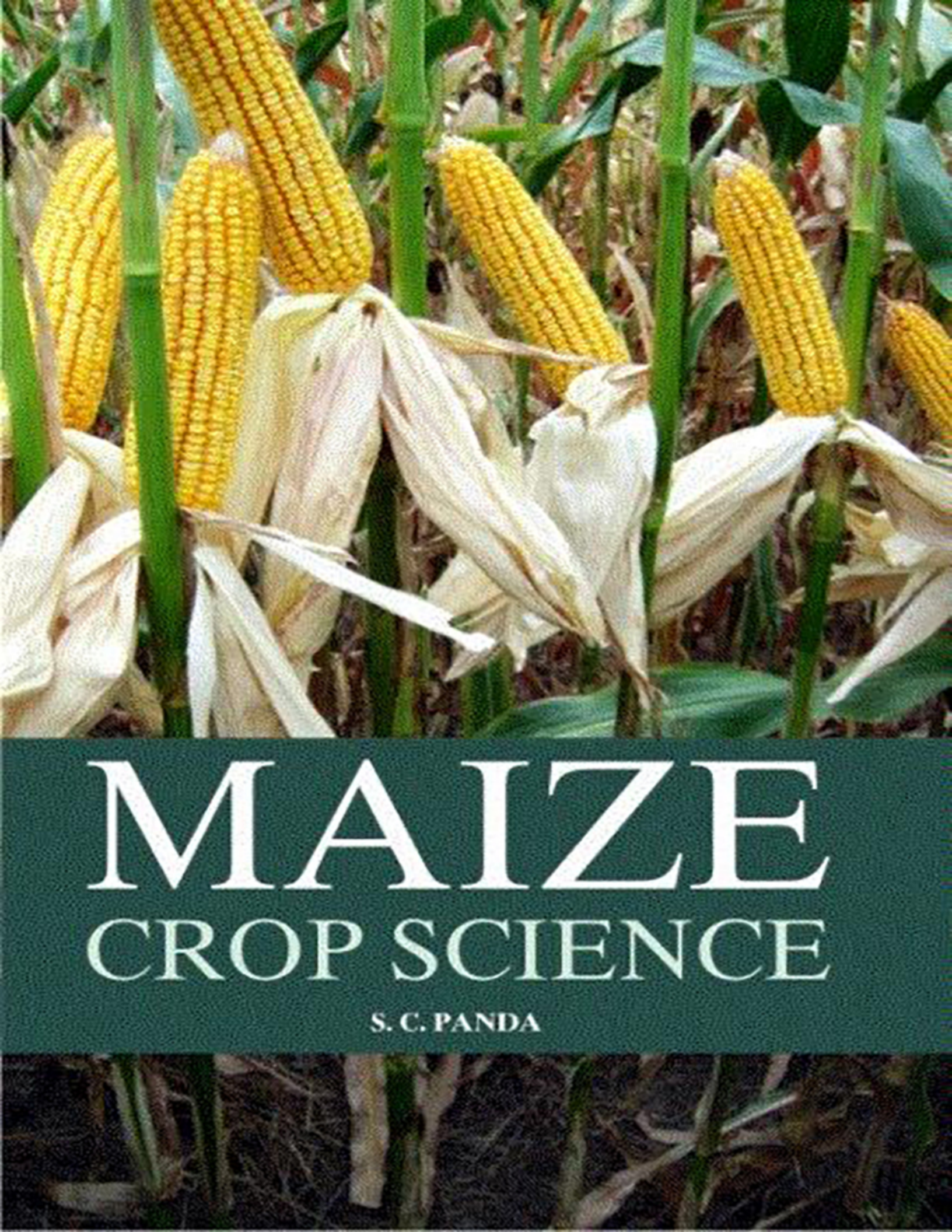

MAIZE
CROP SCIENCE

S. C. PANDA

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CROP SCIENCE

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AT THE FEET OF
LORD SHREE JAGANNATH
PURI, ORISSA

DEDICATED TO MY FATHER
SHYAM SUNDAR PANDA
AND
MOTHER, SHNEHALATA PANDA

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FOREWORD

"Success is the ability to go from failure to failure without losing your enthusiasm"

Maize is one of the world's leading crops cultivated over an area of about 136.4 million hectares with a production of about 602.6 million tonnes of grain (2002). Among the maize growing countries, USA has the highest area followed by Brazil, China, Mexico and India. In respect of production also USA stands first followed by china. In regard to average yield per hectare in India is only 1705 kg which is much lower than most of the maize growing countries of the world.

