 Million.



**STATUS OF INTERNATIONAL MARKET OF BANANA:**

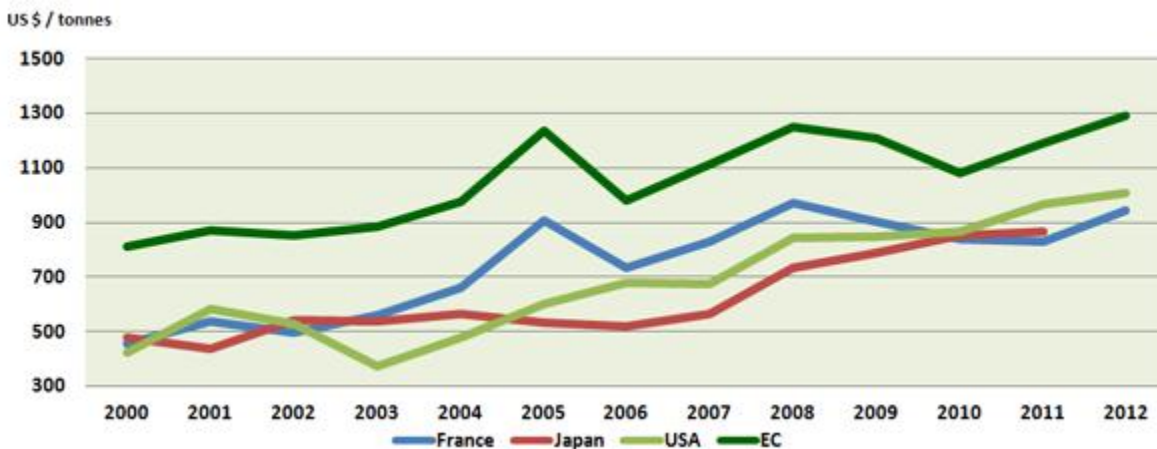
**FAO-STATISTIC 2011-2012:**

**BANANA WORLD IMPORT AND EXPORT STATISTIC:**

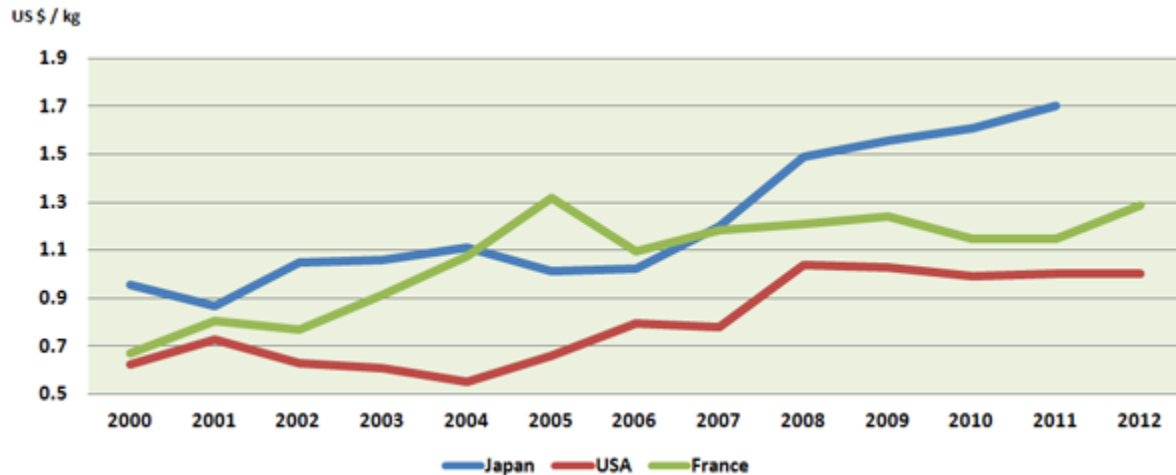
(thousand tonnes)



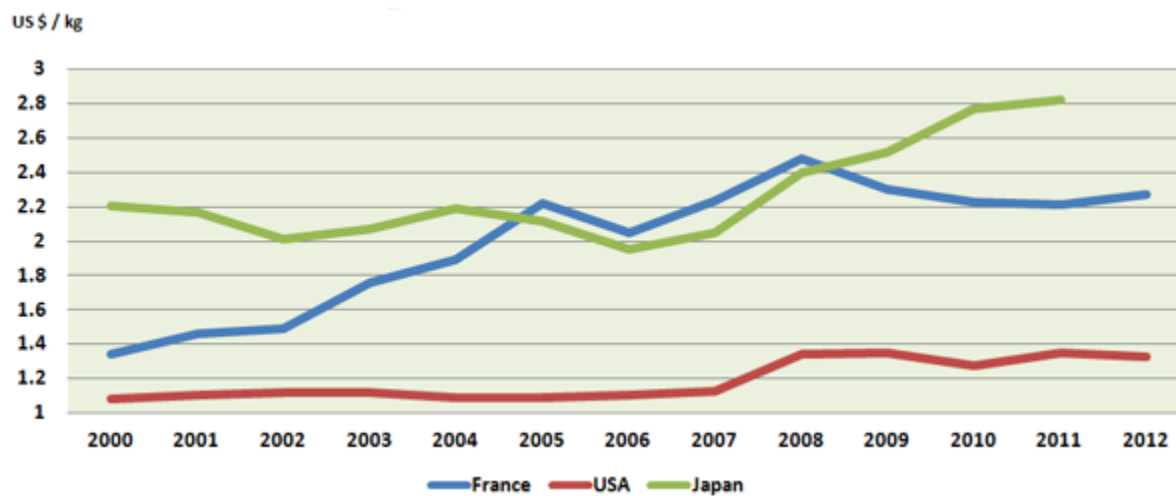
**BANANA- WORLD IMPORT PRICES:**



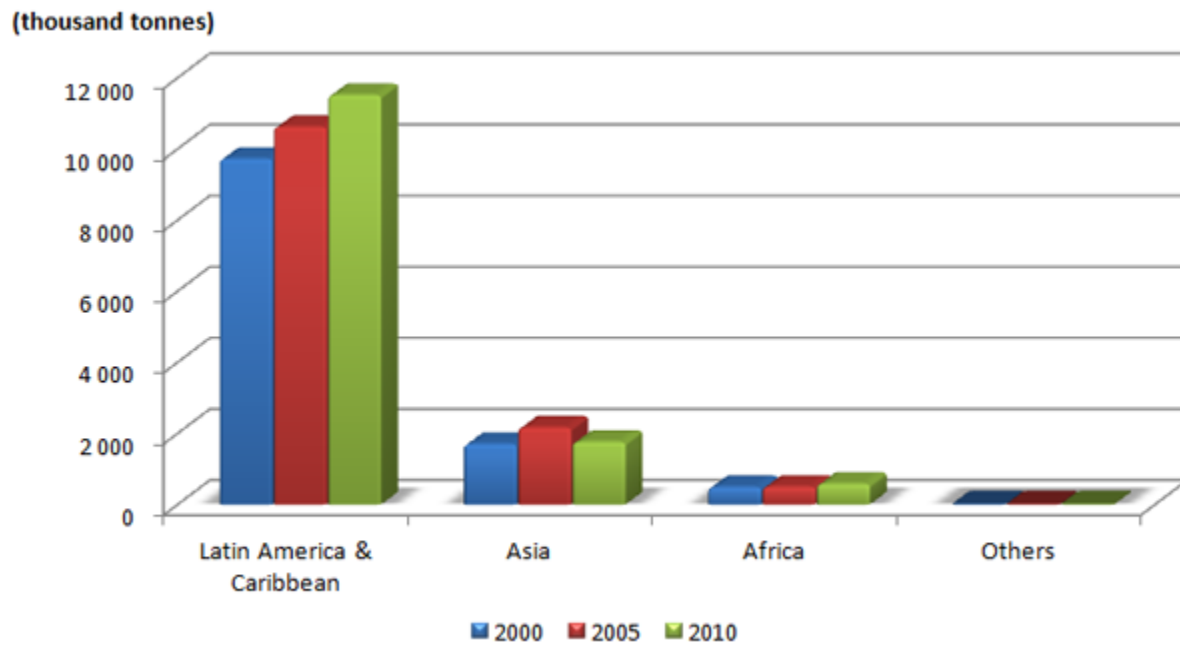
## BANANA WHOLESALERS PRICES:



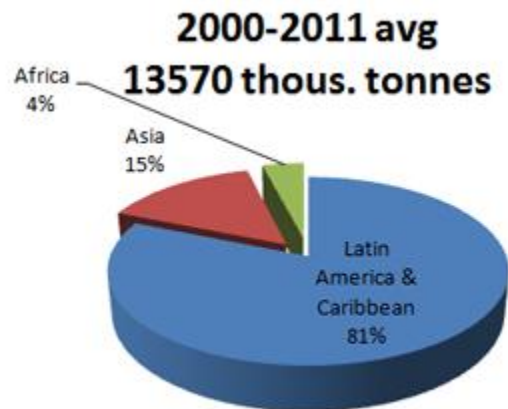
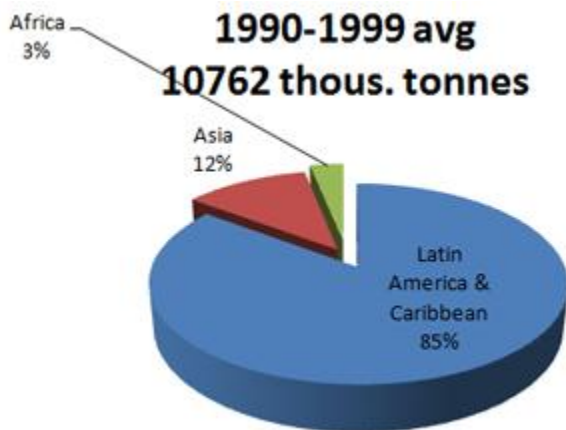
## BANANA RESALES PRICES:



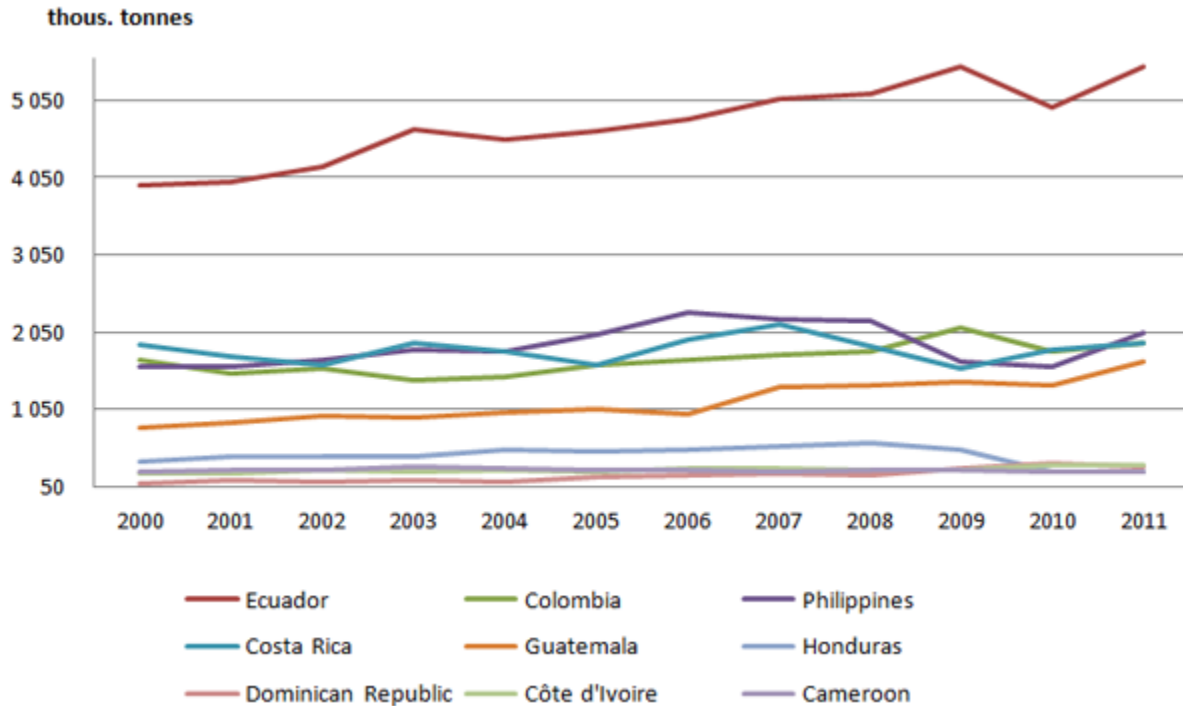
**BANANA EXPORTS (WORLD STATISTIC):**



**BANANA EXPORTS BY REGION:**



## BANANA EXPORTS-MAJOR COUNTRIES:



## SHARE OF COUNTRIES IN WORLD EXPORT OF BANANA IN % :

RANK #	COUNTRY NAME	SHARE IN EXPORT %
1	ECUADOR	30.5
2	COSTA RICA	18
3	COLOMBIA	17.9
4	PHILIPPINES	7.7
5	PANAMA	5.9
6	ITALY	5.3
7	UNITED STATES	5.1
8	FRANCE	4.8
9	GUATEMALA	4.7