In India, it is grown over an area of 6.56 million hectares with total production of about 12.07 million tonnes. Uttar Pradesh, Bihar, Rajasthan, Madhya Pradesh and Punjab are the leading states growing maize on large scale.

Maize is the world's third most cereal crop after wheat and rice. With average yield around 4.1 t/ha, maize ranks first among cereals and followed by rice, wheat and millets with average yields around 3.7, 2.5 and 1.2 t/ha, respectively. Due to high productivity, maize is called as the **'Queen of Cereals'**. Maize is grown primarily for grain, secondarily for fodder, raw material for industrial process and diversified products.

Maize has varied industrial uses. Maize is also known as corn. The maize based industrial products are corn oil, starch and alcohol etc.

Corn Oil: It is commercially produce from corn germ isolated by wet milling or dry milling. Concentration of oil in the kernel varies from 2 to 21%. Crude corn oil is composed of 95% triglycerides. Minor compounds present in crude oil are removed by refining. The flavour of corn oil is stable during storage and cooking due to presence of antioxidants and vitamin E.

Corn Starch: Industrial corn starch contains 0.25 to 0.30% proteins, less than 1.0% minerals and 0.65% fat. It is useful in many industrial applications.

Alcohol: Fermentation industry is dependent on corn. Corn is the major carbohydrate source for distilled liquors like spirits, corn whisky and beer etc.

Apart from this, maize has varied specially uses such as pop corn, sweet corn, high amylase corn, baby corn, corn cob, quality protein maize (QPM) etc. Maize occupies a significant position in our diet as corn flour and corn flake too.

Maize grain is used as food and feed, maize stalk is used as fodder and even the same plant after harvest of green cobs is used as fodder. Maize plant is a wonderful creation of God because it can be used at any stage of crop growth i.e., early stage as succulent green fodder, very early cob stage as baby corn, little later stage as green cob, and at fully matured stage as maize grain. So, it is called as a **'Contingent Crop'**.

Although agriculture is intimately related to weather, not many integrated academic studies on the subject have been made till today. The blame may be placed on the traditional system of education, in which agriculture and the science of weather remained self-contained disciplines. Agricultural scientists have been aware of the effects of weather on the various aspects of agriculture, but they did little to understand and highlight these effects. In fact, agricultural scientists focused their whole attention on the tapping of soil resource and cared little to understand climate even as a resource in agriculture. They have been of the view that the studies on the crop-weather relationship are of little practical value as compared with the knowledge of soil potentials. Scientists in meteorology on the other hand, concentrated their attention on the measurement of atmosphere and on giving mathematical expressions to the various phenomena occurring in the atmosphere. They did little to bring out the importance and usefulness of their findings to agriculture.

Students of agricultural science play the important role in the department of agriculture as agriculture is the backbone of our country**.** The need for comprehensive information on the maize production, its origin and distribution, crop botany, physiology and ecology, agronomy, plant protection, its economic importance and industrial use, staple food for increasing population, feed and fodder for the animals for sustainable crop production relevant to Indian conditions has been felt for quite some time. The text-cum-reference book to meet precisely the felt need is an outcome of the author's active involvement in teaching, research and extension guidance in the field of agronomy for over thirty years.

The author presented the book entitled, **"Maize Crop Science"** in a scientific and systematic manner to understand the fundamentals clearly and easily which is the beauty of this book. Potential yield can only be achieved under ideal management in an optimal physical, chemical and biological environment.

Concern about environmental safety and sustainability of land productivity is increasing among scientists, administrators and environmentalists. With the increasing population, it is also becoming clear that food security to the teeming millions will not be possible unless the available resources are efficiently utilized for increasing the productivity.