Nationmaster

**VALUE OF BANANA EXPORTED IN US \$ (MILLIONS)  
STATISTIC:**

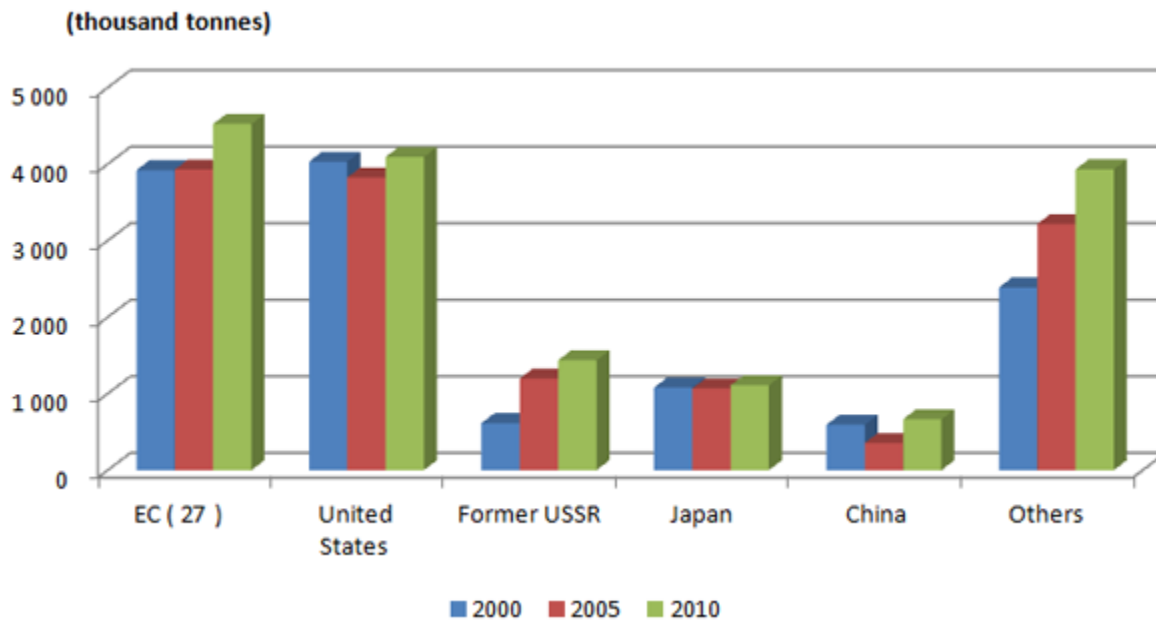
RANK #	COUNTRY NAME	AMOUNT \$ (MILLION)
1	ECUADOR	954.00
2	COSTA RICA	564.00
3	COLOMBIA	560.00
4	PHILIPPINES	241.00
5	PANAMA	184.00
6	ITALY	165.00
7	UNITED STATES	161.00
8	FRANCE	151.00
9	GUATEMALA	147.00