It is important for the teachers to process the mass of information and make it available to the students in an early understandable manner. The information provided should not only be simple to understand but also to comprehend in an integrated manner. The book is intended to introduce the students of various disciplines to the subject of Agro-techniques for maize production as Maize Crop Science and to make them realize the importance of weather conditions in agriculture.

I am confident that this book will serve as a text book for Agronomy, Agricultural Sciences, Agriculture Engineering, Soil Science and Veterinary students, a reference for research scientists and teachers in the areas of the maize crop production, cropping systems, production technology management under different situations, soil fertility management, and its economic importance. This book will also serve as a guide to the extension officials of the department of agriculture. I congratulate Dr. S. C. Panda for his pains taking effort in bringing out this book covering the latest technologies for maize crop production associated with integrated enterprises in farming systems to meet the growing interest in sustainable agriculture. I am confident that this book will be widely accepted among the students. I extend my best wishes to Dr. Sharat Chandra Panda for the success of this book.

Bhubaneswar
Date 23.04.2009 **Dr. Bhagabat Panda**

PREFACE

"Butterfly keeps flying from one flower to another in search of nectar without losing enthusiasm. Similarly one should never lose enthusiasm as it is the only force, which drives people to perform at their best and allows them to achieve the worthiest of causes"

Maize is the world's third most cereal crop after wheat and rice. Among the cereals, the productivity of maize is the highest (4.1 t/ha) as compared to rice (3.7 t/ha) and wheat (2.5 t/ha). Corn is produced largely in the western hemisphere and Europe. It is the most important grain crop in the United States. About 40% of world maize production is from the United States followed by China. About 58% of the world maize production is in the developed countries with the U.S.A. as the major producer and exporter while about 22% developing countries. Other corn producing countries are China, Brazil, Mexico, Russia, India, Indonesia and Philippines. Due to high productivity, maize is called as the **'Queen of Cereals'**. Maize is grown primarily for grain, secondarily for fodder, raw material for industrial process and diversified products.

Apart from this, maize has varied specially uses such as pop corn, sweet corn, high amylase corn, baby corn, corn cob, quality protein maize (QPM) etc. Maize occupies a significant position in our diet as corn flour and corn flake too. Maize grain is used as food and feed, maize stalk is used as fodder and even the same plant after harvest of green cobs is used as fodder.

Maize plant is a wonderful creation of God because it can be used at any stage of crop growth i.e., early stage as succulent green fodder, very early cob stage as baby corn, little later stage as green cob, and at fully matured stage as maize grain. So, it is called as a **'Contingent Crop'.**

The grain crop of maize is harvested when cob sheath turns brownish, grains become hard and they do not contain more than 20 per cent moisture in them. There are two methods of maize harvesting viz., plucking of cobs and

stalk cutting. The left over plants are used for **hay**, the sheath is used for **fuel**, and cobs after grains are separated out are used as **fuel**.

Maize grown for fodder are harvested at the milk to early dough stage, the earlier harvested crop usually yields less and is poor in protein content. For **silage** making late dough is preferred.

Grain yields vary according to variety, place of cultivation and inputs used. Normally in case of local varieties of low fertility a yield of one or two tones per hectare is observed while hybrid/open pollinated /composite varieties grown in Indo-Gangetic plain have yielded about four tones/ha and the same varieties in Peninsular India around 5-7 tonnes/ha.

Maize crop furnishes huge quantities of green fodder for cattle. Several industries like starch, milling etc., are based on maize products and byproducts. In addition to big industries, several cottage industries are also flourishing on the byproducts of maize.

Maize is called as **'Queen of cereals', 'Contingent crop'** and **'an Emerging Industrial Crop'**. The importance of this crop is much more than other crops.

Maize is ideally suited to intercropping with legumes such as green gram, black gram, gram, arhar, soybean, cowpea, groundnut etc. Legumes improve soil fertility on account of improved organic carbon (matter) in soil. Legume crops leave a substantial amount of residual N which may vary from 30 kg to 60 kg N/ha in the case of gain legumes and 90 kg to 120 kg in the case of forage legumes such as berseem or alfalfa (Lal et al., 1978; Sharma et al., 1987).