Nationmaster

**TOTAL AMOUNT: \$ 3,127.00 MILLION**

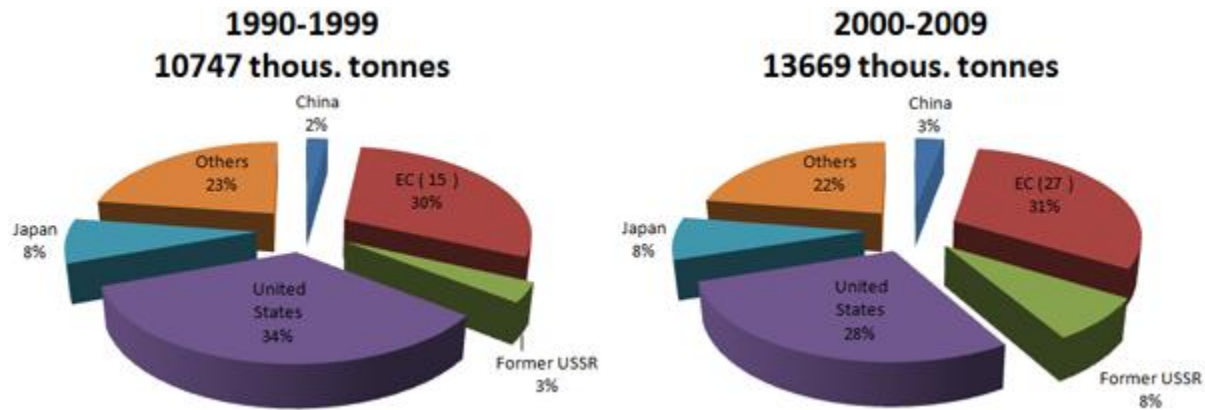
**WEIGHTED AVERAGE: \$ 347.44 MILLION**

**BANANA IMPORTS (WORLD STATISTIC):**

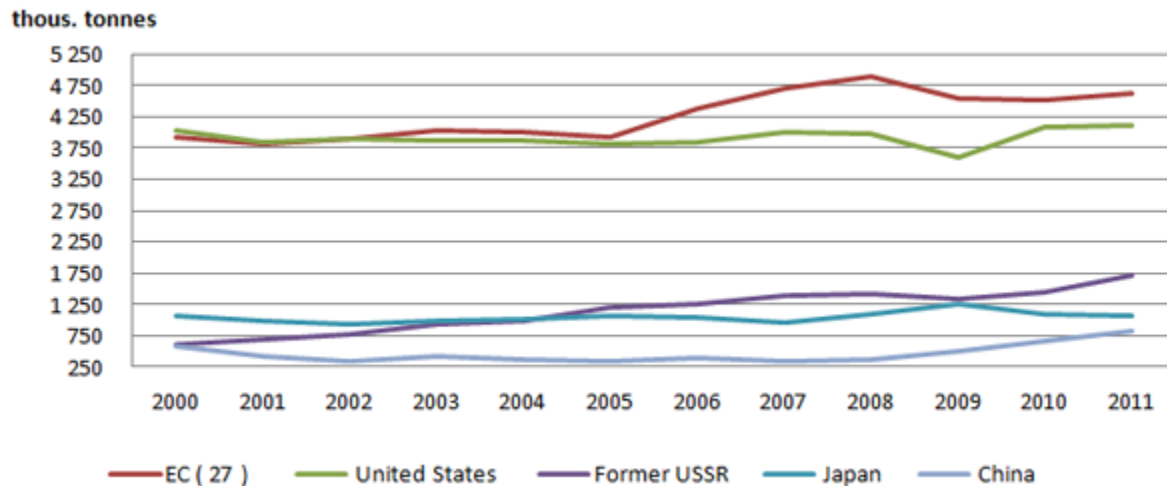




**BANANA IMPORTS BY REGION:**



**BANANA IMPORTS MAJOR COUNTRIES:**



**SHARE OF COUNTRIES IN WORLD IMPORTS OF BANANA IN %:**

RANK #	COUNTRY NAME	SHARE IN %
1	UNITES STATES	33.4
2	GERMANY	16.6
3	JAPAN	13.2
4	UNITED KINGDOM	12.8
5	ITALY	8.3
6	FRANCE	4.8
7	SWEDAN	3.7

8	RUSSIA	3.6
9	CANADA	3.6

Nationmaster

## VALUE OF BANANA IMPORTED IN US \$ (MILLIONS) STATISTIC:

RANK #	COUNTRY NAME	AMOUNT \$ (MILLION)
1	UNITES STATES	1,389.00
2	GERMANY	689.00
3	JAPAN	548.00
4	UNITED KINGDOM	534.00
5	ITALY	346.00
6	FRANCE	201.00
7	SWEDAN	152.00
8	RUSSIA	151.00
9	CANADA	149.00

Nationmater

**TOTAL AMOUNT: \$ 4,159.00MILLION**

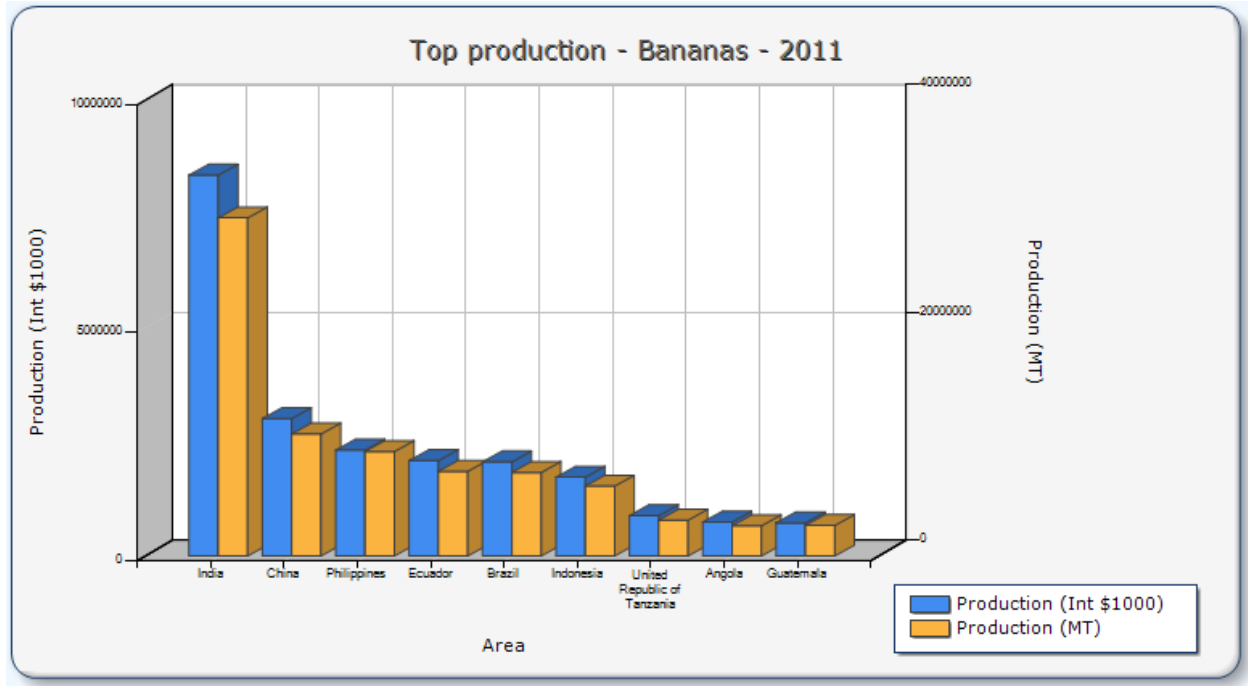
**WEIGHTED AVERAGE: \$ 462.11MILLION**

## TOP TEN COUNTRIES OF WORLD IN PRODUCTION AND THEIR SHARE IN % IN WORLD PRODUCTION OF BANANA:

RANK #	COUNTRY NAME	PRORUCTION IN METRIC TONNES	SHARE IN %
1	INDIA	11,000,000	19.9
2	BRAZIL	6,339,350	11.5
3	ECUADOR	5,000,000	9.1
4	CHINA	4,812,530	8.7
5	PHILIPPINES	3,560,800	6.4
6	INDONESIA	3,165,730	5.7
7	COSTA RICA	2,101,450	3.8
8	MEXICO	1,802,280	3.3
9	THAILAND	1,720,000	3.1
10	COLOMBIA	1,570,000	2.8

Naionmaster

## BANANA PRODUCTION -2011 (WORLD STATISTIC)



## NUTRITIONAL PROFILE OF BANANA:

SERVING SIZE: 100 gm

MATURITY STAGE: RIPE



QUANTITY: SINGLE BANANA

### CALORIC CONTENT

Nutrient	Values per 100 gms. of edible portion	Content as compared to other fruits
Calories	116	Caloric dense
Protein (g)	1.2	Average
Fat (g)	0.3	Low
Dietary fibre (g)*	2.6	Rich
Carbohydrates (g)	27.2	Rich

### MINERAL CONTENT

Nutrient	Values per 100 gms. of edible portion	Content as compared to other fruits
Calcium (mg)	17	Average

Phosphorous (mg)	36	Rich
Iron (mg)	0.36	Low
Magnesium (mg)	41	Rich
Sodium (mg)	36.6	Average
Potassium (mg)	88	Rich
Zinc (mg)	0.15	Average

### VITAMIN CONTENT

Nutrient	Values per 100 gms. of edible portion	Content as compared to other fruits
Carotene (mcg)	78	Average
Vitamin C (mg)	7	Low
Vitamin B6(mg)*	0.8	Rich

note: figures may vary due to climacteric conditions, or agronomic practices, pre and post harvest management.

### **BENEFITS OF BANANA PULP AND BANANA PEEL:**

So often, the humble banana is often overlooked when it comes to providing nutritional and medicinal value. Bananas in fact have a lot to offer us, both nutritionally, as well as in relieving the symptoms of a myriad of physical complaints. The peels serve a few useful purposes as well.

- **BANANA PEEL AS FERTILIZER:**

Banana Peel makes an amazing fertilizer in the garden, especially for roses. Simply bury a few peels near the plant or bush, and they will normally cause the roses to thrive.

- **BANANA PEEL AS COSMETIC AGENT:**

Peels also act as cosmetic agent for humans Pimples is able to be dried out naturally by rubbing the inside of the banana peel on the affected spot on the skin.

### **BENEFITS OF BANANA FOR HEALTH:**

Bananas can be eaten whole, as a part of a salad, as a healthy beverage or as an ingredient of a



vegetable. It is a fruit made by ALLAH for one and all and for every age group and it has lot of benefits for health.

- **BANANA AS A SOURCE OF INSTANT ENERGY:**

Banana pulp is composed of soft, easily digestible flesh with simple sugars like fructose and sucrose that when eaten replenishes energy and revitalizes the body instantly; thus, for these qualities, bananas are being used by athletes to get instant energy and as supplement food in the treatment plan for underweight children.

- **BANANA IS A SOURCE OF VITAMIN B6:**

It is also a very good source of **vitamin-B6** (pyridoxine), provides about 28% of daily-recommended allowance. Pyridoxine is an important B-complex vitamin that has a beneficial role for the treatment of neuritis, and anemia. Further, it helps decrease homocystine (one of the causative factors in coronary artery disease (CHD) and stroke episodes) levels within the body.

The vitamin B6 in bananas helps protect against sleeplessness, mood swings and irritability.

- **BANANA IS A SOURCE OF VITAMIN C:**

The fruit is an also moderate source of **vitamin-C** (about 7 mg per 100g). Consumption of foods rich in vitamin-C helps the body develop resistance against infectious agents and scavenge harmful oxygen-free radicals.

- **BANANA IS A SOURCE OF COPPER:**

Banana provides adequate level of copper, which is required for the production of red blood cell. Hence, Good source to reduce anemia.

- **BANANA IS A SOURCE OF POTASSIUM:**

Fresh banana is a very rich source of potassium. 100 g fruit provides 88 mg potassium. Potassium is an important component of cell and body fluids that helps control heart rate and blood pressure, countering bad effects of sodium. Potassium also promotes bone health.

Conditions like diarrhea can easily dehydrate the body and deplete the electrolytes. Consumption of banana helps to restore the lost potassium and helps maintain heart function.

Banana help **counteract the urinary calcium loss** caused due to increase ion potassium levels in the urine.

Another benefit to bananas high potassium content derives from that mineral's role as an energy-supplying electrolyte. Since bananas also contain tryptophan, serotonin and norepinephrine, banana helps to prevent depression while encouraging feelings of well-being and relaxation.

- **BANANA IS A SOURCE OF MAGNASSIUM AND MAGNESIUM:**

Fresh bananas provide adequate levels of minerals like magnesium, and manganese. Magnesium is essential for bone strengthening and has a cardiac-protective role as well. Manganese is used by the body as a co-factor for the antioxidant enzyme, superoxide dismutase.