Development of suitable crops and cropping systems harmonizing growth rhythm with water availability has been the major thrust in dry land research. Cropping systems are planned on the **availability soil, climate and water resources** and taking into account farmers' preference so as to obtain the maximum production or worth of the produce per unit land and water resources.

In India, at present, about 35% of the maize produced in the country is used for human consumption, 25% each in poultry feed and cattle feed and 15% in food processing (corn flakes, popcorns, etc.) and other industries (mainly starch, dextrose, corn syrup, corn oil etc.). According to some experts, India may have to produce 20 million tonnes of maize to meet its requirement for human consumption, piggery, pharma industry and fodder by 2020 (Singal, 1999).

Maize can be grown in all three seasons of the year, in hill slopes and degraded soils, conserves soil and water. Grains can be stored for a pretty long

period and rich source of nutrients and add to nutritional security of poor people. Maize has also ready marketability.

Maximum care should be taken for cultivation of maize extensively and intensively for providing food for human feed and fodder for animals, important raw material for poultry industry and raw material for industrial process and diversified products. Maize will solve the food crisis of India if we take seriously of its cultivation scientifically, intensively and extensively.

In India, the maize is milled largely by dry milling process, both for producing the flour and livestock and poultry feed industry (the stone ground or non-degerming process).

Fermentation and Distilling: Various alcoholic beverages and industrial products are produced by maize distilling and fermentation industries**. Malt** converts maize starch to sugar, which is fermented by yeast to ethyl alcohol and CO_2. The by-products that remain including oil, vitamin and protein concentrates and grain-germ mixtures are used as livestock feed.

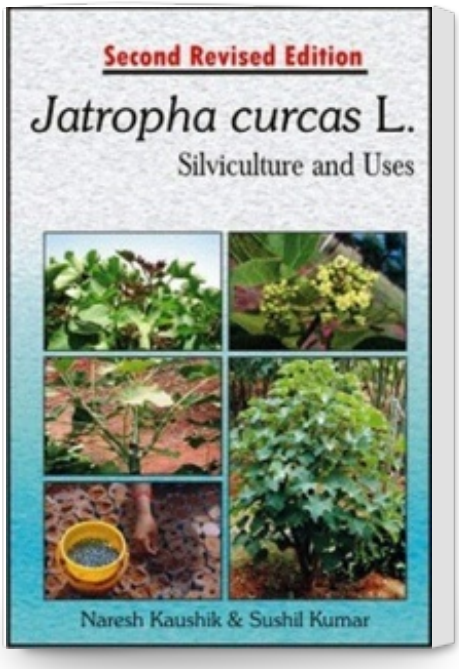
Maize is increasingly being used as the carbohydrate source **in beer making**, either as a dry adjunct (mainly dry milled maize flakes, grits) or as a liquid adjunct (mainly maize syrups and dextrose). Maize is also used **to manufacture whiskey and vodka**. The ferment ability of maize starches and sweeteners has also made maize as important feedstock for ethanol (ethyl alcohol). **Ethanol** is being used both as a complete fuel substitute in **gasoline engines** or in a mixture of 10% ethanol and 90% gasoline, called **gasohol.**

Composite Flours: Use of maize flour to supplement wheat flour for making bread and biscuits is quite an-age-old practice. Milling and baking researches have shown that it is technically feasible to substitute flours of crops like maize, sorghum, millet or cassava for wheat flour to a limited extent.

Industrial use of maize in India is limited and there exists great scope in context of large textile and paper industry; as feed stock for liquor, beer, whiskey and industrial alcohol; as sweetener and bakery, pharmaceutical and germ oil industry, besides as the base-source material for supplement staple food for human consumption, livestock, dairy and poultry feed and breakfast industry. Maize is, therefore, sure to occupy the pivotal position as an alternate crop to rice and wheat in the new millennium.

Corn Flakes: Corn flakes are one of the best vegetarian sources of iron (25% RDA) and vitamin C (50% RDA). Iron is important for physical mental well-being of the family. This is because – mental performance depends on adequate iron at every stages of life for all members of the family.

Maize Crop Science



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