- **BANANA IS A SOURCE OF SOLUBLE DIETARY FIBRES:**

The fruit contains a good amount of soluble dietary fiber (7% of DRA per 100 g) that helps normal bowel movements; there by reducing constipation problems.

- **BANANA IS A SOURCE OF HIGH CALORIES:**

Banana fruit is one of the high calorie tropical fruits. 100 g of fruit provides 90 calories. Besides, it contains good amounts of health benefiting anti-oxidants, minerals, and vitamins.

- **BANANA IS A SOURCE OF FRUCTOOLIGOSACCHARIDES:**

They are a rich source of **fructooligosaccharides which act as a pre biotic** and stimulate the growth of friendly bacteria in the intestine. They protect us from harmful bacteria that cause gastric disturbances. Fructooligosaccharides also produce digestive enzymes which improve the ability to absorb nutrients.

- **BANANA IS A SOUCRE OF CAROTENOIDS:**

They are a good source of **carotenoids which are antioxidants** and have a protective effect against chronic disease condition. They also have a high content of antioxidant phenolic compounds.

- **BANANA IS A SOURCE OF SHORT CHAIN FATTY ACID:**

Bananas are good source of short chain fatty acids which are essentially needed by the cells lining the intestinal tract to stay healthy. This further improves the nutrient absorption.

- **BANANA IS A SOURCE OF PROTECTION AGAINST STOMUCH ULCER:**

Bananas have an **antacid effect** and are said to protect against stomach ulcers. They contain a compound called as protease inhibitor which protects the stomach from unfriendly bacteria which cause stomach or gastrointestinal disturbances.

- **BANANA IS A SOURCE OF GOOD VISION:**

Bananas, combined with the African herb orinol, have been used to treat cataracts in Nigeria. They also share with other fruits the ability to prevent macular degeneration, the leading cause of vision loss in adults. According to a study published in the Archives of Ophthalmology in 2004, people who eat 3 servings of fruit per day are statistically unlikely to develop the vision-diminishing disease

- **BANANA IS A GOOD SOURCE OF PERFECT BABY FOOD:**

Since BANANA are easily digested, bananas are a perfect food for babies just beginning to move to solid foods.

- **BANANA IS A SOURCE OF PROTECTION OF HIV :**

The Journal of Biological Chemistry in March 2010 published a study which revealed the healing potential of BanLec, a lectin protein in bananas. Researchers found that this protein which binds to sugars can also bind to HIV-infected cells, enveloping them and preventing their replication and transmission.

## **SAFETY PROFILE REGARDING BANANA:**

ALMIGHTY ALLAH has blessed banana with lot of benefits, but there few harmful effect of banana..

Banana fruits are sometimes known to cause skin and systemic allergic reactions. In "oral allergy syndrome" which causes itching and swelling around the mouth or throat within hours after ingestion and is related to birch tree and other pollen allergies.

The other type of reaction is related to latex allergies and causes urticaria and potentially serious gastrointestinal symptoms like nausea, vomiting, and diarrhea. (Medical disclaimer)

Sugar patient should consult with doctor before taking banana .As banana is rich in carbohydrates.

(NOTE: ALL THE INFORMATION IN THIS REPORT IS USED FOR EDUCATIONAL PURPOSE)

## A GUIDE FOR BETTER UNDERSTANDING OF REPORT:

- **POST HARVEST MANAGEMENT:**

In agriculture, post harvest handling or post harvest management is the stage in crop agronomy which starts immediately after harvesting. It includes cooling, cleaning, sorting, grading and packaging. As soon as crop is removed from ground or separated from mother plant, it begins deteriorate. Post harvest treatments determine final quality whether a crop is sold for fresh consumption or used as an ingredient for in a processed food.

- **PRESERVATION:**

It is the Process of protecting fruits or vegetables from damage or decay. It is done in order to extent shelf life of products.

- **PROCESSING:**

It is the process to treat the produce in a way that will make it keep longer and more palatable.

- **PHATHOLOGICAL DISORDERS:**

These are the disorders caused by micro –organisms such as virus, bacteria etc.

- **PHYSICAL DISORDERS:**

These are disorders caused by mechanical damages because of poor harvesting and transportation practices or careless handling of crops after harvesting or during harvesting.

- **PHYSIOLOGICAL DISORDERS:**

Physiological disorders are caused by poor light, sudden change in weather or deficiency of nutrients. Physiological disorders are different from plant disease caused by micro- organisms .In physiological disorders function of plant or fruit is disturbed,

- **MATURITY:**

When the commodity (fruit or vegetable) possess all specific characters as its own natural classification and ready for consumption is called maturity.

- **RIPENING:**

It is specific stage for many fruits and vegetables which turns the commodity for table consumption.

- **CONTROLLED ATMOSPHERE:**

The conditions in which concentration of oxygen and carbon dioxide are regulated and monitored, e.g. in order to improve the storage of fruits and vegetables.

- **RELATIVE HUMIDITY:**

The relative humidity is a measure of a water vapor in an air (at a specific temperature) compared to the maximum amount of water vapor air could hold at that temperature,

It is given as percentage value.

- **ETHYLENE:**

It is a hydrocarbon occurring in natural gas and ripening fruit.

**PRODUCT STABILTY:**

It is the state of the product being stable and not change.

**SPOILAGE:**

It is the process of food becoming inedible , specially because of poor storage conditions.

**IRRIGATION:**

The artificial supplying and application of water to land with growing crops.

**FERTILIZER:**

A chemical or natural substance spread and mixed with soil to stimulate plant growth.

**ORGANIC PRODUCTION:**

A method of farming/ crop production which doesn't involve the use of artificial fertilizers or pesticides.

**SHELF LIFE:**

The number of days or weeks for which a product can stay on the shelf of a shop and still be good to use.

**DRYING / DEHYDRATION:**

It is the process of removing water from something inorder to preserve it.

**STOWAGE FACTOR:**

The stowage factor of a cargo is the ratio of weight to stowage space required under normal conditions. It indicates how many cubic meters one metric ton of a particular type of cargo occupies in a hold, taking account of unavoidable stowage losses in the means of transport or the CTU (Cargo Transport Unit).

**PESTICIDE RESIDUE:**

The amount of a pesticide that remains in the enviroment after application in the field.

**RATOON CROP:**

The second and later crop taken from the regrowth of a crop after it has been harvested.

(note : all the information in this report is used for educational purposes only)





## REFERENCES:

- <http://un.org.pk/unido/cdp-pdf/Diagnostic%20Study%20Report%20Of%20Banana%20Cluster%201.pdf>
- [http://www.naturalnews.com/034151\\_bananas\\_nutrition\\_facts.html](http://www.naturalnews.com/034151_bananas_nutrition_facts.html)
- <http://www.nutrition-and-you.com/banana-fruit.html>
- <http://www.medindia.net/patients/lifestyleandwellness/health-benefits-of-bananas.htm>
- <http://www.celkai.in/Crops/Fruits/Banana/processing.aspx>
- <http://postharvest.ucdavis.edu/PFfruits/Banana/>
- [http://www.academia.edu/1000022/Banana\\_Post\\_Harvest\\_Practices\\_Current\\_Status\\_and\\_Future\\_Prospects-A\\_Review](http://www.academia.edu/1000022/Banana_Post_Harvest_Practices_Current_Status_and_Future_Prospects-A_Review)
- [http://www.fao.org/inpho\\_archive/content/documents/vlibrary/ae615e/ae615e031.htm](http://www.fao.org/inpho_archive/content/documents/vlibrary/ae615e/ae615e031.htm)
- <http://www.howtodothings.com/home-and-garden/a3071-how-to-harvest-bananas.html>
- <http://nhb.gov.in/fruits/banana/ban004.pdf>
- [http://www.naturalnews.com/031308\\_bananas\\_health\\_benefits.html](http://www.naturalnews.com/031308_bananas_health_benefits.html)
- [http://www.slideshare.net/JituRajpurohit/value-added-product?utm\\_source=slideshow03&utm\\_medium=ssemail&utm\\_campaign=share\\_slideshow\\_loggedout](http://www.slideshare.net/JituRajpurohit/value-added-product?utm_source=slideshow03&utm_medium=ssemail&utm_campaign=share_slideshow_loggedout)
- <http://www.unece.org/fileadmin/DAM/trade/agr/meetings/ge.01/document/Codex%20bananas%20E.pdf>
- <http://www.fao.org/economic/est/est-commodities/bananas/en/>
- [http://www.tis-gdv.de/tis\\_e/ware/obst/banane/banane.htm](http://www.tis-gdv.de/tis_e/ware/obst/banane/banane.htm)
- <http://www.iita.org/banana-and-plaintain>
- <http://nhb.gov.in/fruits/banana/ban009.pdf>
- <http://archives.dawn.com/2002/01/21/abr13.htm>
- <http://archives.dawn.com/weekly/science/archive/030426/science6.htm>
- <http://www.thenews.com.pk/Todays-News-3-107048-Banana-prices-go-up-as-supply-declines>
- [http://www.fao.org/nr/water/cropinfo\\_banana.html](http://www.fao.org/nr/water/cropinfo_banana.html)
- [http://www.nationmaster.com/graph/agr\\_ban\\_imp-agriculture-banana-imports](http://www.nationmaster.com/graph/agr_ban_imp-agriculture-banana-imports)
- [http://www.nationmaster.com/graph/agr\\_ban\\_exp-agriculture-banana-exports](http://www.nationmaster.com/graph/agr_ban_exp-agriculture-banana-exports)
- <http://postharvest.ucdavis.edu/PFfruits/BananaPhotos/>
- <http://www.slideshare.net/sathes32/tissue-culture-techniques-of-banana>
- <http://sedf.gos.pk/pdf/sectors/banana/An%20overview%20of%20banana%20production%20Sindh..pdf>





